MODERNISING SCIENTIFIC CAREERS

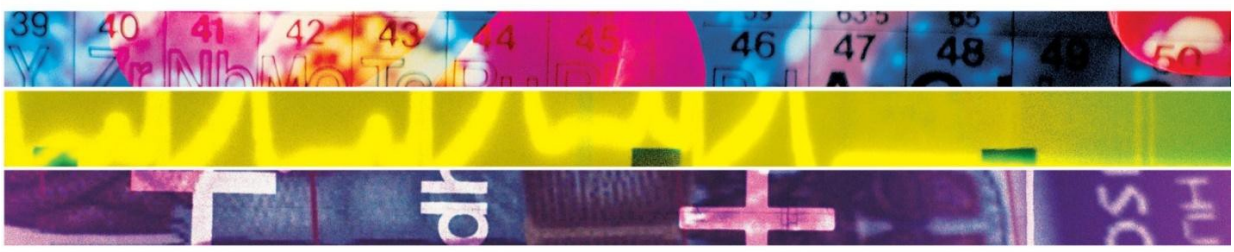
Higher Specialist Scientist Training Programme

Curriculum

CARDIAC SCIENCE

2015/16

Modernising Scientific Careers



Science in healthcare DRIVING A MODERN NHS

Contents

ACKNOWLEDGEMENT

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SECTION 1: INTRODUCTION TO THE PROGRAMME

1.1 The Role of the Consultant Clinical Scientist in Cardiac Science

Context

Diseases of the cardiovascular system are the main cause of death in the UK. The prevalence of risk factors such as diabetes and obesity are placing a significant burden on the NHS and costing the UK economy over £6.7 billion a year. Improvements in diagnosis and treatments has given rise to significant growth in paediatric and adult congenital heart disease over recent years and this is expected to continue due to improved patient survival with children surviving into adulthood. As congenital heart disease is a lifelong condition these older patients continue to require care. Patients deserve and will expect the highest quality of healthcare delivered by experts. Consultant Clinical Scientists in Cardiac Science will be responsible for advanced expertise in the analysis, interpretation and reporting of high-quality cardiac investigations to inform treatment decisions. Further, it is anticipated that through a programme of Higher Specialist Scientist Training (HSST) reflecting the standards of training undertaken by doctors to train as consultants, some clinical scientists will bring high-level scientific and clinical leadership as Consultant Clinical Scientists. They will challenge the evidence of existing practice; innovate and introduce new investigations and new medical devices; and build the evidence for change through ethical and appropriate clinical research to influence practice in the workplace and nationally. It is envisaged that the Consultant Cardiac Scientist role will complement that of established medical consultant roles to enhance the overall provision of cardiac diagnostic and therapeutic services.

Scientific Services and Clinical Care

Consultant Clinical Scientists in Cardiac Science will be the national experts in their service. They will develop national guidelines and consensus documents and determine the strategic development of the specialty of Cardiac Science within the UK. In their workplaces they will be pivotal members of multidisciplinary teams of experts working in collaboration to optimise patient care. They will provide an expert scientific opinion in meetings and discussions relating to the most complex and challenging cases. Relying on up-to-date knowledge of the scientific literature and a comprehensive understanding of the range of procedures and techniques available they will recommend patient diagnostic pathways and evaluate the validity of results and diagnostic reports. The Consultant Clinical Scientist in Cardiac Science will focus on the diagnostic outcome of the patient. They will be a forceful advocate for the patient in issues related to appropriateness, safety, quality and performance of investigations. They will challenge and educate other professionals to ensure that all patients investigated within their department experience the highest possible standards of care and achieve the best outcomes.

Leadership and Management

Consultant Clinical Scientists in Cardiac Science will be dynamic leaders of their services. Their professional conduct will be a model for other members of the scientific workforce to emulate and will promote communication and collaboration with other health professionals. They will give their department strategic direction, ensuring that this is compatible with the overall direction of their employer; they will have both the knowledge and authority to develop their service. They will be practiced in influencing and managing other colleagues so that excellent science remains at the forefront of clinical practice.

Research, Innovation and Education

Consultant Clinical Scientists in Cardiac Science will be clinical leaders with the scientific and research skills to question their own clinical practice, as well as the breadth of cross-disciplinary technical skills to innovate and to effect change. They will be able to critically evaluate the benefits and opportunities offered by new scientific discoveries and technological advances, contextualising them to the clinical arena and the skills to influence their implementation into service for the benefit of patients. They will use their own expertise to implement innovative research and lead research programmes. Critically, they will have learnt and practiced the skills needed to teach the next generation of clinical scientists how to approach learning about science in health in order to optimise outcomes for patients.

1.2 Overall Description of the HSST Programme

Modernising Scientific Careers (MSC) is a UK programme led by the Chief Scientific Officer (CSO), working in conjunction with the other devolved health administrations and relevant scientific, medical and surgical educational institutions. MSC provides a transparent, standards-driven educational and training framework for more than 45 specialisms in healthcare science.

Higher Specialist Scientist Training (HSST) is a five-year training programme that has been developed to enable a selected cohort of Clinical Scientists to be trained to take on the role of a Consultant Clinical Scientist. During training, Clinical Scientists in HSST and their supervisors will use this HSST curriculum to advance their learning, practice and performance, and monitor their progress by reference to the learning outcomes and competences defined within it. Clinical Scientists in HSST will be encouraged to lead their own learning and to measure their achievement against clear learning objectives. It will help the Clinical Scientist in HSST and their educational supervisor/mentor to maintain a regularly reviewed and updated education plan to ensure that all the outcomes of the curriculum are met. Finally, the curriculum will facilitate regular assessment of the Clinical Scientist's progress and satisfactory completion of training against high-quality standards, providing the means by which the public can be assured that individuals are fit for Consultant Clinical Scientist practice.

It is expected that Clinical Scientists in HSST will train in a multiprofessional environment with the opportunity to learn and work with those in other training programmes across the health professions, e.g. medical, nursing, pharmacy and allied health professionals, and with those outwith health, for example those following MBA, leadership, management and finance programmes.

1.3 Curricula Development, Review, Updating and Implementation

HSST curricula were developed during 2012–2015 under the auspices of several of the Medical Royal Colleges (MRCs), following the publication in 2012 of a formal statement of support from the Academy of Medical Royal Colleges (AoMRC) [www.aomrc.org.uk/about-us/news/item/academy-statement.html]. Membership of the MRC curricula development groups included practising senior healthcare scientists nominated by scientific professional

bodies and medical representatives from the MRCs, as well as educationalists from the relevant MRC and MSC teams. Consultant-level scientists from the specific scientific specialism provided the major expert input into the development of the scientific curriculum. The public, a range of scientific and medical professional bodies, universities, patients, employers and trainees were also involved. Specifically, review and comments on this curriculum were sought from other MRCs with an interest in the specialism, their related Specialty Advisory Committees (SACs) and specialist societies, healthcare science professional bodies, trainees in healthcare science, patients and the public. Governance and oversight of curricula development was through a dual process involving each relevant MRC and the Health Education England (HEE) educational approval process on behalf of the National Health Service (NHS) and HEE.

Although the curriculum content is derived from current UK clinical, diagnostic and laboratory practice in clinical science, there have been intensive efforts to identify and predict future technological developments, changes in service delivery and future patient requirements in order to ensure that the curricula are as robust and as sustainable as possible. This is in relation both to scientific content and anticipated future scientific developments (e.g. in genomics and precision/personalised medicine), and is reflective also of the new commissioning system for service and training. There will be regular reviews and updates of the curriculum to ensure that it remains relevant.

Standards of professionalism in healthcare science are set out in *Good Scientific Practice* (GSP; www.academyforhealthcarescience.co.uk/good-scientific-practice/), which describes the principles and values developed for the profession and which are comparable to the standards set by the General Medical Council (GMC) for medicine. This has been developed into a GSP syllabus that is common to all HSST curricula. The five domains of GSP emphasise clinical leadership development, expert scientific and clinical practice, research and innovation, and excellent communication and team working behaviours. For the public, it describes more specifically what can be expected from those who will be CCSs responsible for patient care.

The Academy for Healthcare Science (AHCS) will assess applications from Clinical Scientists applying for recognition of previous training, experience and qualifications ('equivalence to HSST'), based on the professional and scientific contents and standards of behaviour set out in the curricula. Applicants seeking equivalence will be evaluated through AHCS processes against HSST curricula and will need to demonstrate that they have met AHCS requirements for the Certificate of Equivalence in a given area of practice. This will entitle the Clinical Scientist to register on the Higher Specialist Scientist (HSS) Register held by the AHCS.

Implementation of the curriculum will be evaluated and monitored by the National School of Healthcare Science (NSHCS) through continuous feedback from training programmes, educational supervisors, trainers, Clinical Scientists in HSST and patients.

1.4 Curriculum Purpose

The purpose of this HSST curriculum is to define and specify the training programme and outcomes of training to ensure that Clinical Scientists undertaking HSST are fully prepared to provide, lead and innovate scientific services at consultant level in the NHS and in the rest of the UK. It aims to promote excellence through training, assessment and

professional development so that Clinical Scientists exiting HSST programmes are fit to practise as Consultant Clinical Scientists.

This HSST curriculum is modular in design. It builds on the Scientist Training Programme (STP) and leads to the Certificate of Completion of Higher Specialist Scientist Training (CCHSST) issued by the NSHCS. Clinical Scientists in HSST will require evidence of satisfactory achievement of the requirements of the GSP professional syllabus, the specialty-specific syllabus and the related assessment programme (including the Innovation in Clinical Sciences [ICS] project), which together form the curriculum for the attainment of the standards of professional and specialism-based knowledge applied to practical, laboratory, clinical, teaching, research activities, as well as innovation. In addition, for those in Physical Science, the Physiological Sciences and Clinical Bioinformatics, the CCHSST will also indicate that the underpinning doctoral programme/award (DClinSci) has been achieved. In the Life Sciences, the CCHSST indicates achievement of the FRCPath and the ICS project (which together meet the learning outcomes of the doctoral programme), although the doctoral award itself is not required. The CCHSST will enable the AHCS to admit the Clinical Scientist to its HSS Register. Once admitted to this Register, Clinical Scientists will be eligible to apply for available Consultant Clinical Scientist posts.

This curriculum also describes the integral teaching, learning programme and assessment programme that are consistent with the both the Health and Care Professions Council's (HCPC) and the GMC's Standards for Curricula and Assessment Systems (April 2010).

1.5 Entry Requirements

Once the Local Education and Training Board (LETB) [or equivalent bodies in the rest of the UK] and training provider (which has been accredited by the NSHCS accreditation process) have agreed the establishment of an HSST post, entry into HSST programmes will be through a national competitive appointment and benchmarking process in England, led by the NSHCS.

Eligibility for appointment into an HSST programme requires the following:

- registration (or eligibility and application to register) as a Clinical Scientist with the HCPC;
- *normally* at least one further year in the workplace to consolidate and enhance skills, learning and experience (including research and education);
- where required, applicants must be eligible to register for doctoral-level study at a higher education institution (HEI);
- individual specialisms may also have specialty-specific requirements, which will be clarified at the time of the appointment process for the HSST post through the job description and person specification.

An individual appointed to an HSST programme may not commence the programme until registration with the HCPC has been completed.

1.6 Routes of Entry

There will be two routes of entry into HSST training. Through the direct entry route, the Clinical Scientist in HSST will be competitively appointed into a formal HSST post, established for the purpose of training a Consultant Clinical Scientist. Alternatively, some Clinical Scientists may enter into HSST with the support of their employers through an in-service training route that does not involve the creation of a new training post *per se*, although the potential appointee will have to meet benchmarking standards for entry into HSST. In both circumstances in England, a training grant will be allocated from the LETB to the provider training unit to support training.

All HSST applicants must participate and be successful in the national appointment process. For direct entry Clinical Scientists this is a competitive process with other applicants for the available training opportunity; for in-service Clinical Scientists, participating in the national selection process ensures benchmarking against the standards for entry into HSST for this specialism. The appointment process will select not only for scientific expertise and talent in all its manifestations, but for abilities in a range of professional areas, including leadership, innovation, personal skills and values.

1.7 Equality and Diversity

The AHCS, HEE, MSC, MRCs and scientific professional bodies are committed to the principle of diversity and equality in employment, membership, academic activities, assessment, examinations and training.

As part of this ethos these groups are committed to inspire and support all those who work, train and provide training in healthcare science to operate in a fair, open and honest manner. The approach taken is a comprehensive one and reflects all areas of diversity, recognising the value of each individual. This means that no one is treated less favourably than another on the grounds of ethnic origin, nationality, age, disability, gender, sexual orientation, race, or religion, in accordance with the Equality Act 2010. This reflects not only the letter but also the spirit of equality legislation, taking into account current equality legislation and good practice.

1.8 The HSST Curriculum

This curriculum sets out the standards of specialism-based knowledge, clinical judgement, technical and professional skills, attitudes and behaviour that must be acquired in order to practise and progress throughout the five-year training programme. The curriculum comprises the following components:

The ***Specialist Scientific Clinical*** syllabus, providing for:

- a broad understanding of the diagnosis and management of patients within the specialism from a clinical and scientific perspective;
- the diagnostic techniques required in the practice of the specialism;
- understanding of the clinical areas detailed in the curriculum;
- knowledge of the specialist areas defined within the curriculum.

The professional generic ***Good Scientific Practice*** (GSP) syllabus, setting out the requirement for the:

- communication skills required for practice in the specialism and the teaching, learning and assessment skills necessary for effective practice;
- acquisition of clinical leadership and management skills needed for the excellent delivery and development of analytical toxicological scientific services;
- experience of research, development and innovation projects, and critical evaluation of published work in order to lead scientific, technological and service innovation;
- need for a life-long commitment to adopting a structured approach to continuing personal and professional development (CPPD);
- experience of the practice of clinical governance[1] and quality improvement activity, including audit (specialist and multidisciplinary) through evaluation of practice against the standards of evidence-based medicine;
- consistent demonstration and practice of attitudes, values and behaviours that support those set out in the NHS Constitution.

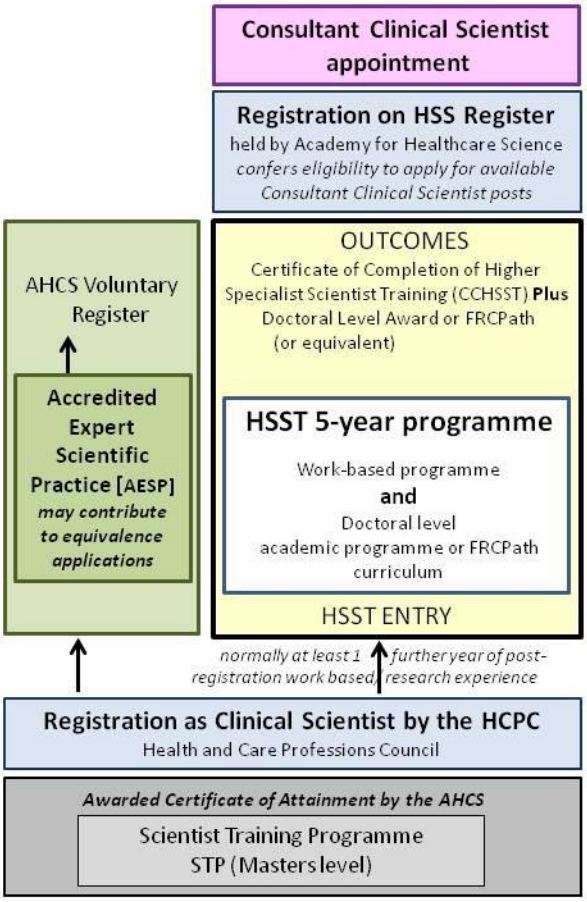
The Relationship of the GSP Syllabus to the Specialist Scientific Clinical Syllabus

The professional knowledge, skills and behaviour of *GSP* are contextualised and evidenced through clinical practice. It is not possible to achieve competence in the specialist scientific and clinical syllabus *unless* these professional skills and behaviours are also evident. Clinical Scientists in HSST must be able to show progress in acquiring GSP competences and the underpinning academic knowledge, demonstrating these behaviours across a range of situations as detailed in the scientific clinical syllabus.

1.9 The Structure and Operation of the HSST Training Programme

The broad structure and description of the HSST programme is shown overleaf.

[1] *A framework through which NHS organisations are accountable for continuously improving the quality of their services and safeguarding high standards of care, by creating an environment in which excellence in clinical care will flourish. Schellekens W. Clinical governance in a changing NHS.* International Journal of Integrated Care*, vol 6, April to June 2006.*



Higher Specialist Scientist Training (HSST)

Composition of 5-year programme

1. Work-based training

Major component of the 5-year programme; curriculum developed in conjunction with Medical Royal Colleges (MRCs) and scientific professional bodies and overseen by the National School of Heath Care Science (NSHCS)

- training providers accredited through NSHCS
- accredited providers receive training grant through Local Education and Training Board (LETB) for each Clinical Scientist in HSST which includes academic fees
- work-based assessment programme and final assessment process conducted by NSHCS with scientific professional bodies and MRCs
- use of on-line learning and assessment portfolio (OLAT) for documenting and monitoring outcomes by NSCHS

2. Doctoral Level Academic Qualification (DClinSci)

Professional doctorate (PD) awarded by Higher Education Institute (HEI) to underpin/support work-based training (or equivalent evidence of learning) to include:

A. Leadership and professional development (120 credits)
B. Specialist scientific clinical programme (180 credits)
C. Research development and innovation (240 credits)

Note: *The professional doctorate programme is optional for those in the Pathology specialisms) as they will be undertaking the professional qualification of the Fellowship of the Royal College of Pathologists (FRCPath), although the learning outcomes of the PD must be demonstrated.*

Outcomes

- Certificate of Completion of HSST (CCHSST) from NSHCS **and** the Doctoral award or FRCPath (or equivalent) which together lead to
- registration on the Higher Specialist Scientist (HSS) Register held by the Academy for HCS (AHCS). This confers eligibility to apply for available Consultant Clinical Scientist roles.

The implementation and quality management of the HSST programme is the responsibility of the NSHCS, which will ensure through its Themed Boards that Clinical Scientists in HSST are provided with access to an appropriate range of educational experience to complete their training. The appropriate Themed Board in the NSHCS will also monitor and support the overall progress of Clinical Scientists in HSST on a regular basis, throughout the entirety of the programme.

1.10 Modularity of Training and Learning

This curriculum has been developed in a modular format, with each module having defined competences, assessment requirements and learning outcomes. There is a staged approach requiring the satisfactory completion of specified modules within each stage prior to progression to the next, so that Clinical Scientists in HSST may not progress to Stage 2 of training until they have satisfactorily completed Stage 1. They will continue to broaden their experience and understanding of common clinical and scientific problems and their management throughout their training. The underpinning doctoral-level programme will provide the underpinning academic framework for learning to support workplace practice. The knowledge gained and applied will be supported and assessed on an ongoing basis through quality assured work-based assessments and through a structured final assessment programme.

1.11 Doctoral-level Programme

A doctoral-level academic programme underpins HSST. The purpose of this doctoral-level programme is to formalise and *facilitate the learning* of Clinical Scientists in HSST as they:

- systematically acquire and apply a substantial body of scientific and clinical knowledge at the forefront of their specialism and embrace the future scientific and technology advances within the field;
- create and interpret new knowledge through original research and scholarship requiring advanced academic enquiry;
- systematically acquire, develop and apply the qualities and transferable skills necessary for employment as a Consultant Clinical Scientist, requiring the exercise of personal responsibility and taking largely autonomous initiative in complex and unpredictable situations;
- develop the knowledge, skills, experience, behaviours and attitudes required of a clinical leader in an evolving and rapidly developing health and life sciences sector.

Following a full tender and contracting process the doctoral programme will be provided by the Manchester Academy for Healthcare Science Education (MAHSE), a consortium of universities that will deliver the programme through partnership arrangements involving a range of organisations, including specialist professional bodies and/or MRCs. The doctoral programme will have three sections, reflecting the higher-level skills and requirements to support consultant-level practice:

- **Section A: Leadership and Professional Development** aligned to GSP, including leadership, professionalism, innovation, bio enterprise, teaching and learning, quality improvement, bioinformatics, health policy, human resource and business management, and research methods, although these areas are not necessarily exhaustive and others may be identified.
- **Section B: Specialist Scientific Clinical Programme** developed by the MRCs-led curriculum working groups of senior scientists and medical consultants, underpinned by supervised work-based and mentored training. This section will centre on the knowledge and understanding learning outcomes from the specialist scientific clinical syllabus for each HSST specialism, underpinned by supervised work-based and mentored training, reflective practice, experiential learning and a robust assessment system.
- **Section C: Research, Development and Innovation** that aims to improve health and health outcomes and may include scientific and/or clinical outcomes, service transformation, innovation, leadership, policy, education, or educational research.

Since a key purpose of the doctoral programme is to facilitate the opportunities for learning by Clinical Scientists in HSST by providing a structure within which they can obtain underpinning knowledge and learning to support their progression through the programme, it is not necessarily a requirement for the doctoral award itself to be obtained. The doctoral-level programme will be designed in a modular format, and although successful completion of the totality of the programme will lead to the award of a professional doctorate, it is not an essential requirement for all of those undertaking HSST programmes to obtain the doctoral award *per se*.

In the Life Sciences, for example, Clinical Scientists in HSST must obtain the FRCPath, which includes the learning outcomes of the professional doctorate, but not necessarily obtain the award itself. In the Physiological Sciences, Medical Physics and Biomedical Engineering, and Clinical Bioinformatics, all Clinical Scientists in HSST will be expected to participate in the full professional doctorate programme (or potentially show equivalence to aspects of it) and gain the professional doctorate award. It will therefore be necessary for all Clinical Scientists in HSST to demonstrate that they have acquired the knowledge, skills and outcomes of the HSST curriculum to the required doctoral level in all the practice and academic elements of the programme. The doctoral-level award and programme will underpin and support this, but in itself is not an end point of the HSST programme; nor is the award required for the demonstration of competence and fitness to practise. This will be defined within the HSST assessment strategy and in conjunction with the MRCs and the NSHCS.

Research

Clinical Scientists in all HSST programmes will also be expected to undertake doctoral-level research, usually through the commissioned professional doctorate. Alternatively, research that demonstrates that such a level has been achieved may be offered, e.g. a coherent body of papers that reaches the standard suitable for publication in peer-reviewed journals, which has been undertaken during the HSST programme or during the three years before entry to the HSST programme. Clinical Scientists in HSST will also be encouraged to present and defend their research at national/international scientific conferences.

1.12 Models of Learning

HSST curricula will be delivered through work-based experiential learning and through achievement of the underpinning academic programme and/or its learning outcomes. The environment within the departments must therefore encourage independent self-directed learning and make opportunities for relevant off-the-job education by making provision for attendance at local, national and, where appropriate, international meetings and courses. It is the Clinical Scientist's responsibility, with the support of their educational supervisor and trainers, to seek learning and training opportunities and ensure that they access appropriate experiential learning. The training programme must allow for a significant component of clinical training and experience through service provision. This will normally be in the range of 30–80% of training time, depending on the specialism and the year of training.

It is therefore recognised that a large component of training will occur using an apprenticeship model of learning, under appropriate work-based supervision. Delivery of training must be under the supervision of a scientific or medical consultant and provide appropriate experiential content, including a broad exposure to both scientific and clinical issues. The environment within the department should encourage independent self-directed learning. The NSHCS will be responsible for the quality assurance of the work-based learning environment.

1.13 Learning Experiences

A wide range of teaching/learning opportunities/methods will be used during the programme to support the attainment of the learning outcomes and competences. However, it is part of the Clinical Scientist's professional development to seek out and organise relevant learning opportunities for themselves. In consultation with their educational supervisor, the Clinical Scientist in HSST may wish to consider organising some of the following learning events.

Experiential or opportunistic learning (learning through normal routine work experiences, learning by doing, observing, critical reflection), which will include*:*

- experiential working in the specialism, gaining practical and clinical skills, and observing, assisting and discussing aspects of practice with senior/consultant scientific and medical staff, patients and other members of the multiprofessional team;
- task-specific, on-the-job training, working under consultant supervision and reflecting on and discussing experiences;
- observation of diagnostic/clinical/laboratory methods;
- tailored clinical experience, including team and directorate meetings in the specialty;
- attendance and participation at relevant organisational committees to enhance management and leadership skills;
- attending and participating in training provided through equipment and kit manufacturers;
- attending and participating in MDT meetings;
- teaching undergraduates and other health professionals;
- attending and participating in regional, national and international medical or scientific conferences;
- interaction with/attachment to specialist reference laboratories where required;
- completion of a doctoral-level research or innovation project from identification of the research question to dissemination of the output;
- contribution, as the leader or member of a team, to grant applications;
- dissemination of research findings through publications, presentations, etc.;
- attending and participating in medical clinics, including specialty clinics;
- gaining practical diagnostic experience;
- attending and participating in formal postgraduate education/teaching.

Learning approaches, which may include:

- independent self-directed learning;
- e-learning and m-learning (mobile learning);
- learning with peers;
- clinical skills teaching, including simulation;
- advanced library study, journal review;
- work-based experiential learning;
- small group teaching, lectures, tutorials;
- advanced journal clubs, audit meetings, etc.;
- service development projects.

1.14 Completion of Training

Successful completion of the HSST programme results in the award of a CCHSST by the NSHCS. The award will be made to Clinical Scientists in the Physical Sciences and Biomedical Engineering, the Physiological Sciences and Clinical Bioinformatics who complete the requirements of the work-based curriculum through work-based training, the ICS project and the professional doctorate, and who participate in the full training period (or as much as may be required if assessed by the AHCS as having done an equivalent period of training at some other point), including the final annual progression review/assessment, denoting satisfactory completion of the programme. In the Life Sciences, the CCHSST indicates achievement of the FRCPath and the ICS project (which together meet the academic learning outcomes of the doctoral programme), although the doctoral-level award itself is not required. Clinical Scientists in HSST in the Life Sciences may, however, choose to undertake modules from the professional doctoral programme or, indeed, undertake the entire doctoral-level programme and achieve the DClinSci award.

The CCHSST indicates that the Clinical Scientist has achieved the standards set by the AHCS in order to gain entry to their HSS Register, having demonstrated the ability to lead, manage and critically evaluate services and practice, contributing to the team and individually to scientific, technological and service innovation. A Clinical Scientist on the HSS Register will be expected to maintain their professional development in line with GSP. It is anticipated that in due course, as for medical and surgical consultants, Consultant Clinical Scientists will undergo a regular process of revalidation that will be developed and overseen by the AHCS.

1.15 Supervisory Arrangements

Supervision and Feedback

Supervision, support and mentoring for Clinical Scientists in HSST must be available to ensure safe and effective practice for patients and the public, and to support independent learning and high standards of professional conduct. Those undertaking a supervisory, training or mentoring role for Clinical Scientists in HSST programmes must have relevant professional qualifications and experience and have undertaken appropriate and up-to-date training as agreed by the NSHCS. The HEI providing the underpinning doctoral programme will also be expected to have an academic supervisory, support and mentoring scheme in place to support the academic programme.

Clinical Scientists in HSST must be appropriately mentored, supported and supervised by the senior scientific and medical staff on a day-to-day basis, under the direction of a designated educational supervisor. Educational supervision is a fundamental conduit for delivering teaching and training in the NHS. It takes advantage of the experience, knowledge and skills of educational supervisors/trainers and their familiarity with clinical and scientific situations. It ensures regular interactions between an experienced clinician and the Clinical Scientist in a HSST programme. This is the desired link between the past and the future of scientific practice, to guide and steer the learning process of the Clinical Scientist in the programme. Clinical supervision is also vital to ensure patient safety through providing Clinical Scientists in HSST with the support to deliver high-quality services to patients. It is therefore expected that Clinical Scientists in HSST programmes

reaching the end of their training will also be able to demonstrate competence in clinical supervision before the award of the CCHSST.

Educational supervision should promote independent learning and reflective practice and support the Clinical Scientist in HSST to produce action plans to address identified learning needs. It will need to ensure that the Clinical Scientist learns specific higher skills and competences, helping them to develop self-sufficiency and self-awareness in the ongoing acquisition of skills and knowledge. At every stage, patient safety must be paramount. Supervision will also require the provision of pastoral care for some Clinical Scientists in HSST. Supervision during training will be undertaken by a range of appropriately trained healthcare professionals within and outwith healthcare science, e.g. consultant or senior medical staff, Clinical Scientists, research scientists, senior biomedical scientists, etc.

The Educational Supervisor

The educational supervisor will be an appropriately skilled senior scientist/clinician under whose direct supervision the Clinical Scientist in HSST is working. This person(s) will be responsible for monitoring, supporting and assessing the Clinical Scientist on a day-to-day basis in their scientific, clinical and professional work, and would usually be expected to take on the role of co-supervisor of the research project as part of the academic supervisory team.

To become an educational supervisor, a senior scientist or medical consultant must have consistently demonstrated an interest in and a commitment to teaching, learning, assessment and training, have appropriate access to teaching resources and be trained in the appropriate delivery of work-based assessments and learner-centred feedback in accordance with the MSC HSST assessment strategy. Educational supervisors must undertake appropriate training in educational principles and assessment (e.g. Training the Trainers programme, offered by the NSHCS in England or MRCs). Attainment of formal qualifications such as a postgraduate award in teaching, learning and assessment or an MSc in Medical/Clinical Education is desirable for some members of each supervisory team. Educational supervisors are expected to keep up to date with developments in training, have access to the support and advice of their senior colleagues regarding any issues related to teaching and training, and to keep up to date with their own professional development.

The role of the HSST educational supervisor therefore, with respect to the Clinical Scientist in HSST, includes responsibilities to:

- have overall educational and supervisory responsibility for the Clinical Scientist in HSST in a given post;
- ensure that they are familiar with the curriculum for each year/stage of training;
- ensure that they have appropriate day-to-day supervision appropriate to their stage of training;
- act as a mentor and help with both professional and personal development;
- ensure that they are making the necessary clinical and educational progress;
- ensure that they are aware of the assessment system and process;
- agree a training plan (formal educational contract) to make clear the commitment required to ensure that appropriate training opportunities are available;

- ensure that an induction (where appropriate) has been carried out soon after appointment to the HSST programme;
- discuss the training requirements and progress with other trainers with whom the Clinical Scientist in HSST spends a period of training;
- undertake regular formative/supportive appraisals (at least two per year, approximately every six months) and ensure that both parties agree to the outcome of these sessions and a written record is kept;
- regularly review the evidence submitted to the Online Learning and Assessment Tool (OLAT) so that they are aware of their progress and are encouraged to discuss any issues arising during training, ensuring that records of such discussions are kept;
- keep the NSHCS Professional Lead informed of any educational or pastoral issues that may affect the Clinical Scientist's ability to complete the HSST programme.

The process of gaining competence in supervision must start at an early stage in training, with the Clinical Scientist in HSST supervising more junior trainees, e.g. those undertaking STP. The example provided by the educational supervisor is the most powerful influence on the standards of conduct and practice of a Clinical Scientist in HSST.

Supporting Roles

In addition to the educational supervisor who will have overall educational responsibility for the Clinical Scientist in HSST, there will be other clinical trainers and assessors who will help facilitate the provision of educational opportunities and feedback to the Clinical Scientist as required. They will also be in a position to provide evidence to support the educational supervisor's judgement about a Clinical Scientist's overall performance, competence and capability. Since Clinical Scientists in HSST will learn in a multiprofessional environment, assessments will be carried out by a range of members of the team, including those who may not be scientifically or medically qualified. However, all those carrying out assessments must be appropriately qualified in the relevant professional specialism and trained in the methodology of workplace-based assessment, including the delivery of appropriate feedback. This does not apply to multisource feedback (MSF), where those contributing to the feedback will be from a wider pool. Clinical Scientists in HSST and their educational supervisors should look to identify opportunities to incorporate feedback from patients, where possible, in the assessment of competence.

1.16 The Assessment Programme

The assessment programme for HSST is set within the context of the overall assessment strategy for MSC. A summary of the HSST strategy is set out in Table 1, and the detailed assessment programme for Clinical Scientists in HSST is shown in Table 2. Table 1 also shows the methods by which each component is assessed.

The HSST assessment programme is designed to capture evidence of the Clinical Scientist's mastery of the three main components of HSST, reflecting the five domains of GSP.

1. Clinical/scientific skills, and values, behaviours and attitudes relating to professionalism and the delivery of scientific/clinical services (Domains 1 and 3).

2. Scientific content (Domain 2).
3. Contribution to research, innovation and leadership in healthcare science (Domains 4 and 5).

The purpose of the assessment programme is to:

- provide evidence of satisfactory acquisition and application of knowledge, skills, experience and professionalism relevant to practice;
- enable each Clinical Scientist in HSST to demonstrate readiness to progress through the training programme and generate feedback to inform progress and learning needs;
- help to identify Clinical Scientists in HSST who may be in difficulty and who may need additional support;
- provide evidence to inform an annual progression review and the completion of the work-based assessment component of HSST;
- gather evidence that would assure the public that the Clinical Scientist in HSST is ready for independent professional practice as a Consultant Clinical Scientist.

Approach and Methods of Assessment

Assessment for HSST is a blend of academic, professional and workplace-based assessments, which together provide evidence of the achievement of learning outcomes, clinical/scientific competence and the progression of the Clinical Scientist in HSST through to completion of training. All assessments are aligned to the curriculum and the domains of GSP. There are two routes through the HSST assessment programme to accommodate different requirements across the sciences: Route 1 is for Clinical Scientists in the Physiological Sciences, Physical Sciences and Biomedical Engineering, and Clinical Bioinformatics, and Route 2 is for Clinical Scientists in the Life Sciences. Table 1 shows that Clinical Scientists following Route 1 will complete assessments relating to the professional doctorate, an assessment of clinical skills, the workplace-based assessment programme and the ICS project. Clinical Scientists following Route 2 will be assessed through the Fellowship Examination of the Royal College of Pathologists (FRCPath), the workplace-based assessment programme (with an option to take selected modules or the entire professional doctorate) and the ICS project.

Aim of the Innovation in Clinical Science Project

The aim of the ICS project is to allow Clinical Scientists in HSST to demonstrate the achievement of the learning outcomes of the ICS set out below by:

1. conceiving an innovation[2] in healthcare science that has the potential to make a positive contribution to service delivery, patient experience, patient outcomes, health economics, or any other aspect of healthcare. The Clinical Scientist's innovation should be at doctoral level and therefore must be original and make a new contribution to knowledge. It must not draw directly from work they may have submitted previously as

[2] Defined as *'An idea, service or product, new to the NHS or applied in a way that is new to the NHS, which significantly improves the quality of health and care wherever it is applied.'* Improvement & Efficiency Directorate, Innovation and Service Improvement (2011, p9). *Innovation, Health and Wealth: Accelerating Adoption and Diffusion in the NHS.* Department of Health.

part of a Master's degree or PhD – although the ICS project may contribute to the HSST professional doctorate or FRCPath dissertation;
2. undertaking a critical review of the literature considering relevant research in order to develop the rationale for the innovation;
3. undertaking a feasibility study, including consultation with stakeholder groups;
4. preparing and planning for implementation;
5. leading implementation and evaluation;
6. drawing realistic and evidence-based conclusions about the potential contribution and feasibility of the innovation.

Learning Outcomes from the ICS Project in the HSST Programme

The ICS project represents one component of the overall assessment strategy for the HSST programme that must be passed in order to receive the Certificate of Completion of Higher Specialist Scientist Training (CCHSST) from the NSHCS. All Clinical Scientists in HSST (including those taking the FRCPath route to completion of HSST) will need to complete the ICS. The project is designed to support the independent learning and demonstration of achievement of the following learning outcomes grouped under three areas, which reflect key components of the GSP syllabus as set out in the HSST curriculum.[3]

Professionalism and Professional Development (Domain 1)
By the end of the ICS project the Clinical Scientist in HSST will be able to demonstrate that they have:

- gained critical insight and professional understanding of the conceptual, ethical, value-based and analytical frameworks that underpin professional practice and their relationship to *Good Scientific Practice;*
- enhanced their skills and confidence to enable them to operate effectively and creatively within a healthcare science setting and the wider, diverse and changing healthcare environment.

Leadership and Quality Improvement in the Clinical and Scientific Environment (Domains 1, 2 and 5)

By the end of the ICS project the Clinical Scientist in HSST will be able to demonstrate that they have:

- broadened, built and applied their knowledge and skill base so that they are prepared for more senior, leadership roles within healthcare science and the wider healthcare environment where they will have responsibility as a future leader and team member for setting the policy, strategic direction, leadership and quality performance of their service and organisation to provide patient centred, high quality, compassionate patient;.
- led a quality improvement programme/s within their clinical environment, using the knowledge, skills and experience of organisational leadership which demonstrate the

[3] The domains indicated in the table relate to the AHCS's *Good Scientific Practice* document (http://ahcs.flinthosts.co.uk/wordpress/wp-content/uploads/2013/09/AHCS-Good-Scientific-Practice.pdf). Within every HSST curriculum is the detailed GSP syllabus that contextualises GSP to the level and practice of the Clinical Scientist in HSST.

behaviours and attitudes described in the current frameworks and models of excellent leadership.

Improving Outcomes for Health and Social Care (Domain 4)
By the end of the ICS project the Clinical Scientist in HSST will be able to demonstrate that they have:

- built on and developed the knowledge, skills and experience of research and innovation methodology to demonstrate the high level skills required to undertake doctoral level research.
- the criticality to explain the process, barriers and enablers for publication and implementation of research and innovation findings.

Overview of the ICS Project

The innovation may be developed from work that the Clinical Scientist in HSST has submitted as part of the professional doctorate, or FRCPath, or other HSST work, in consultation with their clinical supervisor. It is envisaged that completion of the ICS project will consist of the following stages**.**

Stage 1 *Conception*: identify innovation, literature review, refine innovation and rationale.
Stage 2 *Feasibility*: consultation with stakeholders, financial planning, implementation, plan, analysis of limitations and constraints.
Stage 3 *Pilot testing*: critical analysis and evaluation, reformulation of innovation.
Stage 4 *Assessment*: preparing for the ICS project assessment.

Clinical Scientists in HSST will not pass or fail the ICS project based on the success, or otherwise, of the innovation pilot alone, as it is recognised that innovations may succeed and fail due to factors that are outside the control of the Clinical Scientist. Similarly, it is recognised that Clinical Scientists are operating in a rapidly changing healthcare context and that the rationale for the innovation, or the innovation itself, may be superseded during the course of the project. The chief assessment criteria will therefore relate to the quality of the Clinical Scientist's insight into innovation and leadership in healthcare science, and the appropriateness of the conclusions drawn from their feasibility and pilot studies.

Annual Progression Review

It is a shared responsibility between the Clinical Scientist, their educational supervisor and the NSHCS to monitor and review satisfactory completion of all assessments. At the end of each year there will be a formal progression process that will consist of a meeting between the Clinical Scientist in HSST and their educational supervisor (Annual Progress Review; APR), and a formal meeting of the Annual Progression Review Board (APRB). These two processes will be overseen by the NSHCS and will be the means by which eligibility to progress through the five-year programme will be judged. As a summary of the processes:

- the APR will be conducted by the educational supervisor, using documentation, guidance, criteria and standards that are common across specialisms. The purpose of the APR is to discuss the Clinical Scientist's experiences and perceptions of progress, and to scrutinise evidence of the Clinical Scientist's performance in the workplace to enable the educational supervisor to make a recommendation to the APRB about progression. This may include a recommendation that additional support is required. A progression recommendation will also take into account any issues regarding the completion of HSST in a non-linear way, including consideration of equality and diversity issues.
- an APRB meeting will be convened for each HSST specialism and will involve representation from the NSHCS, the relevant professional body/bodies, Consultant Clinical Scientists and a lay representative. The role of the Board will be to review the recommendations from educational supervisors, the assessment results and any additional feedback from the providers of the professional doctorate (Route 1) or FRCPath (Route 2), the important value judgements made as part of MSF, and to complete a formal scrutiny of the evidence held on the OLAT. The purpose of the APRB is to ensure that the Clinical Scientist in HSST has demonstrated sufficient evidence of achieving the learning outcomes and competences appropriate to the stage of the programme, and to confirm progression to the next year of training. Where the APRB is not able to confirm progression, the NSHCS will, with the guidance of the APRB representatives and the Clinical Scientist's educational supervisor, facilitate the implementation of a remediation and support process or, exceptionally, a HSST exit support strategy (which would require a review of evidence that the remediation and support process had not achieved the outcomes as specified by the APRB).

Table 1: Summary of HSST assessment strategy

Programme component	Route[1]	Assessment components	Assessment tool/s	Administrative responsibility[2]	Component weighting
Mastery of scientific content	**1**	Professional doctorate (PD)	As required by the HEI provider of the PD	HEI	100%; must pass PD or FRCPath to receive the Certificate of Completion for HSST from the NSHCS
	2	FRCPath, with an option to take selected, or all, components of the PD[3]	FRCPath	RCPath	
Mastery of clinical skills, values and behaviours	**1**	Workplace-based assessment (WPBA) Clinical skills assessment	Multiple WPBAs OSFA/OSCSA[4]	Workplace, recorded on OLAT and monitored by NSHCS NSHCS (in collaboration with Medical Royal Colleges [MRCs] and Professional Bodies [PBs])	100%; must have evidence of satisfactory completion of all WPBAs, and gain a 'Pass' in the OSFA/OSCSA or FRCPath to receive Certificate of Completion for HSST from the NSHCS
	2	WPBA FRCPath	Multiple WPBAs FRCPath	Workplace, recorded on OLAT and monitored by NSHCS RCPath	
Contribution to innovation, service improvement, patient safety, or quality management in healthcare science	**1**	Innovation in Clinical Science (ICS) project	Short report, plus presentation to multiprofessional panel	NSHCS to administer, in collaboration with MRCs and PBs	100%; must pass component to receive Certificate of Completion for HSST from the NSHCS
	2	Contribution to innovation, service improvement, patient safety, or quality management in healthcare science	Option to (1) complete as part of FRCPath Part 2 (report and presentation to Penultimate Progression Review Board) **or** (2) complete ICS project as for non-Life Sciences[5]	(1) RCPath or (2) NSHCS to administer, in collaboration with MRCs and PBs	

[1] Route 1 is for Clinical Scientists in the Physiological Sciences, Physical Sciences and Biomedical Engineering, and Clinical Bioinformatics; Route 2 is for Clinical Scientists in the Life Sciences.
[2] Where assessments are created and delivered by the NSHCS's partners, the School will request access to data about the performance of these assessments, and data on individuals' assessment outcomes.
[3] Clinical Scientists taking the FRCPath route through HSST have the option of completing any of the modules offered as part of the professional doctorate. However, in successfully completing the FRCPath (and the ICS project, which may be part of the FRCPath), the Clinical Scientist has demonstrated that they have achieved the learning outcomes of the professional doctorate.
[4] Work is ongoing to establish whether an OSFA (Objective Structured Final Assessment) or OSCSA (Objective Structured Clinical Skills Assessment) is the best fit to the assessment purpose.
[5] Clinical Scientists in Life Sciences who choose not to undertake the innovation component as part of FRCPath will be required to complete the ICS project, which will require the production of a short report and presentation to a multiprofessional panel.

Table 2: HSST assessment road map for Physiological Sciences, Physical Sciences and Biomedical Engineering, and Clinical Bioinformatics

Stage	Year	Professional doctorate (PD)	Innovation in Clinical Science (ICS) project[1]	Formative assessment	Summative assessment	Annual Progression Review (APR)/Annual Progression Review Board (APRB)	Completion
1	1	↓	↓	As required and available in the workplace and as part of the PD	12 DOPS[2]; 1 MSF; and assessments as required for PD	APR, plus APRB[3]	APRB
	2			As required and available in the workplace and as part of the PD	12 DOPS[2]; 1 MSF; and assessments as required for PD	APR, plus APRB[3]	APRB
2	3			As required and available in the workplace and as part of the PD	8 OCEs; 4 CBDs[2]; and assessments as required for PD	APR, plus APRB[3]	APRB
	4			As required and available in the workplace and as part of the PD; mock OSFA/OSCSA; plus local mock assessment of ICS project	8 OCEs; 4 CBDs[2]; 1 MSF; OSFA/OSCSA; and assessments as required for PD	APR, plus APRB[3]	APRB, plus pass in the OSFA/OSCSA
	5			As required and available in the workplace and as part of the PD	Assessments as required for PD; ICS project; 1 MSF	Final Review Board (FRB)	FRB, plus pass for the ICS project and pass for the PD
NSHCS awards the Certificate of Completion upon submission of evidence of successful completion of the WPBA programme, the Professional doctorate, the Innovation in Clinical Science project and the OSFA/OSCSA.							

[1] Clinical Scientists in HSST should discuss with their educational supervisor how to schedule their plans for completion of the ICS project in order to achieve all the specified learning outcomes (see other relevant HSST documentation). The ICS project will be assessed in Year 5, unless the Clinical Scientist wishes to complete the assessment earlier.

[2] The number of workplace-based assessments is indicative only; as is the scheduling of DOPS, CBDs and OCEs across Stages 1 and 2. There is no requirement to complete a minimum number of WPBAs, or any requirement to complete certain assessments at particular stages of the programme. Clinical Scientists in HSST should discuss and negotiate with their educational supervisor, as part of the development of the training plan, the type and number of assessments that will be most appropriate to demonstrate achievement of the learning outcomes.

[3] Criteria for progression to be determined in consultation with stakeholders.

The Online Learning and Assessment Tool (OLAT)

Every Clinical Scientist in HSST will need to develop and maintain an electronic learning portfolio (e-portfolio) to document and provide evidence of their progress through the training programme. The framework for the e-portfolio will be the OLAT, which is provided by the NSHCS. The OLAT will enable the Clinical Scientist in HSST to record all work-based assessments, supervisors' reports, multisource feedback outcomes and reflections on their progress, learning experiences and participation in learning events, such as journal clubs and national and international conferences, etc. The OLAT is also designed to facilitate and encourage ongoing dialogue between the Clinical Scientist in HSST and their supervisor about the Clinical Scientist's personal and professional development at consultant-level practice. Clinical Scientists in HSST will be given access to OLAT upon enrolment.

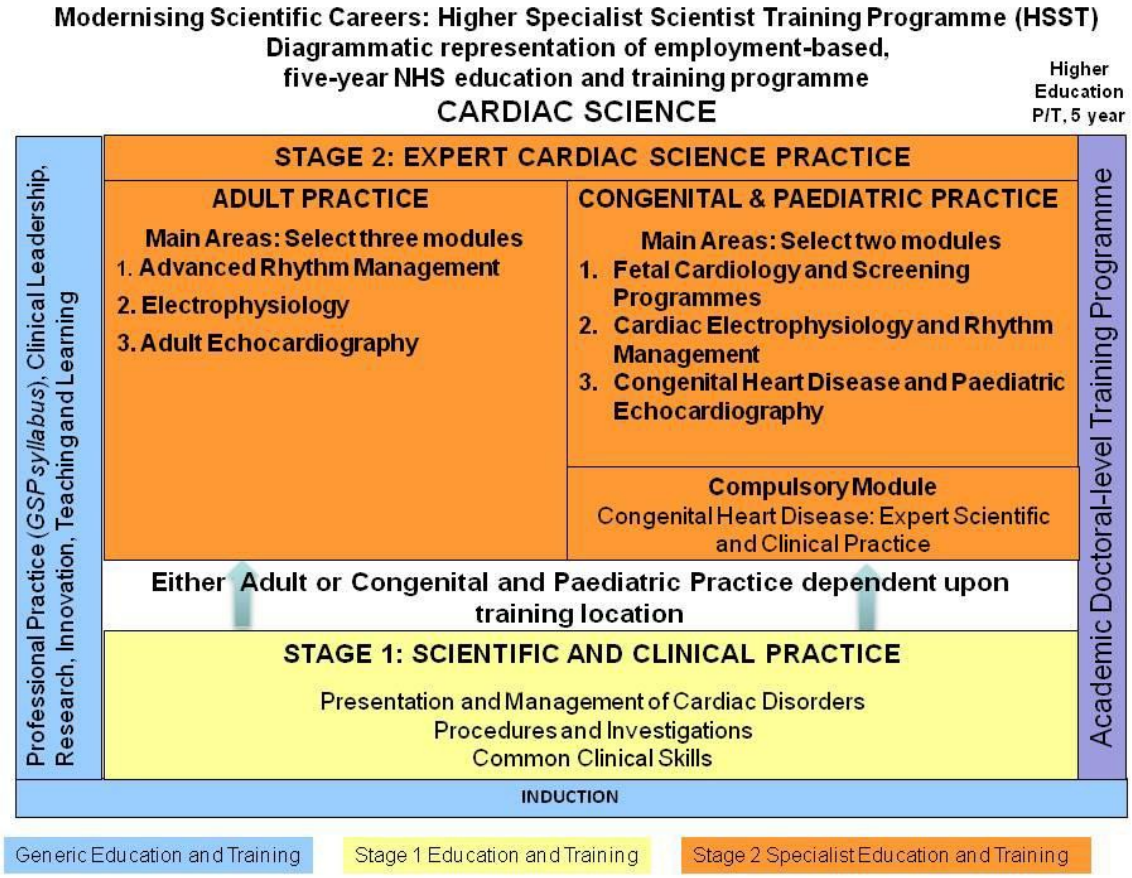
SECTION 2: HSST IN CARDIAC SCIENCE

2.1 Details of the Curriculum in Cardiac Science

HSST training will begin with a brief, formal introduction to advanced scientific and clinical aspects of Cardiac Science, including health and safety as well as an overview of the leadership, management and organisational structures within which this specialist service works. It will be important for Clinical Scientists in HSST to understand at an early stage the scientific, clinical and multiprofessional environments in which the specialism of Cardiac Science operates, and the importance of this to patient care and the organisation. Following a work-based clinical induction period Clinical Scientists in HSST will begin to gain experience in specialism-specific aspects of the curriculum, both scientific and clinical, as befits an independent adult learner. The emphasis will be on acquiring additional specialty skills ('spiralling up' from the learning/practice undertaken in the relevant Scientist Training Programme [STP]) in a routine diagnostic and clinical setting. Undertaking the required doctoral programme designed to support learning will provide the academic underpinning for the clinical programme. In Cardiac Science they will also be expected to register for the doctoral level award (DClinSci).

Towards the latter part of the programme Clinical Scientists in HSST will apply their sound theoretical, scientific, practical and clinical knowledge of Cardiac Science and have the opportunity to gain, under indirect supervision, clinical and scientific experience in either adult or congenital and paediatric cardiac science, enabling them to acquire increasing confidence and self-sufficiency in the expert practice of Cardiac Science. Clinical Scientists in HSST will be expected to critically apply their knowledge and master a range of skills demonstrating new insights into routine and novel situations. Critical reflection will be crucial to the personal development of each Clinical Scientist in HSST, who will be expected to demonstrate high standards of professional practice. The ability to identify and lead research and innovation from inception to implementation and to demonstrate the influencing and management skills of a clinical leader will also be required.

The diagram overleaf summarises the training programme for Cardiac Science.



2.2 Stage 1 Scientific and Clinical Practice

To complete Stage 1 the Clinical Scientist in HSST must demonstrate a comprehensive and critical understanding of the principles of Cardiac Science, and the wider clinical and scientific issues that underpin higher study and practice. Stage 1 of training is normally 24 months whole-time equivalent training. It will begin with a formal introduction to the essential and advanced core principles of Cardiac Science, including the higher scientific and clinical practices that span Cardiac Science but which were not covered at STP level. The vertical strands (i.e. professional practice, clinical leadership, research, innovation and teaching/learning), including *Good Scientific Practice*, will begin in Year 1 and all Clinical Scientists in HSST must complete these by the end of Year 5.

By completion of Stage 1 the Clinical Scientist in HSST will have an excellent understanding of the principles and practices underpinning Cardiac Science. They will be able to deal with most of the day-to-day issues in the specialism under indirect supervision but will still require consultant medical or clinical scientist input with regard to complex management diagnostic, scientific and clinical issues. In addition they will have a high-level understanding of the complex and integrating principles of anatomy, physiology and physiological measurement of the specialism.

In summary, in order to satisfactorily complete Stage 1 of the curriculum, the Clinical Scientist in HSST must have:

- completed a minimum training period of 24 months (whole-time equivalent);

- achieved the required level of competence in the requisite number of specialty work-based assessments;
- obtained a satisfactory outcome in the Annual Progression Review Process;
- provided evidence of acceptable progress towards achievement of the learning outcomes of the doctoral-level programme.

2.3 Stage 2 Expert Scientific and Clinical Practice

(in either Adult Cardiac Science or Congenital Heart Disease and Paediatric Cardiac Science)

Stage 2 of training takes place between Years 3 and 5 of whole-time equivalent training. In Stage 2 the Clinical Scientist in HSST will discuss and agree with their educational supervisor the **three** Expert Practice modules they will undertake during Stage 2 training from the list given in the table overleaf. Depending on the site and nature of their clinical practice during higher specialist scientist training, Clinical Scientists in HSST will follow the curriculum in either an adult or paediatric setting, and the relevant modules will be selected. However, please note that if for service or development reasons a Clinical Scientist in HSST wishes to undertake adult congenital heart disease (ACHD) as a significant area of future practice they should undertake both module 2CHD(i): Congenital Heart Disease Expert Scientific and Clinical Practice and module 2A(ix): Adult Congenital Heart Disease in addition to one other from the adult options. If this is the case then the Clinical Scientist in HSST and their supervisor will need to make arrangements for the Clinical Scientist to spend sufficient time in a paediatric setting where this is necessary.

This modular approach provides flexibility within the training programme to enable future Consultant Clinical Scientists roles to be developed commensurate with specific service requirements. For example, individuals may wish to gain expertise in one of the subspecialist areas indicated below, e.g. in advanced rhythm management, electrophysiology or echocardiography. If this is the case then the relevant modules leading to this outcome should be undertaken. Others may wish to develop broader interests, e.g. in heart failure, requiring expertise in cardiac resynchronisation therapy, advanced transthoracic echocardiography and/or ACHD. Under these circumstances the individual and their educational supervisor may choose any three from the available modules. It is envisaged that additional specialist training modules will be incorporated into future editions of this curriculum as fields such as cardiac magnetic resonance imaging (MRI) and cardiac computed tomography (CT) imaging develop as service needs dictate.

ADULT EXPERT SCIENTIFIC AND CLINICAL PRACTICE

The **three** Expert Practice modules chosen should reflect either the particular relevance of the modules to areas of expert practice and workforce need or be a wider combination supporting more general practice in adult cardiology.

Advanced Rhythm Management

2A(i): Pacemaker Therapy
2A(ii): Implantable Cardioverter-Defibrillator Therapy
2A(iii): Cardiac Resynchronisation Therapy

Electrophysiology
2A(iv): Cardiac Electrophysiology 1

2A(v): Cardiac Electrophysiology 2

Adult Echocardiography

2A(vi): Advanced Transthoracic Echocardiography
2A(vii): Transoesophageal Echocardiography
2A(viii): Stress Echocardiography
2A(ix): Adult Congenital Heart Disease

CONGENITAL HEART DISEASE AND PAEDIATRIC CARDIAC EXPERT SCIENTIFIC AND CLINICAL PRACTICE

All Clinical Scientists in HSST following the congenital heart disease and paediatric Stage 2 programme will be required to complete the following compulsory module.

2CHD(i): Congenital Heart Disease Expert Scientific and Clinical Practice

In addition they will be expected to complete **two** further modules from those listed below, reflecting the expert practice they will be undertaking.

Fetal Cardiology and Fetal Screening Programmes

2CHD(ii): Fetal Screening Programmes
2CHD(iii): Fetal Cardiology

Cardiac Electrophysiology and Rhythm Management

2CHD(iv): Cardiac Electrophysiology and Pacing
2CHD(v): Cardiac Resynchronisation Therapy
2CHD(viii): Adult Congenital Heart Disease

Congenital Heart Disease and Paediatric Echocardiography

2CHD(vi): Transthoracic Echocardiography in Congenital Heart Disease
2CHD(vii): Transoesophageal Echocardiography in Congenital Heart Disease
2CHD(viii): Adult Congenital Heart Disease

During Stage 2 the Clinical Scientist in HSST will also be required to complete the vertical strands of learning involving *Good Scientific Practice* and Research, Innovation, Clinical Bioinformatics, and Teaching and Learning. These will run in parallel with Stage 2 expert practice training but have a different focus. They will deliver key leadership and professional practice aspects of the profession, spanning genomics, bioinformatics, innovation and innovative service delivery, teaching, learning, assessment and supervision, and doctoral-level research.

Training during the latter part of this stage of the curriculum enables the Clinical Scientist in HSST to prepare for undertaking independent practice in a Consultant Clinical Scientist post. By the completion of training the Clinical Scientist in HSST will have an in-depth knowledge and understanding of the principles and practice of the specialism. They should be competent to discuss and deal with the subject (or, where appropriate, perform the task/procedure), demonstrating a level of clinical, critical and professional judgement commensurate with independent professional practice at consultant level. Until training is completed the Clinical Scientist in HSST will have senior input readily available at all times when required. By the end of training the Clinical Scientist in HSST must be able to demonstrate a level of

knowledge and skill indicating capability and suitability for independent professional practice.

The table below lists all of the modules in this HSST programme.

Stage 1: Advanced Clinical Skills
1(i): Advanced History Taking 1(ii): Performing a Focused, Relevant Clinical Examination 1(iii): Therapeutics in Cardiac Science 1(iv): Resuscitation Immediate Life Support 1(v): Radiation Use and Safety 1(vi): End of Life Care in Cardiology 1(vi): Presentation and Management of Cardiac Disorders 1(vii): Cardiac Arrhythmias 1(viii): Primary and Secondary Prevention of Cardiovascular Disease 1(ix): Hypertension 1(x): Congenital Heart Disease 1(xi): Assessment of Patients with Cardiovascular Disease Prior to Non-Cardiac Surgery 1(xii): Community Cardiology **Procedures and Investigations** 1(xiii): Evidence-Based Non-Invasive Diagnostics 1(xiv): Echocardiography 1(xv): Heart Rhythm Management: Pacing Management 1(xvi): Heart Rhythm Training: Electrophysiology 1(xvii): Imaging Physics in Cardiology
Stage 2: Expert Practice can be undertaken in an adult (A) *or* paediatric (CHD) setting. Three of the following modules will be chosen in consultation with the educational supervisor in adult or congenital and paediatric cardiology so that a combination of learning and experience reflects likely service need.
Adult Practice 2A(i): Pacemaker Therapy 2A(ii): Implantable Cardioverter-Defibrillator Therapy 2A(iii): Cardiac Resynchronisation Therapy 2A(iv): Cardiac Electrophysiology 1 2A(v): Cardiac Electrophysiology 2 2A(vi): Advanced Transthoracic Echocardiography 2A(vii): Transoesophageal Echocardiography 2A(viii): Stress Echocardiography 2A(ix): Adult Congenital Heart Disease **Congenital and Paediatric Practice** 2CHD(i): Congenital Heart Disease (compulsory) 2CHD(ii): Fetal Screening Programmes 2CHD(iii): Fetal Cardiology 2CHD(iv): Cardiac Electrophysiology and Pacing 2CHD(v): Cardiac Resynchronisation Therapy 2CHD(vi): Transthoracic Echocardiography in Congenital Heart Disease 2CHD(vii): Transoesophageal Echocardiography in Congenital Heart Disease 2CHD(viii): Adult Congenital Heart Disease

VERTICAL STRAND: GOOD CLINICAL PRACTICE
Domain 1: Professional Practice
Domain 2: Scientific Practice
Domain 3: Clinical Practice
Domain 4: Research, Development and Innovation
Domain 5: Clinical Leadership
VERTICAL STRAND: GENERIC HEALTHCARE SCIENCE
Innovation in Healthcare Science
Clinical Bioinformatics, Genomics and Precision/Personalised Medicine
Doctoral-level Research
Teaching, Learning and Assessment
Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science
Science Communication

2.4 Integration of the Academic Doctoral Programme with the HSST Curriculum

The diagram below demonstrates the relationship between the HSST curriculum in Cardiac Science and the doctoral-level programme.

HSST DOCTORAL TRAINING PROGRAMME FRAMEWORK
CARDIAC SCIENCE

Year					
5	**Section C: Module C3:** Research, Development and Innovation *(130)*				
4	**Section B: Module B9** *Specialist Option Modules (Adult or Congenital Heart Disease and Paediatric)* **(20)**	**Section B: Module B10** *Specialist Option Modules (Adult or Congenital Heart Disease and Paediatric)* **(30)**	**Section C: Module C2** Research, Development and Innovation *(70)*		
3	**Section A: Module A5** Improving Outcomes for Health and Social Care *(20)*	**Section B: Module B8** *Specialist Option Modules (Adult or Congenital Heart Disease and Paediatric)* **(20)**	**Section B: Module B7** Teaching Learning and Assessment *(20)*	**Section C: Module C1** Research, Development and Innovation *(40)*	
2	**Section A: Module A3** Personal and Professional Development to Enhance Performance in Practice *(30)*	**Section A: Module A4** Leadership and Quality Improvement in the Clinical and Scientific Environment *(20)*	**Section B: Module B3** Contemporary Issues in Healthcare Science *(20)*	**Section B: Module B6** Diagnostics & Monitoring **(20)**	**Section B: Module B5** Therapeutics *(10)*
1	**Section A: Module A1** Professionalism and Professional Development **- M Level** *(30)*	**Section A: Module A2** Theoretical Foundations of Leadership *(20)*	**Section B: Module B1** Advanced History Taking, Clinical and Communication Skills **(15)**	**Section B: Module B2** Clinical Presentation and Management *(20)*	**Section B: Module B4:** End of Life Care *(5)*

	Section A: Generic Modules for Physiological and Physical Sciences	**Leadership and Professional Development Modules**
	Section B: Theme Modules for Physiological Sciences, a small number of which may also be shared by Physical Sciences	**Modules shared by more than one specialism Specialist Scientific and Clinical Programme Module**
	Section B: Specialist Modules	**Modules from Specialism Specific Scientific and Clinical Programme**
	Section C: Generic Modules for Physiological and Physical Sciences	**Research, Development and Innovation Modules**

2.5 Requirements for Progression and Completion

In order to complete all of the required elements of the HSST programme in Cardiac Science and to assure the public that the Clinical Scientist is ready for unsupervised and independent professional practice they must have:

- satisfactorily completed a total of at least 60 months of training (whole-time equivalent);
- satisfactorily completed all areas of the curriculum for Cardiac Science;
- achieved the required level of competence in the work-based assessment programme;
- obtained satisfactory outcomes in the Annual Progression Review Process to indicate that all learning objectives (knowledge, skills and competences, attitudes and behaviours) appropriate to the stage (or end) of training have been achieved;
- provided the required evidence for the final award of the CCHST;
- provided evidence of achievement of the learning outcomes of the doctoral-level programme.

SECTION 3: GOOD SCIENTIFIC PRACTICE SYLLABUS

This syllabus is a common component of all Higher Specialist Scientist Training (HSST) curricula and must be followed throughout the whole training period, with engagement at the appropriate level, depending on the stage of training.

The syllabus is divided into five domains. These align with the five domains of *Good Scientific Practice* (GSP):

- Domain 1: Professional Practice
- Domain 2: Scientific Practice
- Domain 3: Clinical Practice
- Domain 4: Research, Development and Innovation
- Domain 5: Clinical Leadership

Each domain contains an overall learning objective, which is described by a number of competence statements. These are presented as:

- knowledge to be acquired and applied;
- practical skills to be demonstrated;
- attitudes and behaviours to be consistently displayed.

Each competence statement is supported by indicative content. Cross-referencing of the syllabus to the GSP standards is included.

Domain 1: Professional Practice

Topic	Professional Practice	GSP reference
Learning objective	By the end of the training programme Clinical Scientists in HSST will be able to exercise personal responsibility and work largely autonomously, taking the initiative in complex and unpredictable situations and performing a range of clinical/practical skills consistent with the roles and responsibilities of a Consultant Clinical Scientist.	
Knowledge	By the end of the training period Clinical Scientists in HSST will be able to: 1. Justify the importance of placing the patient at the centre of care and considering services from a user's point of view. • Compare and contrast models of promoting patient-centred care and how to ensure that the wishes, beliefs, concerns, expectations and needs of patients are respected. • Critique studies that demonstrate the benefits of patients sharing in decision making on their health. • Defend the rights of patients and carers to treatment without discrimination, which includes age, gender, illness, disability, health inequality, cultural and social inequality, diversity. • Critique the evidence base, principles and practice of patient-centred interviewing and examination, including the patient perspective. • Explain and justify why it is important to develop and maintain appropriate patient–professional relationships, and evaluate a range of situations that have had a positive and negative impact on those relationships. • Explain and justify why it is important to have a holistic approach to the patient, recognising that there may be social as well as medical aspects to their management. • Summarise local guidelines for responding to complaints from patients and/or carers and evaluate the impact of these systems in promoting patient-centred care. • Recognise the importance of gathering and responding to patient-derived data. • Summarise local guidelines for responding to unacceptable behaviour by patients, carers, or relatives, including harassment, bullying, or violence, and identify the strengths and weaknesses of these guidelines. • Defend the importance of public engagement in science and its role in health and society.	1.1.1 1.1.9 1.1.10 1.2.1

Topic	Professional Practice	GSP reference
	2. Critically evaluate the importance of keeping professional knowledge and skills up to date and work within the limits of personal competence. • Create, interpret and construct new knowledge of scientific, clinical and professional developments in an area of practice. • Justify the rationale for engaging in continuing personal and professional development (CPPD) and critical reflective practice, and evaluate a range of methods for recording, learning, and developing and evaluating action plans. • Critique the evidence base underpinning CPPD with respect to the Consultant Clinical Scientist, the clinical service and the patient. • Recognise the limits of their own competence and scope of practice in order to make informed and reasonable decisions. • Recognise the limits of competence and scope of practice for those for whom they are responsible and evaluate methods for managing difficult and sometimes unpredictable situations. • Critique methods for evaluating audit and review information on performance of self and those for whom they are responsible.	1.1.3 1.1.4 1.1.5 1.1.7 1.2.5 3.1.5 3.1.17
	3. Critique the ethical, legal and governance requirements arising from working at the level of Consultant Clinical Scientist across a range of complex situations. • Evaluate the principles, guidance and law with respect to medical ethics, patient confidentiality, informed consent, equality and diversity, child protection, use of chaperones. • Justify the role of the Consultant Clinical Scientist in the definition and monitoring of compliance of standards of practice that are ethical and legal, often involving complex issues. • Defend the purpose of clinical governance and the requirements of the employing organisation. • Evaluate the role of clinical audit in demonstrating compliance with local governance requirements. • Evaluate the effectiveness of the Standards of Proficiency and Standards of Conduct, Performance and Ethics of the Health and Care Professions Council (HCPC).	1.1.3 1.2.5 3.1.1 3.1.2 3.1.3 3.1.17
	4. Summarise and critique the evidence to support the high levels of probity required when working at	1.2.3

Topic	Professional Practice	GSP reference
	the level of Consultant Clinical Scientist as a clinical leader. • Evaluate the importance of verifying information in reports and documents, including research. • Analyse and justify the HCPC Standards of Conduct, Performance and Ethics. • Appraise approaches to procedures for identifying and reporting critical incidents. • Appraise approaches to procedures for receiving and responding to complaints. • Summarise the procedures to follow if they are cautioned, charged with a criminal offence, suspended, or have restrictions placed on their personal scientific, clinical, or professional practice.	1.2.4 1.2.5
	5. Understand the importance of personal health and wellbeing in order to ensure that personal performance and judgement is not affected by their own health. • Responsibilities to the public and how these may be compromised by poor health. • Effects of stress on professional performance. • Role and availability of occupational health and other support services.	1.1.8 1.1.9 1.2.2
	6. Analyse NHS organisation, policy and practice as it affects the provision of healthcare, healthcare science and the patients and populations it serves. • Justify the contribution the NHS makes to assure the health of the nation. • Critically evaluate the current structure of the NHS in the relevant jurisdiction of the UK and compare and contrast with alternative models of health delivery in Europe or internationally. • Evaluate current national and local policy issues as they affect the service provided by Clinical Scientists and the healthcare science workforce. • Justify the role of population screening, shared care and self-care in diagnosing and managing disease from the perspective of the patient and the healthcare provider. • Identify and explain the finance issues facing providers of healthcare at national and local level in general, especially budgetary management and commissioning and the effect on healthcare provision. • Evaluate the effectiveness of the role of central government health regulatory and quality improvement agencies across the devolved NHS.	1.1.3 3.1.3

Topic	Professional Practice	GSP reference
	• Explain and analyse the roles and relationships of Health Education England (and equivalents elsewhere in the UK), Modernising Scientific Careers, Academy for Healthcare Science, National School of Healthcare Science, Council of Healthcare Science in Higher Education, Medical Royal Colleges, specialist societies, postgraduate deans and deaneries, and patient organisations in the provision of healthcare science. • Summarise the management structure and key contacts of the employing organisation (including chief executive, medical directors, clinical directors) and evaluate the structure with respect to providing high-quality patient care. • Summarise the management structure of and key contacts with relevant major service users and providers and the contribution to the provision of high-quality patient care. 7. Discuss theories of teaching and learning to underpin the role of the healthcare scientists in education as a teacher or trainer, according to the best contemporary clinical and educational standards. • Critically review the evidence base and apply knowledge of teaching, learning and assessment within the clinical and scientific work base to design, deliver and evaluate education and training programmes that meet the best clinical and educational standards.	1.4.1 1.4.2
Practical skills	By the end of the training period the Clinical Scientist in HSST would be expected to apply in practice a range of clinical skills and critically reflect on their performance and will be able to: 1. Critically apply their understanding of professional practice with conduct that places the patient at the centre of care in a manner that promotes patient wellbeing and self-care through: • Developing and maintaining appropriate patient–professional relationships in practice. • Working with patients and carers in a respectful and non-discriminatory manner. • Taking a clinical history and using the information as part of the clinical decision-making process. • In the context of patient-centred care, giving and receiving feedback sensitively to or from a peer or colleague using an appropriate feedback model. 2. Critically apply their understanding of the role and importance of CPPD to ensure that professional	1.1.2 1.1.10 1.1.11 3.1.10 3.1.11

Topic	Professional Practice	GSP reference
	knowledge and skills are being kept up to date through: • Maintaining personal records of CPPD, providing evidence of critical reflection, including action planning, with respect to clinical practice and professional development in a form suitable for audit by a professional body or regulator, and demonstrate continuing fitness to practise. • Recording critical reflective notes justifying how participation in CPPD has contributed to learning and led to improvements in personal and service performance. • Monitoring their own performance by evaluating the outcome of audit and feedback from a range of sources. • Encouraging a culture in which innovation and developments are identified, discussed, evaluated and potentially introduced to improve service delivery. • Encouraging staff and colleagues to recognise learning opportunities in the workplace and where necessary supporting them to obtain and use study leave to participate and contribute to additional learning experiences, including skills training courses and conferences. 3. Respond to the ethical, legal and governance requirements arising from working at the level of Consultant Clinical Scientist, critically applying accrued knowledge and evidence by: • Recognising the factors influencing ethical decision making, including religion, personal and moral beliefs, cultural practices, making informed decisions and supporting colleagues. • Justifying the use and sharing of information in accordance with the regulations, encouraging such behaviour in other members of the healthcare team and taking action where breaches of the guidelines may have occurred. • Justifying the use and promotion of strategies to ensure confidentiality is maintained, e.g. removal of patient names where appropriate, reviewing and analysing published literature, and considering the impact of such measures on the clinical service. • Recognising the problems posed by disclosure in the public interest, without consent of the patient. • Ensuring patients, relatives and carers are aware of the need for information distribution within members of the immediate healthcare team. • Using appropriate methods of ethical reasoning to justify a decision where complex and conflicting	1.1.4 1.1.5 3.1.5 1.1.11 3.1.1 3.1.2 3.1.17

Topic	Professional Practice	GSP reference
	issues are involved. • Performing and evaluating clinical audit to assess compliance with local governance requirements, taking remedial action as required. 4. At all times act in a manner that demonstrates probity in all aspects of professional practice by: • Working in accordance with GSP with conduct that at all times justifies the trust of patients and colleagues and that maintains public trust in healthcare science. • Writing honest and accurate reports and signing documents appropriately. • Applying honesty and accuracy about personal qualifications, experience and position in the scientific community. • Acting honestly with respect to written and verbal information provided to any formal or legal enquiry, including recognition of the limits of scientific knowledge and experience. • Creating and justifying open and non-discriminatory professional working relationships with colleagues and using critical reflection to review personal behaviour and response to challenging issues. • Responding in an open, constructive and timely manner to critical incidents or complaints about their own or team performance influencing the response, and using critical reflection to review personal behaviour and response to challenging issues. • Taking appropriate action if they suspect they or a colleague may not be fit to practise, putting patient safety at the forefront of practice. • Practising within the HCPC Standards of Conduct, Performance and Ethics. 5. Make appropriate judgements to ensure they limit their work or stop practising if performance or judgement is affected by their health by: • Recognising when personal health takes priority over work pressures, seeking appropriate advice and support, and taking appropriate action. • Developing and maintaining appropriate coping mechanisms for a range of potential issues, including stress, seeking help if appropriate and evaluating the impact of an intervention. 6. Demonstrate professional practice that is consistent with relevant current NHS policy and practice by:	1.1.8 1.2.2 1.2.3 1.2.4 1.2.5 5.1.3 1.1.8 1.1.11

Topic	Professional Practice	GSP reference
	• Identifying and evaluating existing and new NHS policy and advice relevant to the area of practice, the implications of these for personal and team practice, and the impact on patients. • Using a range of communication skills to lead and contribute to discussions and gain agreement in a range of situations, including within the MDT, and steps that need to be taken to align service delivery with the most recent NHS policy and advice. • Sharing information and advice with peers in order to encourage a consistent approach to the implementation of NHS policy and advice. • Evaluating, documenting and justifying any local decisions that are taken that mean that it is not possible to align service delivery with NHS policy and advice. 7. Contribute to the education and training of colleagues planning, delivering and evaluating teaching on the basis of student and peer feedback and active self-reflection by: • Using a range of teaching methods, including lecture-based, small group teaching and practical skills teaching, appropriate to the learners. • Planning, delivering and evaluating a range of assessments appropriate to learning outcomes in the three domains of learning.	1.1.4 1.3.1 2.1.1 2.1.6 1.4.1 1.4.2
Attitudes and behaviours	By the end of the training period the Clinical Scientist in HSST would be expected to demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and will be able to: 1. Apply evidence-based personal and team professional practice that places the patient at the centre of care. • Act in accordance with the principles and practice of patient-centred care, regularly reflecting on personal practice and revising judgements and changing behaviour in light of new evidence. • Critically assess and evaluate personal and team-related performance in the context of evidence-based patient care, identify areas of good practice and make improvements where necessary. • Seek feedback from patients on their own and the team's performance and adapt practice accordingly. 2. Apply knowledge, experience and deep reflection to identify personal development needs using a range of tools, and develop and update action plans to ensure support CPPD.	1.1.9 1.1.10 1.1.11 1.1.4 1.1.11

Topic	Professional Practice	GSP reference
	• Apply the skills of deep reflection to identify personal development needs to transform and maintain up-to-date practice. • Act as a self-motivated professional scientist being willing to learn from self and others, responding positively to constructive and meaningful feedback. • Create a culture that values CPPD to enable staff under supervision and supports them in recognising their strengths and identifying areas for improvement.	1.3.1 1.3.6
	3. Display a professional commitment to ethical practice, consistently operating within national and local ethical, legal and governance requirements. • Accept professional ethical standards and encourage informed debate and critical reflection within healthcare teams. • Seek advice in the event of ethical dilemmas in areas including disclosure and confidentiality. • Respect requests from patients that information should not be shared, unless this puts the patient or others at risk of harm. • Share information about patient care with the patient unless they have expressed a wish not to receive such information.	1.1.11 1.2.1
	4. Apply the principles of GSP and the professional standards, performing to the highest standards of personal behaviour in all aspects of professional practice. • Recognise the importance of leading by example in setting high standards of personal behaviour, and in acting with openness, fairness and integrity, listening to the views of others. • Accept the requirements for professional regulation. • Promote professional attitudes and values at all times. • Recognise the need to be truthful and to admit to and learn from errors. • Accept the requirement to inform the statutory regulator if they are cautioned, charged with a criminal offence, suspended, or have restrictions placed on their personal scientific, clinical, or professional practice.	1.1.3 1.1.8 1.1.9 1.1.11 1.2.2
	5. Consistently operate in accordance with relevant current NHS policy and practice. • Recognise the need to identify and assess the implications of NHS policy and advice for service	

Topic	Professional Practice	GSP reference
	organisation and delivery of high-quality services. • Consult with peers and service users as part of obtaining agreement to align services with NHS policy and advice.	 1.1.3 1.3.1

Domain 2: Scientific Practice

Topic	Scientific Practice	GSP reference
Learning objective	By the end of this stage of training the Clinical Scientist in HSST will be able to assess, plan, deliver and evaluate high-quality scientific services in a safe and secure working environment.	
Knowledge	By the end of the training period the Clinical Scientists in HSST will be able to: 1. Analyse the strengths and weaknesses of current and new scientific investigations and methods used in the diagnosis, monitoring and treatment of clinical disorders relevant to the area of practice. • Evaluate the scientific basis of investigations and procedures. • Discuss the impact of genomics and personalised medicine on health and healthcare science. • Discuss the impact of clinical bioinformatics on health and healthcare science. • Critique the application of scientific investigations and procedures in protocols and patient pathways. • Summarise the strengths and weaknesses of current service provision, in terms of both performance characteristics and clinical application. • Compare alternative approaches and/or improvements to investigations and procedures. • Use scientific principles and reasoning to assess, plan and design new or improved investigations or procedures. • Analyse the role of peer opinion in refining ideas and plans. • Evaluate new and emerging technologies and their potential to improve healthcare and healthcare science. 2. Critique the application of evidence-based practice to the optimisation of scientific investigations and methods. • Summarise and critically review the scientific literature in the area of expertise. • Evaluate the principles and practice of evidence-based medicine relevant to the area of practice. • Appraise approaches to meta-analyses, systematic reviews, clinical trials, cohort studies and related approaches used in this field. • Critique methods for searching, identifying, ranking and evaluating scientific evidence. • Justify the rationale for the use of methods to evaluate and optimise the performance of scientific	2.1.1 2.1.3 1.1.5 2.1.1

Topic	Scientific Practice	GSP reference
	investigations. • Defend methods for comparing performance of two or more scientific investigations or procedures. • Appraise relevant statistical measures applied to research publications. 3. Evaluate and apply information and communication technology (ICT) to facilitate service delivery and development in relevant areas of healthcare science. • Justify the application of ICT in the area of practice. • Evaluate the impact and development of bioinformatics on the practice of healthcare and healthcare science. • Discuss the requirement for data confidentiality, security and protection. • Evaluate the function and operation of the Hospital Information System. • Evaluate and justify the function and operation of linked information systems (e.g. Laboratory Information System) and middleware linking equipment to information systems. • Identify the benefits and barriers with respect to personal computer hardware and software. • Appraise the appropriate use of electronic mail and social networking technology in the context of professional role. • Summarise how electronic literature searching (e.g. PubMed) and storage can be used within the clinical environment. • Access and judge specialist websites and databases relevant to their professional role. • Appraise the range of statistical packages relevant to the area of expertise, including bioinformatics where appropriate. 4. Justify the principles and practice of quality control, external quality assessment and quality management as applied to relevant areas of healthcare science. • Evaluate the purpose and operational requirements of internal quality control and external quality assessment and defend the systems currently in place. • Defend the principles and practice of quality management and, where appropriate, service accreditation.	2.2.9 2.3.1 2.3.2

Topic	Scientific Practice	GSP reference
	• Critique the required quality standards and monitoring of performance against those standards, and the contribution standards make to the provision of a high-quality service. 5. Justify the role of audit and the audit cycle and explain how it is used as a tool to facilitate continuous quality improvement. • Evaluate the principles and practice of scientific and technical audit, including examples of audit improving practice. • Identify aspects of service delivery that should be subjected to regular scientific or technical audit and justify the selection. • Appraise audit reports, including recommendations for improvement and the impact on the service when implemented. • Critically review examples of relevant scientific and technical audits performed locally or elsewhere, and the impact on service delivery. 6. Summarise and interpret health and safety legislation and guidance for the workplace. • Defend the importance of health and safety within the workplace with respect to employees, employers, patients and the public. • Appraise current legislation and guidelines relating to health and safety in the workplace, including, as appropriate to role: biological specimen handling; COSHH; RIDDOR; radioactivity; fire safety; electrical safety; moving and handling; display screen equipment. • Justify local health and safety guidance. • Justify the principles and practice of infection control, including the impact of reducing infection rates on patients. • Critically review procedures involved in risk assessment and risk management and the impact on quality and safety. • Summarise the policy and procedures associated with critical incident reporting and the impact on service improvement and the culture of the organisation.	2.2.2 2.3.4 3.1.17 2.2.6 2.2.7 2.2.8
Practical skills	By the end of the training period the Clinical Scientist in HSST would be expected to apply in practice a range of clinical skills and critically reflect on their performance and will be able to:	

Topic	Scientific Practice	GSP reference
	1. Develop and evaluate investigative strategies/procedures/processes that take account of relevant clinical and scientific evidence and other sources of information. • Critically appraise the scientific credentials and validity of existing investigations and procedures. • Critically appraise the way in which scientific investigations and procedures are used in strategies and protocols for the diagnosis, monitoring and treatment of defined clinical disorders. • Work in partnership with peers and service users to apply scientific principles and reasoning to plan, develop and assess the scientific validity and clinical effectiveness of new or improved investigations, procedures, strategies, or protocols.	2.1.1 2.1.3 2.2.2
	2. Critique the selection and application in practice of scientific investigations in defined clinical situations using quantitative and/or qualitative methods. • Reflect on proficiency in the performance of routine and non-routine scientific and technical procedures used in defined clinical areas of service and develop action plans to improve performance. • Compare their own proficiency with experts in the technical validation of data derived from scientific and technical procedures. • Justify the selection and application of scientific and technical procedures to comply with clinical requests and evaluate the efficacy of this on their own practice. • Apply the principles and practice of evidence-based medicine to critically appraise the effectiveness of scientific and technical investigations and procedures. • Use and evaluate statistical measures such as likelihood ratio, AUC-ROC, number needed to treat/harm.	2.1.2 2.1.3 2.1.4 2.2.1 2.2.3 2.2.4 2.2.5
	3. Master the use of ICT in relevant areas of healthcare science. • Use ICT for all applications in the area of practice. • Justify the rationale and conform to requirements for data confidentiality, protection and security. • Use and apply the Hospital Information System, appropriate linked information systems, middleware and instrumentation hardware and software. • Master the use of personal computers and relevant programmes, including word processing,	2.2.9

Topic	Scientific Practice	GSP reference
	databases, PowerPoint, internet and email, electronic literature searching and storage. • Use relevant statistical packages for data handling, including methods for assessing clinical effectiveness and, where appropriate, basic bioinformatics, and interpret the results/outcomes. 4. Set, apply and maintain quality standards and related quality control, assessment and management techniques to assure the validity of scientific and technical investigations, adapting and developing systems as required. • Critically appraise relevant internal quality control and external quality assessment data and draw conclusions about quality performance. • Present and actively participate in meetings that review quality performance criteria, justifying and defending solutions for improvement, and adapting and implementing corrective action as required. • Contribute to quality management, justifying the definition of standards and monitoring of performance against those standards, and adapting and developing systems as required. • Prepare and review regular quality management reports, including, where appropriate, linkage with service accreditation, adapting and developing systems as required. 5. Perform scientific and technical audit to determine that investigations and methods are fit for purpose, justifying and monitoring the impact of recommendations. • Perform scientific and technical audit of the performance and effectiveness of scientific investigations and service delivery in accordance with local guidelines. • Identify, critically review and communicate the outcomes of scientific and technical audits performed by others in relevant areas of scientific investigation and service delivery, making recommendations for changes and monitoring the impact of those recommendations. • Devise, develop, perform and evaluate scientific and technical audits in their own area of expertise, reporting the outcomes, including learning, modifications and the impact on service delivery resulting from the audit. 6. Promote the importance of health and safety standards in the workplace and identify and justify actions that will improve health and safety and reduce the risk of infection.	2.1.6 2.3.1 2.3.2 2.3.3 2.2.2 2.3.4 3.1.17

Topic	Scientific Practice	GSP reference
	• Perform workplace role complying with current legislation and guidelines relating to health and safety in the workplace. • Adhere to local health and safety guidance. • Perform workplace role in accordance with the control of infection regulations. • Perform risk assessment and risk management of health and safety in the workplace, make recommendations and monitor the impact of the recommendations. • Comply with requirements for critical incident reporting, reflecting on and learning from the occurrence and outcome of critical incidents, adapting practice as necessary. • Investigate and respond to reported health and safety incidents in the workplace.	2.2.6 2.2.7 2.2.8
Attitudes and behaviours	By the end of the training period the Clinical Scientist in HSST would be expected to demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and will be able to: 1. Evaluate current debates in the field and critically appraise scientific developments in the area of expertise. • Understand and utilise a range of approaches to identify, critically review and learn from new and emerging scientific literature in the area of expertise. • Make appropriate judgements in order to search and archive scientific literature. • Engage in critical dialogue on the latest scientific developments (e.g. journal clubs). • Develop planning and critical appraisal skills in self and clinical team through peer review, shared exercises and case review. 2. Apply evidence-based scientific practice as a means of improving patient investigation and care, where necessary revising judgements and changing behaviour in light of new evidence. • Critically evaluate the application of the principles of evidence-based medicine across areas of expertise. • Apply rigorous scientific critiques to the evaluation of data related to clinical practice in the support of clinical decision making and patient management. 3. Evaluate and use ICT to improve service quality and delivery. • Use new ICT, changing practice and behaviour as appropriate.	1.1.5 2.1.6 3.1.5 1.1.5 2.1.5 2.1.6

Topic	Scientific Practice	GSP reference
	• Justify the need to balance data confidentiality, security and protection, and the sharing of data with relevant stakeholders, including patients, to ensure high-quality, patient-centred care.	2.2.9
	4. Listen, influence and lead continuous quality improvement in scientific services.	
	• Justify the importance of continuous quality improvement using the available evidence base. • Influence, lead and support staff in the department/organisation to create a culture that recognises the importance of quality and quality improvement in the delivery of scientific services. • Justify the importance of quality control and quality assessment of all investigations and services influencing and shaping the views of others. • Create opportunities for staff to receive training in quality management by justifying the impact of training on service delivery and personal development.	2.3.2 2.3.3
	5. Understand and utilise audit as a tool to evaluate and optimise scientific services.	
	• Defend scientific and technical audit as a valid tool to improve scientific investigation and service delivery. • Identify training needs of self and others and develop training plans to enable audit to proceed. • Communicate outcomes of scientific and technical audits with peers, managers and other interested parties, persuading others to implement and/or adapt recommendations in their area of practice.	2.2.2 2.3.4 3.1.17
	6. Establish and influence the culture of health and safety in the workplace.	2.2.6 2.2.7
	• Create a culture of health and safety awareness, identification and resolution of issues, and modification of systems to enhance health and safety. • Review and report on health and safety issues, sharing good practice with individuals, the team and wider organisation. • Identify, justify and create opportunities for staff to receive health and safety and first aid training, and monitor the learning and impact of the training on the individual and service.	2.2.8

Domain 3: Clinical Practice

Topic	Clinical Practice	GSP reference
Learning objective	By the end of this stage of training the Clinical Scientist in HSST will be able to assess, plan, deliver, interpret, report and evaluate high-quality clinical services that are targeted to meet the needs of individual and groups of patients.	
Knowledge	By the end of the training period the Clinical Scientist in HSST will be able to: 1. Analyse the strengths and weaknesses of the procedures required to deliver high-quality clinical practice in the investigation and management of patients. • Justify the requirement for patient consent for investigation, including patients who lack capacity, and provide advice to others. • Summarise the requirement to maintain patient confidentiality and respect for a patient's privacy, involving the patient appropriately, and the circumstances when disclosure is allowed. • Justify the rationale of clinical coding and the need for accuracy and use of medical terminology. • Analyse and justify the wider clinical consequences of clinical investigations performed and clinical advice provided. • Relate understanding of setting clinical priorities and time management for patient investigation. • Interpret emerging evidence and knowledge that adds to the clinical evidence base underpinning services provided in order to make informed judgements. • Justify the requirements for accurate record keeping and data security. • Summarise the role of standard operating procedures, clinical protocols and clinical guidelines to promote a safe, patient-centred environment and underpin high-quality scientific services. • Identify common sources of error, identification of risk and critical incident reporting, and analyse how this information can be used to improve services and reduce incidents and risk. • Justify the importance of adopting a no blame culture for identification and investigation of error. 2. Relate understanding of the aetiology of relevant clinical disorders as a means of developing appropriate clinical investigations across the full range of patients accessing the clinical services of personal area of practice. • Describe the detailed causation of clinical disorders in the area of expertise and apply knowledge	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6 3.1.15 3.2.1 3.2.2 3.1.5 3.1.6

Topic	Clinical Practice	GSP reference
	when selecting investigative strategies. • Analyse the strengths and weaknesses of existing clinical investigations and identify and critically appraise potential strategies to improve or develop new clinical investigations in the best interests of patients.	3.1.7
	3. Discuss and evaluate how the results of clinical investigations may be related to defined disorders and patient management strategies across the full range of patients accessing the clinical services of their personal area of practice. • Summarise the use of normal limits and describe the levels of uncertainty in the outcome of clinical investigations. • Analyse patterns of data and results obtained from clinical investigations linked to defined clinical disorders. • Evaluate and justify the use of statistics and predictive values in clinical practice, recognising potential limitations. • Evaluate the effectiveness of relevant clinical guidelines and patient pathways, recognising potential limitations and seeking alternatives.	3.1.4 3.1.12 3.1.13 3.2.4
	4. Evaluate the role of the MDT in optimising clinical outcomes for individual and groups of patients. • Discuss the role of the MDT and evaluate the effectiveness of the team. • Summarise the range of MDTs supported by healthcare science and analyse the role of each team. • Justify the operational requirements for individual MDTs, evaluate the clinical effectiveness of the team and suggest areas for improvement.	1.3.2 1.3.3 3.1.14 3.1.16
	5. Discuss and evaluate the principles and practice of clinical audit as a tool to evaluate the effectiveness of services provided. • Principles and practice of clinical audit. • Resources available in local organisation to support clinical audit. • Examples of relevant clinical audits performed locally or elsewhere.	2.2.2 3.1.17
Practical	By the end of the training period the Clinical Scientist in HSST would be expected to apply in practice a	

Topic	Clinical Practice	GSP reference
skills	range of clinical skills and critically reflect on their performance, and will be able to:	
	1. Apply in practice consistent high standards of clinical practice in the investigation and management of patients and critically reflect on their performance.	1.1.1 1.1.11
	• Explain and justify the recommended clinical investigations, involving the patient wherever possible.	3.1.1
	• Explain and justify the procedures for preparing samples for clinical investigation.	3.1.2
	• Master a range of clinical investigations relevant to the area of practice, complying with relevant standard operating procedures, clinical protocols and clinical guidelines in accordance with best practice.	3.1.3 3.1.4 3.1.5
	• Produce and maintain clear, accurate and legible records in accordance with the regulations/guidelines governing patient consent, confidentiality and data security.	
	• Analyse the outcome of clinical investigation and give immediate feedback in accordance with agreed protocol.	
	2. Plan, develop, perform, evaluate, interpret and report a range of clinical investigations to assist with the diagnosis, monitoring and treatment of patients, making informed judgements as necessary.	3.1.6 3.1.7 3.1.8
	• Comply with quality standards in the performance of routine and non-routine clinical investigations in the area of practice.	3.1.10 3.1.11
	• Identify and critique opportunities to develop and/or improve clinical investigations to improve patient experience and/or to add certainty to the outcome following relevant governance procedures, acting on advice and feedback from patients.	3.1.15 3.2.1 3.2.2
	• Plan, develop and critically evaluate modified or improved clinical investigations, producing valid comparative data with the existing procedure, involving the views of patients or service users.	3.2.3
	• Discuss outcomes, modifications, or improved clinical investigations with patients or service users before agreeing on whether to implement a change in procedure in adhering to governance processes.	
	3. Provide advice on the clinical significance of the results of investigations, including, where appropriate, follow-up and further investigation, and reflect on the process and justify the advice given.	3.1.12 3.1.13

Topic	Clinical Practice	GSP reference
	• Interpret and report the outcomes of routine and non-routine clinical investigations in the context of the clinical presentation of individual patients, justifying the conclusions. • Provide clear and accurate written and/or verbal clinical advice on the clinical significance of investigations, having regard to the importance and urgency for patients and the underpinning evidence base. • Discuss with relevant medical and other healthcare practitioners the follow-up, further investigation and/or appropriate treatment of individual patients based on the outcomes of clinical investigations and current best practice/evidence.	3.1.14 3.2.3 3.2.4
	4. Actively participate in MDT meetings that review clinical outcomes for individual and groups of patients, challenging decisions/recommendations when necessary. • Use the evidence base to identify MDTs in their area of expertise that would benefit from input from a senior healthcare scientist and make arrangements for participation to influence the judgements of the team. • Participate in a proactive manner in the conduct of MDTs, identifying opportunities to prepare and present clinical material, and offering and defending expert opinion and advice. • Contribute to the preparation and adoption of clinical protocols and clinical guidelines, and analyse the impact on clinical practice.	1.3.1 1.3.2 3.1.14 3.1.16 3.2.4
	5. Perform systematic clinical audit to critically evaluate the performance and suitability of investigations offered, share the outcome of each audit and, where appropriate, justify a modification to practice based on the audit findings. • Initiate, perform and communicate the outcomes of clinical audits of the effectiveness of routine and non-routine clinical investigations, considering national and local audit priorities and in accordance with the governance regulations. • Identify, critically evaluate and communicate the outcomes of clinical audits performed by others in relevant areas of clinical practice and justify a decision to adapt practice as appropriate. • In partnership with service users devise, develop, perform and critically evaluate clinical audits in their own area of expertise to identify areas of good practice and areas for improvement. • Analyse and report the outcomes of clinical audits, including learning points and modifications	1.1.11 2.2.2 3.1.17

Topic	Clinical Practice	GSP reference
	introduced as a result of the clinical audit.	
Attitudes and behaviours	By the end of the training period the Clinical Scientist in HSST would be expected to demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and will be able to: 1. Commit to and provide leadership in the provision of high standards of clinical practice, taking account of the political, social, technical, economic, organisational and professional environment, and act as a positive role model. • Perform the role to high standards of clinical practice, applying knowledge and evidence, making decisions and evaluating the impact of those decisions. • Monitor, evaluate and maintain clinical practice standards. • Share data on clinical practice standards with service users and managers to encourage dialogue and debate. 2. Evaluate and use new research findings and new technology to plan, develop and deliver improved clinical investigations. • Analyse and use research findings and new technology in bringing about quality improvements in clinical investigation. • Use and critically review a range of sources of information to keep up to date with clinical and scientific developments in their area of expertise. • Share ideas on improvements to clinical investigations with peers and service users, setting out the context for change and evaluating the impact of any resulting change. 3. Engage in two-way clinical liaison between those who request and those who provide clinical investigations for individual patients, using the skills of team members effectively. • Lead and promote a culture of interaction with service users and patients. • Analyse, critically review, generate and revise clinical protocols and guidelines, and evaluate how protocols and guidelines contribute to standards of clinical practice. • Train and empower colleagues to participate in two-way clinical liaison. • Initiate an audit of effectiveness of clinical liaison, identifying areas for improvement and collaborating with colleagues to bring about change.	3.1.1 3.1.2 3.1.3 3.1.14 3.1.5 3.1.6 3.1.9 1.3.1 3.1.4 3.1.12 3.1.13 3.1.14 3.2.4

Topic	Clinical Practice	GSP reference
	4. Promote the importance of active participation by Clinical Scientists in MDT meetings to advise and provide a scientific perspective. • Recognise the importance of the MDT and take responsibility for ensuring appropriate and effective decision-making processes are in place. • Support and contribute to the development of multidisciplinary clinical team working and work with the team to determine scientific service priorities. 5. Advocate clinical audit as a tool to evaluate and optimise clinical services and communicate ideas and aspirations. • Support the role of clinical audit as a valid tool to improve clinical effectiveness and patient care. • Commit to training of self and others to enable clinical audit to proceed. • Share the outcomes (both positive and negative) of clinical audits with service users and peers, having regard for clinical governance consequences.	1.3.2 3.1.16 1.1.11 1.3.6 2.2.2 3.1.17

Domain 4: Research, Development and Innovation

Topic	Research, Development and Innovation	GSP reference
Learning objective	By the end of this stage of training the Clinical Scientist in HSST will be able to generate ideas, assess, plan, conduct, supervise, critically evaluate, interpret and report research and innovation projects, which includes original research, translational research and innovation, and the adoption and diffusion of the findings/output.	
Knowledge	By the end of the training period the Clinical Scientist in HSST will be able to: 1. Justify the stages of the research and innovation process from conceptualisation to dissemination and, if appropriate, translation into practice. • Describe the stages of the innovation pathway (Invention, Evaluation, Adoption and Diffusion). • Critically evaluate the literature/evidence base to identify the research question or create a new approach, technique, etc. • Evaluate the clinical importance of any proposed research project and recognise its potential impact on patients and carers. • Recognise the priorities and factors affecting research and innovation in the area of study, and the practical and financial criteria and constraints affecting research. • Appraise healthcare research and innovation funding policy and strategy. • Evaluate the organisation's research, development and innovation policy and strategy, and how this aligns to national policy of the NHS, higher education sector, research councils and charities. • Summarise the organisation's policy with respect to research ethics and regulatory requirements from conception to archive, and justify how this protects the researcher, research subjects and the organisation. • Summarise the sources of funding/grants and provision of expert advice on research funding, how to access them and when to use them. • Identify and evaluate sources of information and expert advice. 2. Justify the rationale for research governance and ethical frameworks when undertaking research or innovation as a principal investigator or supervising others. • Describe the regulatory requirements, including the Research Governance Framework, Ethical Framework and intellectual property that must be considered in the area of study to ensure good	1.1.5 4.1.1 4.1.2 3.1.7 4.1.3 4.1.4

Topic	Research, Development and Innovation	GSP reference
	clinical practice. • Conform to the requirements of data protection and confidentiality guidelines. • Identify and evaluate the possible risks associated with the research or innovation project, appraising the options in terms of benefits and risks and judging how to manage these. • Recognise the right of pressure groups and others who may oppose the research to present the justification for their views. • Justify the benefits of using project management techniques and tools and how to apply them at strategic level. • Describe the scope, objectives and implications of the specific research programme. • Define the roles and responsibilities of those involved in the research programme and clearly set out the relevant lines of communication and authority for the research programme. • Summarise the monitoring and reporting procedures relevant to the research or innovation project and the importance of these procedures as part of the quality assurance programme. 3. Critically appraise the results of a research and development project, draw conclusions in the correct clinical context and, where appropriate, use them to plan follow-up research and development. • Critically appraise the literature review and determine that the conclusions drawn from the evidence supports the hypothesis to be tested. • Evaluate the research plan and its ability to confirm or refute the hypothesis, and address the ethical issues and the extent to which patients/service users/experts have been involved in the design of the study. • Evaluate criteria/metrics for assessing and grading research data and publications in the scientific, NHS and Higher Education sectors. • Summarise and apply the criteria for assessing diagnostic accuracy (e.g. Standards for Reporting of Diagnostic Accuracy, STARD). • Critique methods of capturing and storing data relevant to the research programme, including the ethical issues relating to access to and use of information. • Compare and contrast the range of formats and modes of presentation of data, and defend the methods selected.	2.1.6 3.1.12 3.1.13 3.1.14 4.1.5 4.1.6 4.1.7

Topic	Research, Development and Innovation	GSP reference
	• Apply relevant methods and techniques to analyse results, ensuring the integrity of the data. • Critically appraise the data analysis strategy, including power calculations, and apply relevant statistical methods, seeking advice from experts when required. Defend personal role and responsibilities in respect of interpretation and analysis of research results and levels of authority in respect of interpretation and analysis of research results.	
	4. Appraise the ways in which research and development findings can be disseminated among the scientific community, including peers and other stakeholders in interested parties.	
	• Compare and contrast methods of presenting research (written and oral) and identify the strengths of each method with respect to the target audience. • Identify and, if necessary, seek expert advice with respect to potential intellectual property issues that did not arise in the planning stage, and the implications for publishing. • Summarise the requirements for publications submitted to scientific, education and similar journals, including the current conventions in respect of bibliography and referencing of information, and the implications of open-access publishing.	3.1.16 4.1.9 4.1.10
	5. Appraise and justify the process of translating research findings into service in the interests of patient care.	
	• Identify the likely impact of research and innovation in service design, delivery and clinical effectiveness, including reverse innovation, i.e. stopping doing something that no longer adds value. • With respect to pilot and field studies, identify possible risks, evaluate methods and techniques, and predict the expected outcomes, ensuring compliance with the relevant ethical codes and regulatory requirements. • Identify and evaluate sources of expert advice. • Appraise their own role and responsibilities within the testing process and clearly define the levels of authority and decision making within the testing process. • Describe methods of cost-benefit and cost-effectiveness analysis and how they can be applied to aid decision making with respect to introducing research findings or innovation into service. • Summarise the relevance of the Research Governance Framework to translating research or	4.1.5 4.1.10

Topic	Research, Development and Innovation	GSP reference
	adopting and diffusion of innovation into practice.	

Practical skills	By the end of the training period the Clinical Scientist in HSST would be expected to apply in practice a range of clinical skills and critically reflect on their performance and will be able to:
	• Create the initial new idea, approach, or technique and plan a research and development or innovation project, critically evaluating the research proposal and drawing on expert advice where necessary and involving patients and service users.
	  • Search for and critically appraise relevant publications in the scientific literature, relating ideas to current thinking, knowledge and research.
	  • Identify the potential for innovation in service design and delivery to enhance clinical effectiveness.
	  • Evaluate objectively and critically the feasibility and implications of investigation of the ideas and assessing the potential output, utility and impact of future study.
	  • Identify potential intellectual property (IP) associated with the ideas and the steps to be taken to register IP.
	  • Develop and maintain networks and identify potential collaborators and competition.
	  • Clearly define and prioritise the aims and objectives of the research.
	  • Specify the detailed components and proposed outputs of the research.
	  • Identify methods, tools, techniques and approaches that are capable of achieving the required outcomes.
	  • Establish evaluation criteria and methods.
	  • Identify criteria and issues affecting funding sources at a level of detail sufficient to aid decision making.
	  • Access relevant expert advice regarding sources of funding.
	  • Target appropriate sources of funding for research and innovation.
	  • Incorporate compliance with relevant ethical and regulatory requirements.
	  • Prepare and present the plan to all relevant people, in the appropriate format and by the designated deadline.
	• Conduct and/or supervise a research and development or innovation project.
		1.1.4
		1.1.5
		1.3.1
		3.1.7
		4.1.1
		4.1.2
		4.1.3
		
		1.3.1
		4.1.3

Topic	Research, Development and Innovation	GSP reference
	• Manage relationships with stakeholders and those involved to maximise effectiveness of the research programme. • Provide clear strategic direction and motivation to those involved in the research programme. • Ensure that all members of the research team understand their role and responsibilities, including lines of communication and reporting, and that appropriate training is provided. • Specify clearly the levels of authority and decision making within the research programme. • Ensure availability of and access to technical and administrative support at the appropriate level of expertise. • Conduct investigations in line with the research plan. • Document investigations and results to comply with good research practice and good clinical practice. • Document and report fully any unexpected outcomes of incidents and modify investigation accordingly. • Report any delays or problems experienced to all interested parties, giving a full explanation. • Pay proper attention to adverse events arising from investigations and take appropriate action to minimise risks. • Provide clear and timely guidance to deal with contingencies and factors influencing progress of the research programme. • Ensure compliance with the Research Governance Framework, including continuous review and quality assurance of the research and development programme, adherence to the data archive process and requirement to provide access to the data for regulatory inspections. • Critically appraise the results of a research and development project, draw conclusions in the correct clinical context and, where appropriate, use them to plan follow-up research and development. • Select the type and range of data to be collected in line with the research plan, including primary and secondary sources. • Ensure that records comply with relevant legal, ethical and organisational requirements. • Ensure that records of research data are complete and accurate. • Assess the research information collected for its validity and reliability.	4.1.4 4.1.5 4.1.8 4.1.5 4.1.6 4.1.7

Topic	Research, Development and Innovation	GSP reference
	• Select techniques of analysis and evaluation that are valid, reliable and appropriate to the research design and purpose. • Collate, record and analyse information accurately to produce justifiable results. • Verify the analysis using accepted and valid techniques, including statistical tests. • Assess the results of research against the original objectives. • Assess the clinical significance and impact of the research. • Where the research has failed to achieve its objectives, investigate the reasons and provide a clear explanation. • Draw conclusions from results and explain the rationale for those conclusions.	4.1.10
	• Report and communicate research, development, or innovation to peers and other interested parties, including patients and service users. • Report and endeavour to publish all research, including negative findings. • Define the key purpose and objectives of the research programme and match results to these objectives. • Produce findings in a format appropriate to purpose and in line with relevant legal, ethical and organisational requirements. • Record accurately issues of copyright, declaration of interest and intellectual property rights. • Present findings in a format, language and style suitable for the target audience. • Include all relevant bibliographic references in line with current conventions. • Make a clear distinction between the results and the interpretation placed on them. • Support the presentation with sufficient information to clarify key points. • Support presentation conclusions with reasoned argument and sufficient evidence. • Make recommendations that are realistic, relevant and clearly defined. • Acknowledge collaborators, contributors and funding sources. • Effectively respond to questions and critical comments. • Observe time limitations for oral presentations and deadlines for written presentations.	4.1.9 4.1.10
	• Translate research findings or innovation solutions into service and provide examples of where this	

Topic	Research, Development and Innovation	GSP reference
	has been achieved • Realign research findings or innovative approaches to create a service development or change plan. • Assess the impact of research on innovation in service design and delivery. • Complete pilot and field studies in line with the plan. • Identify and report potential risks associated with the conduct of pilot and field studies. • Maintain records of all pilot and field studies in accordance with the plan. • Present documentation and provide verbal feedback as required by the plan. • Document and report any unexpected outcomes or incidents. • Report any delays or problems experienced to authorised personnel with the relevant degree of urgency. • Report on cost-benefit analysis of implementation.	4.1.5 4.1.10
Attitudes and behaviours	By the end of the training period the Clinical Scientist in HSST would be expected to demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and will be able to: 1. Evaluate current debates and information and identify opportunities for research, development and innovation, identifying and solving problems. • Understand the impact of current clinical outcomes on patients and carers in their research area. • Accept the need to mitigate factors that limit current clinical outcomes and patient experience in their research area. • Explore areas of clinical practice where significant improvements could contribute to better clinical outcomes and/or patient experience. • Recognise the opportunities for innovation in service design and/or delivery. • Use examples from the literature and their own experience where research, development and innovation have contributed to better clinical outcomes and/or patient experience. 2. Apply rigorous standards to the conduct of research, development and innovation. • Adhere to and accept and work within current research ethics and research governance requirements applicable within the organisation, raising concerns when necessary.	4.1.1 4.1.2

Topic	Research, Development and Innovation	GSP reference
	• Promote methods for defining and demonstrating compliance with relevant research ethics and research governance requirements. • Adhere to and accept methods for external assessment of compliance with research ethics and research governance requirements, and learn from the process. • Critically reflect on and use examples of problems encountered by others when compliance with research ethics and research governance requirements was inadequate, and apply learning to all aspects of research, development and innovation.	4.1.4
	3. Commit to and lead collaborative research in the interests of improving clinical outcomes and/or patient experience. • Accept and value the knowledge and experience that each research collaborator can bring to the planning, implementation and evaluation of a research project, listening to and evaluating the views of others. • Promote the importance of the MDT in setting practice standards and in auditing outcome against those standards. • Identify and promote the benefits to their own specialism by being a partner in collaborative research.	
	4. Commit to sharing and disseminating research findings and the outcome and learning from innovation projects with peers. • Accept the benefits and constraints of patents and confidentiality in research outcomes and innovation opportunities. • Collaborate with a group of peers with an interest in improving clinical outcomes and/or patient experience in the same area of research to create opportunities for research, development and innovation. • Facilitate peer discussions on the value of current research and the opportunities for new research, be open to challenge and revise views in response to discussion when necessary. • Promote opportunities to present research findings to peers and critically appraise the research findings of others.	4.1.3 4.1.10
	5. Actively seek opportunities to translate research findings and the diffusion and adoption of innovation	

Topic	Research, Development and Innovation	GSP reference
	into clinical practice. • Challenge and influence to mitigate current barriers to the translation of research findings or new, innovative ways of working into clinical practice across the organisation and, where appropriate, nationally. • Promote opportunities to undertake targeted translational research and innovation, encouraging the contribution of the healthcare team. • Identify examples of where the translation of research findings into practice has resulted in improved clinical outcomes and/or patient experience to influence the translation, adoption and diffusion of new findings, negotiating, questioning and challenging where necessary. • Promote the importance of innovation in service design and/or delivery, including the contribution of research and innovation in healthcare to business and the UK economy. • Engage service users, patients and the public to promote the positive impact of research and innovation on clinical outcomes and/or patient experience.	4.1.6 4.1.7 4.1.9 4.1.9 4.1.10

Domain 5: Clinical Leadership

Topic	Clinical Leadership	GSP reference
Learning objective	By the end of this stage of training the Clinical Scientist in HSST will be able to critically appraise the evidence base underpinning clinical leadership frameworks and operate as a clinical leader involved in the planning, delivery and transformation of health and social care services.	
Knowledge	By the end of the training period the Clinical Scientist in HSST will be able to:	
	1. Evaluate the personal qualities required of a clinical leader and critically reflect on performance to identify their own personal qualities, including values, principles and assumptions, developing action plans to adapt personal behaviour as necessary.	1.1.2 1.1.3 1.1.5 1.1.6 1.1.7 5.1.1
	• Critically appraise models of leadership, including the shared or distributed model for organisations where tasks are more complex and highly interdependent. • Evaluate a range of tools that enable exploration of the ways in which individual behaviours impact on others. • Evaluate a range of feedback models to obtain and respond to feedback from others. • Review and justify the use of a range of tools and techniques for managing stress, including occupational health and other support networks. • Recognise the importance of best practice, transparency and consistency. • Summarise the professional, legal and ethical codes of the HCPC and other relevant bodies. • Evaluate a range of tools to identify personal preferences and prejudices and those within others, society and cultures.	
	2. Evaluate the importance of working with others in teams and networks to deliver and improve services.	1.3.1 1.3.2 1.3.5 5.1.2 5.1.4 5.1.5 5.1.7
	• Discuss the role of team dynamics in the way a group, team, or department functions. • Evaluate a range of team structures and the structure, roles and responsibilities of the MDTs within the broader health context relevant to the specialism, including other agencies and the impact of different structures on the delivery of care. • Critique a range of techniques and methods that facilitate effective and empathic communication and the evidence base underpinning them.	

Topic	Clinical Leadership	GSP reference
	• Evaluate a range of models to facilitate conflict resolution. • Critically explore a range of leadership styles and approaches and identify the applicability, strengths and weakness of each to different situations and people. 3. Critically evaluate methods by which services may be planned and people and resources managed effectively. • Summarise the structure, financing and operation of the NHS and its constituent organisations and compare this with other systems of healthcare. • Analyse and justify the ethical and equality aspects relating to management and leadership, e.g. approaches to use of resources/rationing and approaches to involving services users in decision making. • Discuss business management principles: priority setting and basic understanding of how to produce a business plan. • Identify the requirements of running a department, unit, or practice relevant to their specialism. • Justify the allocation of funding to scientific services and evaluate how clinical resources to provide high-quality care should be allocated, considering the financial constraints of the NHS and local organisations. • Summarise the commissioning, funding and contracting arrangements relevant to their specialism, including education, training and CPPD. • Critique relevant legislation (e.g. equality and diversity, health and safety, employment law) and local human resources policies and the impact of these policies on people and the organisation. • Discuss the duties rights and responsibilities of an employer and of a co-worker. • Justify the role of individual performance review, considering its purpose, techniques and processes, including the difference between appraisal, assessment and revalidation. • Compare and contrast methods to measure and manage the performance of the organisation. • Analyse the source of complaints, and review and reflect on how complaints are managed and the learning that is fed back into the organisation to improve the patient and staff experience. • Critically evaluate how clinical leadership can support the delivery of high-quality services and service improvements and the methods by which these may be achieved. Evaluate risk	5.1.1 5.1.6

Topic	Clinical Leadership	GSP reference
	management issues pertinent to the area of practice and wider organisation, identifying potential sources of risk and risk management tools, techniques and protocols. • Summarise how healthcare governance influences patient care, research, innovation and educational activities at local, regional and national level. • Summarise key government reports on maintaining professional standards and discuss the mechanism for raising issues where you consider that standards are being compromised ('whistleblowing'). • Appraise quality improvement methodologies, including a range of methods obtaining feedback from users, staff, patients and the public, and explore the impact on patients, services and the organisation. • Discuss the principles and processes of evaluation, audit, research and development, innovation, clinical guidelines and standard setting in improving quality, and identify barriers to the adoption and success of each measure in practice. • Identify a variety of methodologies for developing creative solutions to improving services. • Explore the implications of change on systems and people, and methods to minimise the negative effects of change, including strategies for motivating people to change and the effect of organisational culture. • Describe project management methodology and how it can be used during change. 4. Justify the importance of strategic planning in line with the aspirations of the organisation. • Summarise the responsibilities of the various Executive Board members and Clinical Directors or leaders. • Summarise the functions and responsibilities of national bodies such as the Department of Health (DH), Care Quality Commission (CQC), NHS Evidence, National Patient Safety Agency (NPSA), Medicines and Healthcare products Regulatory Agency (MHRA), Royal Colleges and faculties, specialty organisations, representative bodies, regulatory bodies, educational and training organisations. • Analyse patient outcome reporting systems within the specialism and the organisation, and how these relate to national programmes. • Summarise how research, development and innovation contribute to strategic planning.	1.1.12 2.2.2 2.3.2 2.3.2 2.3.3 2.3.4 3.1.17 5.1.8 5.1.10 5.1.11 1.3.1 1.3.3

Topic	Clinical Leadership	GSP reference
	• Critically review the decision making for individuals, teams and the organisation, and the impact on service delivery and patient care. • Compare and contrast a range of communication strategies and identify the factors that promote effective communication strategies within organisations. • Explore methods of undertaking impact mapping of service change and how this can support the process of change. • Identify barriers to change and how to develop strategies to explore and break down barriers. • Summarise qualitative methods to gather and analyse the experience of users, patients and carers, and utilise the data to recognise areas of good practice/planning and help shape the planning process.	5.1.1 5.1.6 5.1.12
Practical skills	By the end of the training period the Clinical Scientist in HSST would be expected to apply in practice a range of clinical skills and critically reflect on their performance and will be able to: 1. Demonstrate through personal example their own personal qualities, including values, principles and assumptions, and critically reflect on personal performance and: • Maintain and routinely practise critical self-awareness, including ability to discuss strengths and weaknesses with their supervisor, recognising external influences and changing behaviour accordingly. • Show awareness and sensitivity to the way in which cultural and religious beliefs affect approaches and decisions, and respond effectively. • Recognise the manifestations of stress on self and others and know where and when to look for support. • Balance personal and professional roles and responsibilities, prioritising tasks and having realistic expectations of what can be completed by self and others. • Use a reflective approach to practice with an ability to learn from previous experience. • Use assessment, appraisal, complaints and other feedback to discuss and develop an understanding of their own development needs. • Recognise, analyse and know how to deal with unprofessional behaviours in clinical practice, taking into account local and national regulations.	1.1.12 1.2.3 5.1.1 5.1.2 5.1.3 5.1.4 5.1.12 1.3.4

Topic	Clinical Leadership	GSP reference
	• Create open and non-discriminatory professional working relationships with colleagues, including awareness of the need to promote equality of opportunity and to prevent bullying and harassment in the workplace. 2. Work with others in teams and networks to deliver and improve services. • Work in differing and complementary roles within the different communities of practice within which they work. • Support bringing together different professionals, disciplines and other agencies to provide high-quality healthcare. • Develop effective working relationships with colleagues and other staff through good communication skills, building rapport and articulating their own views. • Communicate effectively in the resolution of conflicts, providing feedback and identifying and rectifying team dysfunction. • Facilitate, chair and contribute to meetings within the department, the organisation, national societies/professional bodies. • Encourage staff to develop and exercise their own leadership skills. • Enable individuals, groups and agencies to implement plans and decisions. • Identify and prioritise tasks and responsibilities, including delegation and safe supervision. 3. Manage services effectively, using critical reflection to evaluate and improve personal performance. • Develop and implement protocols and guidelines. • Analyse feedback and comments and integrate them into plans for the service. • Use clinical audit with the purpose of highlighting resources required. • Manage time and resources effectively in terms of delivering services to patients. • Prepare rotas, delegate, organise and lead teams. • Contribute to the recruitment and selection of staff. • Contribute to staff development and training, including mentoring, supervision and appraisal. • Use and adhere to clinical guidelines and protocols, relevant reporting systems and complaints management systems.	1.3.5 1.3.6 5.1.1 5.1.2 5.1.3 5.1.4 5.1.10 1.4.1- 1.4.6 5.1.5 5.1.6 5.1.8 5.1.9 5.1.10 5.1.11

Topic	Clinical Leadership	GSP reference
	• Improve services following evaluation/performance management.	
	4. Contribute to continuous service improvement, developing improvements to service and reflecting on experience to ensure the delivery of high-quality services.	1.1.11
	• Report clinical incidents in accordance with reporting procedures. • Assess and analyse situations, services and facilities, implementing recommendations to minimise risk to patients and the public. • Monitor the quality of equipment and safety of the environment relevant to the specialism, acting swiftly to resolve issues. • Design and undertake an audit project, present the results and develop an implementation and re-evaluation plan as appropriate to the audit. • Contribute to meetings that cover audit, critical incident reporting, patient outcomes challenges, justifying and influencing as appropriate. • Question and challenge existing practice in order to improve services. • Apply creative thinking approaches (or methodologies or techniques) to propose solutions to service issues. • Provide clinical expertise in evolving situations. • Present written and verbal information in a clear, concise way, using language appropriate to the audience.	1.4.4 1.4.5 1.4.6 5.1.3 5.1.7 5.1.8
	5. Contribute to and undertake strategic planning in line with the aspirations of the organisation and its impact on service quality and delivery.	5.1.1
	• Discuss the local, national and UK health priorities and how they impact on the delivery of healthcare relevant to the specialism. • Identify trends, future options and strategy relevant to the specialism and delivering patient services. • Compare and benchmark healthcare services. • Use a broad range of scientific and policy publications relating to delivering healthcare services. • Prepare for meetings – reading agendas, understanding minutes, action points and background	5.1.12

Topic	Clinical Leadership	GSP reference
	research on agenda items. • Work collegiately and collaboratively with a wide range of people outside the immediate clinical setting. • Evaluate outcomes and re-assess the solutions through research, audit and quality assurance activities. • Evaluate the wider impact of implementing change in healthcare provision and the potential for opportunity costs.	
Attitudes and behaviours	By the end of the training period the Clinical Scientist in HSST would be expected to demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and will be able to: 1. Operate consistently within a sphere of personal capability and level of authority, managing personal workload and objectives to achieve quality of care. • Adopt a patient-focused approach to decisions that acknowledges the right, values and strengths of patients and the public. • Comply with relevant legislation to recognise and show respect for diversity and differences in others. • Be conscientious, able to manage time and delegate responsibly. • Recognise personal health as an important issue in maintaining personal capability. • Accept responsibility for their own actions. • Commit to CPPD, which involves seeking training and self-development opportunities, learning from colleagues and accepting constructive criticism. • Accept professional regulation and ensure compliance with relevant standards. • Promote appropriate professional attitudes and values. • Act with probity and be willing to be truthful and admit to and learn from errors. 2. Actively seek to encourage and work within a team environment, including MDTs. • Interact effectively with professionals in other disciplines and agencies. • Respect the skills and contributions of colleagues. • Recognise good advice and continuously promote value-based, non-prejudicial practice.	1.1.3 1.1.4 1.1.6 5.1.1 1.3.1 1.3.2

Topic	Clinical Leadership	GSP reference
	• Use authority appropriately and assertively, being willing to follow when necessary. • Use authority sensitively and assertively to resolve conflict and disagreement. • Take full part in MDT meetings. • Show recognition of a team approach and willingness to consult and work as part of a team. • Respect colleagues and other healthcare professionals. 3. Manage resources effectively in the interests of improving patient services, promoting equity in healthcare access and delivery. • Use public money appropriately and take action when resources are not used efficiently or effectively. • Recognise that in addition to patient-specific clinical records, clinical staff also have responsibilities for other records (e.g. research). • Supervise the work of less experienced colleagues, supporting them to develop. • Use communication skills and inspire confidence and trust. • Respond constructively to the outcome of reviews, assessments, or appraisals of performance. • Recognise the needs of all staff in the clinical team. 4. Engage in continuous service improvement in the interests of better patient outcomes. • Actively seek advice/assistance whenever concerns about patient safety arise. • Take responsibility for clinical governance activities, risk management and audit in order to improve the quality of the service. • Listen to and reflect on the views of users, patients and carers, dealing with complaints in a sensitive and cooperative manner. • Act as an advocate for the service. • Be open-minded to new ideas. • Adopt a proactive approach to new technologies and treatments. • Support colleagues to voice ideas. • Be positive about improvement and change. • Strive for continuing improvement in delivering patient care services.	1.3.1 1.3.5 5.1.2 5.1.6 5.1.11 1.1.12 1.2.2 3.1.17 5.1.6 5.1.7 5.1.8

Topic	Clinical Leadership	GSP reference
	5. Contribute to articulating the aspirations of the organisation and be willing to align strategic planning with these aspirations to improve service quality and delivery. • Comply with national guidelines that influence healthcare provision. • Articulate ideas and use effective influencing skills. • Identify and reflect on issues and potential solutions before acting. • Understand the importance of involving service users, the public and communities in developing health services. • Participate in decision-making processes beyond the immediate clinical care setting. • Implement proven improvements in clinical practice and services. • Obtain and analyse the evidence base before declaring effectiveness of changes. • Support the dissemination of good practice.	5.1.10 5.1.11 5.1.10 5.1.11 5.1.12

SECTION 4: CARDIAC SCIENCE SCIENTIFIC AND CLINICAL SYLLABUS

Introduction

The precise composition of an individual training programme should be structured around NHS workforce need, the past experience and aspirations of each Clinical Scientist in HSST and should set out educational objectives against which progress can be assessed. Programmes should identify how specific areas of training not covered by the departments involved will be obtained (e.g. secondment for experience in subspecialist areas).

Dependent on the site and nature of their clinical practice during higher specialist scientist training, Clinical Scientists in HSST will follow the Stage 1 Cardiac Science curriculum in either an adult or congenital heart disease/paediatric cardiac setting, although may need to spend some time on secondment to settings out with their own department to achieve all of the learning outcomes. The HSST curriculum for Cardiac Science follows.

STAGE 1
Stage: Common Clinical Skills
1(i): Advanced History Taking

Topic	Advanced History Taking	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to advanced history taking, will be able to critically analyse, synthesise, evaluate and apply their expert knowledge, perform and master a range of clinical skills and consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and be able to: • elicit a relevant focused history from patients with increasingly complex issues and in increasingly challenging circumstances; • record the history accurately and synthesise this with relevant clinical examination; • formulate a management plan that takes account of likely clinical evolution. ***All Clinical Scientists in HSST working in a paediatric setting or who see patients of paediatric age in their practice must be appropriately trained in child safeguarding.***		

Topic	Advanced History Taking	Assessment methods	GSP reference
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and critically apply their expert knowledge with respect to history taking in adult and paediatric patients as appropriate to their clinical practice, including: • protecting patients of paediatric age and vulnerable adults from maltreatment, abuse, neglect, or exploitation (safeguarding); • the importance of different elements of the patient history; • patients not always presenting their history in a structured fashion; • likely causes of and risk factors for conditions relevant to the presentation; • the way that the history should inform examination, investigation and management.		1.1.1 1.2.1 3.1.2 3.1.6 3.1.15
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a range of clinical skills in adult and paediatric patients as appropriate to their clinical practice. This will span history taking, examination, decision making, diagnostic skills, interpretation of physiological and laboratory measurements, communication with the multidisciplinary team and patients. They will also be expected to have a critical understanding of current research and its application to the performance, adaptation and mastery of the range of these clinical and communication skills and will: • clearly explain the role of the Clinical Scientist/Consultant Clinical Scientist to the patient and if necessary the differences between them and a medical consultant; • find clues in the cardiac history to allow for provisional diagnosis and planned management; • recognise and overcome barriers to effective communication, manage time and draw consultation to a close appropriately; • supplement history with standardised instruments/questionnaires when relevant; • manage alternative and conflicting views from family, carers and friends; • assimilate history from the available information from patient and other sources; • recognise and interpret the use of non verbal communication from patients and carers;		2.1.6 3.1.6

Topic	Advanced History Taking	Assessment methods	GSP reference
	• focus on relevant aspects of cardiac history; • reflect on the challenges of applying research to practice in relation to these procedures and suggest improvements, building on a critique of available evidence.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, showing respect and behaving in accordance with *Good Scientific Practice*.		1.1.1 1.1.2 1.1.3 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.3

1(ii): Performing a Focused, Relevant Clinical Examination

Topic	Performing a Focused, Relevant Clinical Examination	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to performing a focused, relevant clinical examination in adult and paediatric patients as appropriate to their clinical practice, will be able to critically analyse, synthesise, evaluate and apply knowledge, perform a range of technical procedures and clinical skills, and demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist and be able to: • perform a focused, relevant and accurate clinical examination in patients with increasingly complex issues and in increasingly challenging circumstances; • relate physical findings to history in order to establish diagnosis(es) and formulate a management plan. ***All Clinical Scientists in HSST working in a paediatric setting or who see patients of paediatric age in their practice must be appropriately trained in child safeguarding.***		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge with respect to clinical examination, including: • protecting patients of paediatric age and vulnerable adults from maltreatment, abuse, neglect or exploitation (safeguarding); • the anatomical and physiological basis for clinical signs and the relevance of positive and negative physical signs; • the need for a relevant and targeted physical examination as appropriate in the role of a Consultant Clinical Scientist, knowing when to refer to medical colleagues for further expertise. • constraints (including those that are cultural or social) to performing physical examination and strategies that may be used to overcome them; • the limitations of physical examination, in particular in relation to the role of a Consultant Clinical Scientist, and the need for adjunctive forms of assessment to confirm diagnosis when the offer/use of a chaperone is appropriate or required.		1.1.1 1.1.2 1.1.3 1.1.7 3.1.1 3.1.2 3.1.8

Topic	Performing a Focused, Relevant Clinical Examination	Assessment methods	GSP reference
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to undertake a range of clinical skills in adult and paediatric patients as appropriate to their clinical practice. This will include history taking, examination, decision making, diagnostic skills, interpretation of physiological and laboratory measurements, communication with the multidisciplinary team and patients. They will also demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills, and will: • perform a thorough cardiovascular examination that is valid, targeted and time efficient, and elicit physical signs that are relevant to the presentation, both positive and negative physical signs; • ascertain the possibility of deliberate harm in vulnerable patients and report suspicions to appropriate agencies; • elicit important clinical findings. • identify the important signs of valvular disease and heart failure; • elicit the signs of widespread cardiovascular atheromatous disease; • perform the relevant adjunctive examinations; • gain appropriate informed consent prior to undertaking examination; • reflect on the challenges of applying research to practice in relation to these procedures and suggest improvements, building on a critique of available evidence.		3.1.1 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff and including: • showing respect and behaving in accordance with *Good Scientific Practice*; • ensuring that examination, while clinically appropriate and within the constraints of		1.1.1 1.1.2 1.1.3 1.1.7 1.1.9 1.1.10 1.2.1

Topic	Performing a Focused, Relevant Clinical Examination	Assessment methods	GSP reference
	the role of Consultant Clinical Scientist, considers social, cultural and religious boundaries; • appropriately communicating findings and making alternative arrangements where necessary.		1.3.1 5.1.3

1(iii): Therapeutics in Cardiac Science

Topic	Therapeutics in Cardiac Science	Assessment methods	GSP reference
Learning objectives	Clinical Scientists in Cardiac Science are not currently permitted to issue prescriptions as either supplementary or independent prescribers. However, there are circumstances known as patient-specific directions whereby medicines can be given by another professional following the directions of an approved prescriber. Provider organisations should have arrangements in place that enable these legal requirements to be implemented. This therapeutics module is included in this HSST curriculum to provide the underpinning knowledge and understanding of a range of therapeutics utilised within Cardiac Science to support the Clinical Scientist in HSST to work with other clinicians and healthcare professionals as part of the multidisciplinary team. By the end of this module the Clinical Scientist in HSST, in respect to Cardiac Science, will be able to critically analyse, synthesise, evaluate and apply knowledge of appropriate cardiac-specific therapeutic interventions relevant to clinical practice, including non-medication-based therapeutic and preventative interventions (e.g. pacemaker programming) within the scope of practice of a Consultant Clinical Scientist.		
Knowledge	By the end of this module the Clinical Scientist in HSST, with respect to their clinical practice/scope of practice, will analyse, synthesise, critically evaluate and apply their knowledge with respect to the: • mode of action, indications, contraindications, side effects, interactions and dosages of commonly used cardiac drugs in adult and paediatric patients; • range of adverse reactions to commonly used drugs, including complementary medicines; • practical challenges and psychological barriers that adversely impact on patient adherence and strategies that support patients and improve adherence; • drugs requiring therapeutic monitoring and interpretation of the results; • involvement of patients/carers in shared decision making in their treatment and care; • use of medications appropriate for use in pregnancy and during breast feeding; • prescribing and medication errors in adults and children and strategies to reduce errors; • tools used to promote patient safety in prescribing, including electronic clinical		1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 1.3.1 1.3.2 2.1.1 2.2.9 3.1.8 3.1.12

Topic	Therapeutics in Cardiac Science	Assessment methods	GSP reference
	record systems and other IT systems; • effects of age, body size, organ dysfunction and concurrent illness on drug distribution and metabolism relevant to the Clinical Scientist in HSST's practice; • the importance of following updates on drug trials in cardiac drugs in paediatrics; • roles of regulatory agencies involved in drug use, monitoring and licensing (e.g. National Institute for Clinical Excellence [NICE], Committee on Safety of Medicines [CSM], Medicines and Healthcare products Regulatory Agency [MHRA] and hospital formulary committees); • safety and efficacy of treatment strategies in relation to the design of clinical trials, including ethical/regulatory approval from relevant bodies such as the UK Gene Therapy Advisory Committee, MHRA, on-site research governance committee and local ethics committee, compliance with *Good Clinical Practice*, EU Directive 2001 and Declaration of Helsinki.		
Clinical skills	Although not undertaking independent prescribing of medications, by the end of this module the Clinical Scientist in HSST will be expected to critically reflect and apply in practice a range of clinical and communication skills to advise and communicate effectively with relevant clinicians and other healthcare professionals and will, within the multiprofessional team: • review the continuing need for, the effect of including adverse drug interactions and the adverse effects of long-term cardiac medications relevant to the Clinical Scientist in HSST's clinical practice; • recognise and anticipate avoidable defined drug interactions, including with complementary medicines; • suggest appropriate dose adjustments following therapeutic drug monitoring or physiological change (e.g. deteriorating cardiac function); • employ validated methods to improve patient compliance with prescribed medication; • provide comprehensible explanations for the use of drugs to the patient and to carers when relevant;		1.1.3 1.1.4 1.1.5 1.1.6 2.2.9 3.1.5 3.2.3

Topic	Therapeutics in Cardiac Science	Assessment methods	GSP reference
	• the principles of compliance in ensuring that drug regimens are followed; • utilise non-medication based therapeutic interventions and preventative health interventions.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and will: • recognise the benefit of minimising the number of medications and interventions taken by a patient to a level compatible with best care; • remain open to advice from other health professionals on medication issues; • ensure information is shared promptly and accurately with a patient's health providers, including between primary and secondary care; • participate in adverse drug event reporting processes; • remain up to date with therapeutic alerts and respond appropriately.		1.1.1 1.3.1 1.3.2 3.1.5

1(iv): Resuscitation – Immediate Life Support

Topic	Resuscitation – Immediate Life Support	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to immediate life support, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform and master intermediate life support. They will also consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist while resuscitating adult and paediatric patients if appropriate.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge and the underpinning evidence base with respect to resuscitation, including: • current guidelines on resuscitation and the underpinning evidence base; • the principles of cardiopulmonary resuscitation; • cardiac and non-cardiac causes of cardiac arrest.		1.1.4 1.1.5 3.1.3 3.1.5
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to master: • immediate life support (ILS), including the successful completion of an ILS course.		3.1.10 3.1.13 3.1.15
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff and will: • support relatives; • appreciate the legal and ethical considerations of resuscitation; • be familiar with the legal and ethical issues associated with 'do not attempt resuscitation' orders.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2

Topic	Resuscitation – Immediate Life Support	Assessment methods	GSP reference
			5.1.3

1(v): End of Life Care in Cardiology

Topic	End of Life Care in Cardiology	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to end of life care, will be able to recognise the professional role undertaken by scientific staff in end of life care of relevance to cardiac conditions in patients of all ages (e.g. valvular heart disease, heart failure, congenital heart disease) where the focus of care should change from therapies designed to alter the natural history of the disease to those aimed at symptom control, and consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge with respect to end of life care in cardiology, including: • the natural history and prognosis of chronic cardiovascular diseases (coronary artery disease, heart failure, valvular heart disease, CHD and pulmonary hypertension); • policy and practices with respect to the deactivation of implantable devices in terminally ill patients.		1.1.4 1.1.5 3.1.3 3.1.5
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills, and will: • discuss palliative care management related to devices with the patient and their family/carers; • reflect on the challenges of applying research to practice in relation to end of life care in cardiology and suggest improvements, building on a critique of available evidence.		3.1.10 3.1.13 3.1.15
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist		1.1.1 1.1.2 1.1.3

Topic	End of Life Care in Cardiology	Assessment methods	GSP reference
	in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate that palliative care is a multidisciplinary holistic approach to patient care at end of life involving the patient and their family/carers.		1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(vi) Presentation and Management of Cardiac Disorders

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to the symptoms, presentation and management of patients with cardiac conditions, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment, diagnosis and treatment of patients while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge with respect to the presenting symptoms and diagnosis of cardiac disease, including: **Symptoms that may have a cardiac cause** **Chest pain, including:** • the causes of chest pain; • differential diagnosis of a patient presenting with chest pain; • the indications, limitations, risks and predictive value of non-invasive and invasive investigations; • the associated psychological factors of patients with chest pain; • non-cardiac causes of chest pain. **Breathlessness, including:** • causes of acute and chronic breathlessness; • differential diagnosis of a patient presenting with breathlessness; • management of patients with chronic shortness of breath; • non-cardiac causes of breathlessness. **Pre-syncope and syncope, including:** • causes of syncope and pre-syncope; • indications, limitations, risks and predictive value of non-invasive and invasive		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference
	investigations; • indications for tilt table testing and loop recorders; • current recommendations concerning fitness to drive in patients with pre-syncope and syncope; • importance of the history from relatives and witnesses; • problems specific to the elderly and address their social and medical needs; • impact of syncope on patients' lifestyle; • non-cardiac causes of pre-syncope and syncope. **Diagnosis** **Stable angina, including:** • the pathogenesis of atheroma and the importance of risk factors; • the natural history, pathophysiology and presentations of coronary artery disease; • the pharmacology of drugs currently used in the treatment of stable angina; • the indications, limitations, risks and predictive value of non-invasive and invasive investigations; • which patients should be investigated further and referred for intervention; • the interaction of symptoms with the patient's lifestyle. **Acute coronary syndromes and myocardial infarction, including:** • the pathogenesis of acute coronary syndromes and the importance of risk factors; • the natural history, pathophysiology and acute presentations of coronary artery disease; • the pharmacology of drugs currently used in the treatment of acute coronary syndromes; • the indications, limitations, risks and predictive value of non-invasive and invasive investigations; • which patients should be investigated further and referred for intervention. **Heart failure:**		

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference
	• the aetiology, pathophysiology, diagnosis and management of heart failure; • the natural history and clinical presentation of patients with heart failure; • the pharmacology of drugs used to treat heart failure; • when and whom to refer for device therapies for heart failure (cardiac resynchronisation therapy [CRT] and implantable cardioverter defibrillators [ICDs]); • the indications for onward referral for consideration of surgical interventions (including valve surgery, cardiac transplantation and assist devices. **Cardiomyopathy:** • different types of cardiomyopathy; • pathogenesis, natural history and prognosis of the cardiomyopathies; • genetic basis for cardiomyopathies, especially hypertrophic cardiomyopathy; • role of screening; • role of medical therapy, implantable cardioverter defibrillators, catheter-based and surgical-based treatments of the cardiomyopathies; • indications for transplantation; • current and future application of genomics and clinical bioinformatics. **Valvular heart disease:** • the pathological processes that are responsible for valvular heart disease; • the natural history of valve disorders; • the indications, limitations, risks and predictive value of non-invasive and invasive investigations; • the indications for surgical intervention; • the different types of prosthetic valve available for clinical use; • the anticoagulation regimens appropriate for patients with valve disease and valve prostheses; • which patients need regular follow-up; • endocarditis prophylaxis protocols.		

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference

Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills appropriate to a range of cardiac disorders and will:
	
	History taking, clinical examination and investigation:
	• gain informed consent;
	• take a relevant, focused history, elicit relevant physical signs, formulate a differential diagnosis, plan appropriate further investigations and formulate an appropriate management plan;
	• perform a reliable and appropriate examination;
	• select and use investigations appropriately, which may include:
	  ▪ echocardiography
	  ▪ magnetic resonance imaging (MRI)
	  ▪ exercise testing
	  ▪ determination of oxygen consumption.
	
	Management:
	• diagnose cardiac disorders accurately;
	• recognise and respond appropriately to presence of acute coronary syndromes and myocardial infarction;
	• discuss the risks and benefits of an intervention to a patient/carer/parent in a way that they understand and answer any questions they may have;
	• recognise the role of other healthcare professionals working in this area;
	• discuss the concerns and anxiety of patients and relatives with cardiac disorders;
	• advise patients regarding lifestyle and long-term risk factor management;
	• educate patients, carers and relatives appropriately;
	• discuss sexual issues, including erectile dysfunction and use of drugs, with the patient and their partner in a sensitive manner;
			1.1.1
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			1.1.3
			1.1.4
			1.1.5
			1.1.6
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			3.1.1
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			3.1.15
			3.2.1
			3.2.2
			3.2.4

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference
	• critically reflect on the challenges of applying research to practice in relation to cardiac disorders and suggest improvements, building on a critique of available evidence; • discuss the advantages and disadvantages of medical versus surgical management in a way that patients can understand; • discuss the advantages and disadvantages of different valve prostheses with patients; • appreciate the importance of educating patients about endocarditis prophylaxis and the natural history of valvular heart disease.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the importance of the history in evaluating patients presenting with cardiac disorders; • adopt a non-judgemental and non-stereotyping approach to patients; • appreciate the anxiety and concerns of patients and relatives with cardiac disorders; • appreciate the contribution non-medical and non-cardiological disciplines have to play in the treatment of patients with cardiac disorders; • appreciate the associated psychological factors of patients with cardiac disorders; • involve/refer to other specialists, e.g. respiratory physicians, ENT, neurologists, as required, appreciating the contribution of the multiprofessional team; • appreciate the importance of lifestyle, exercise and weight loss on the management of cardiac disorders; • recognise the role of cardiac nurse specialists and cardiac rehabilitation; • appreciate the interaction of symptoms with the patient's lifestyle, including		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

Topic	Presentation and Management of Cardiac Disorders	Assessment methods	GSP reference
	occupation and leisure; • appreciate the importance of rehabilitation; • develop supportive relationships with patients with chronic cardiac disorders, e.g. heart failure; • work collaboratively as part of a multiprofessional team.		

1(vii): Cardiac Arrhythmias

Topic	Cardiac Arrhythmias	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to cardiac arrhythmias, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment and treatment of patients with a range of cardiac arrhythmias. They will be able to perform a range of technical procedures and clinical skills to: (i) explain the principles that underpin human inheritance and the role of genetic factors in cardiac disease; (ii) interpret physiological data while being cognisant of potential genetic involvement and demonstrate appreciation of the increasing relevance and application of genomic technology to cardiology. They will also consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of arrhythmias, including the: **Cardiac arrhythmias:** • genetics, genomics, pathogenesis, natural history and prognosis of arrhythmias; • methods of presentation of arrhythmias, their aetiology, recognition and management; • normal electrophysiology of the heart and the basis of arrhythmogenesis; • pharmacology of drugs currently used in the treatment of arrhythmias, including thromboprophylaxis; • indications for temporary and permanent pacemakers; • indications for electrophysiological studies and the use of radiofrequency ablation; • indications for ICDs and CRT; • current recommendations concerning fitness to drive. **Atrial fibrillation:** • epidemiology, pathophysiology and prognosis classification; • diagnosis, clinical features and impact on quality of life; • associated conditions;		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Cardiac Arrhythmias	Assessment methods	GSP reference

	• diagnostic procedures;
	• embolic complications;
	• anticoagulation options and indications;
	• management:
	  ▪ rhythm vs rate control
	  ▪ conversion to sinus rhythm
	  ▪ prevention of recurrences
	  ▪ control of ventricular rate
	  ▪ pacemaker-defibrillator therapy
	  ▪ catheter ablation or surgery
	• the importance of coexisting structural heart diseases for the outcome and management of atrial fibrillation (AF);
	• the limitations and risks of anti-arrhythmic drug therapy;
	• the importance of anticoagulant therapy;
	• the palliative nature and potential adverse effects of non-pharmacological therapies;
	• newer methods for treating AF and how to refer patients for specialist treatment when appropriate.
	
	Channelopathies and other inherited syndromes:
	• the inherited cardiac disorders presenting to cardiology:
	  • channelopathies and other inherited syndromes:
	  – long and short QT syndromes
	  – Brugada syndrome
	  – hypertrophic cardiomyopathies
	  – right ventricular arrhythmogenic cardiomyopathies
	  – catecholaminergic polymorphic ventricular tachycardia
	  – ryanodine syndrome
	  • cardiac disorders with a genetic component and multisystem disorders in		

Topic	Cardiac Arrhythmias	Assessment methods	GSP reference
	which there is potential for cardiac involvement: – neuromuscular cardiomyopathies (myotonic dystrophy) – Fabry disease • genetic disorders associated with CHD: – Down syndrome • congenital conduction disorders.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • take a relevant history, including family history, and perform an appropriate examination; • select and use investigations appropriately; • select appropriate drugs; • perform and/or interpret: • electrocardiogram (ECG) • echocardiogram • transesophageal echocardiogram • prolonged ECG monitoring exercise testing • develop appropriate antithrombotic strategies as appropriate; • select patients appropriately for cardioversion; • perform rhythm or rate control therapy; • select and refer patients for consideration of: • atrial catheter ablation or surgical ablation • pacemaker and defibrillator implantation • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients with arrythmias and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1

Topic	Cardiac Arrhythmias	Assessment methods	GSP reference
	Channelopathies and other inherited syndromes: • identify findings in physiological data associated with genetic disorders; • construct and interpret a family tree to recognise basic patterns of inheritance; • synthesise communications with respect to cardiac genetic disorders provided by clinical geneticists; • discuss genetic conditions with other professionals and patients.		3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff and will: • appreciate the anxiety patients suffer with arrhythmias and with some methods of management, e.g. ICD; • respond appropriately to anxious patients with arrhythmias and their carers and relatives, including discussing the possible management methods, e.g. catheter ablation and pacing; • work within professional limits with regard to genetic conditions and when to seek further advice; • work within a multiprofessional team to account for the fact that genetic conditions are often multisystem, hence other healthcare professionals are likely to be involved in patient care; • appreciate that genetic information impacts not only on the patient but also on their family; • consider the ethical issues involved in genetic testing, such as confidentiality, testing of children and pre-symptomatic testing.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(viii): Primary and Secondary Prevention of Cardiovascular Disease

Topic	Primary and Secondary Prevention of Cardiovascular Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to primary and secondary prevention of cardiovascular disease, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment and treatment of patients (both adults and children) with risk factors for vascular disease while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of primary and secondary prevention of cardiovascular disease, including: • how to investigate and manage patients with systemic hypertension (both primary and secondary), lipid disorders, diabetes, peripheral vascular disease, smoking and family history of cardiovascular disease; • how to calculate an individual patient's absolute risk of cardiovascular disease on the basis of standard risk factors; • the difference between relative and absolute risk; • the epidemiology of cardiovascular disease.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills, and will: • assess the prevalence of cardiovascular disease in the community in which they work; • manage risk factors appropriately for individual patients.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5

Topic	Primary and Secondary Prevention of Cardiovascular Disease	Assessment methods	GSP reference
			3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the importance of risk factor management; • appreciate racial and regional variation in cardiovascular risk factor distribution; • emphasise the central role of patient education; • offer advice and support to family members with familial disease; • make active efforts to encourage patients to adopt a healthier lifestyle with specific emphasis on risk factors; • appreciate the importance of other specialists, such as dieticians, diabetologists and nurse specialists.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(ix): Hypertension

Topic	Hypertension	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to Hypertension, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment and treatment of adult and paediatric patients with risk factors for vascular disease. They will also consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of hypertension in adult and paediatric patients as appropriate, including: • current guidelines for the diagnosis and management of hypertension and the evidence base underpinning the guidelines; • epidemiology and public health issues; • examination, investigation and management of patients with hypertension (both primary and secondary), including the role of office, home and 24-hour ambulatory blood pressure measurement; • the causes of hypertension; • assessment of patients with hypertension for end organ damage; • investigation of patients with suspected secondary hypertension; • non-pharmacological management of hypertension; • the pharmacology of drugs currently used in the treatment of hypertension indications, actions, side effects; • target blood pressure levels across the range of patients, including those with diabetes and/or renal disease; • how to identify and manage a patient with resistant hypertension; • when to refer a patient for specialist management; • emerging treatments for hypertension, including surgical treatments.		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Hypertension	Assessment methods	GSP reference
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • accurately measure blood pressure in accordance with current guidelines; • implement protocols and management plans for hypertension; • interpret appropriate biochemical investigations and imaging modalities in the diagnosis and assessment of hypertension; • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients with hypertension and achieving target blood pressure control, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence,		1.1.1 1.1.2 1.1.3 1.1.4

Topic	Hypertension	Assessment methods	GSP reference
	referring as appropriate to senior staff and will: • appreciate the racial variation in hypertension and the varying response to pharmacological treatment; • actively encourage patients to adopt a healthier lifestyle with specific emphasis on risk factors.		1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(x): Congenital Heart Disease

Topic	Congenital Heart Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to congenital heart disease, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment of adult patients with CHD. They should also consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of CHD, including: • the anatomy of the heart and great vessels, and of cardiac embryology and development; • simple and complex congenital defects and the important aspects of their management; • the natural history of simple and complex congenital conditions; • the process of transition from childhood and paediatric services to adulthood and adult services; • genetics, genomics and prenatal diagnosis; • congenital cardiac lesions and previous surgery may be associated with specific arrhythmias – the commonest emergency in patients with adult congenital heart disease (ACHD); • pulmonary hypertension complicating CHD increases the risk of iatrogenic complications; • when to seek specialist advice.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will:		1.1.1 1.1.2 1.1.3 1.1.4

Topic	Congenital Heart Disease	Assessment methods	GSP reference
	• take a relevant history and perform an appropriate examination; • interface with the paediatric team in the handover of patients from paediatric to adult services; • select and use investigations appropriately; • recognise the arrhythmias that are peculiar to some forms of CHD and require specialist advice; • formulate an appropriate management plan.		1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They should consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the importance of genetic counselling; • refer patients for a specialist opinion as necessary; • have appropriate self-confidence and recognition of limitations;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10

Topic	Congenital Heart Disease	Assessment methods	GSP reference
	• appreciate the social and emotional difficulties encountered by patients with CHD.		1.2.1 1.3.1 5.1.2 5.1.3

1(xi): Assessment of Patients with Cardiovascular Disease Prior to Non-Cardiac Surgery

Topic	Assessment of Patients with Cardiovascular Disease Prior to Non-Cardiac Surgery	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to surgical pre-assessment, will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform the specialist assessment of adult and paediatric patients with cardiovascular disease prior to non-cardiac surgery. They will also consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge with respect to the assessment of patients with cardiovascular disease prior to non-cardiac surgery.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • apply a range of cardiac investigatory techniques to assess risk prior to non-cardiac surgery for patients with cardiac disease and give advice and develop management plans with the patient and colleagues accordingly; • make an active contribution as a member of a multidisciplinary team; • reflect on the challenges of applying research to practice in relation to these procedures and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11

Topic	Assessment of Patients with Cardiovascular Disease Prior to Non-Cardiac Surgery	Assessment methods	GSP reference
			3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They should consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • communicate appropriately with the patient, placing the patient at the centre of care and considering the interplay of physiological and psychological aspects of heart disease and the importance of patient education; • prioritise the safety of the patient, recognising the importance of cardiac function in patients being considered for surgical procedures; • lead and promote a culture of interaction with service users and patients; work effectively within the multidisciplinary clinical team (including anaesthetists, surgeons and nurse specialists) and when appropriate take responsibility for ensuring appropriate and effective decision-making processes are in place; • consistently work to high standards of clinical practice, applying knowledge and evidence, making decisions and evaluating the impact of those decisions; • support and contribute to the development of multidisciplinary clinical team working and work with the team to determine scientific service priorities.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(xii): Community Cardiology

Topic	Community Cardiology	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to community cardiology, will be able to critically analyse, synthesise, evaluate and apply knowledge with respect to the structures and systems for the delivery of cardiovascular medical and scientific care to local populations. They should consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of community cardiology, including: • the policies, strategies and health data underpinning local provision of cardiac care; • the interactions of local stakeholders in the implementation of policies and strategies, including screening programmes; • how to access community support for patients/carers and the role of support groups, the voluntary sector and other agencies; • local social and cultural issues and practices that affect health inequalities and outcomes (unemployment, smoking, addictive behaviour, poverty, etc.).		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • interact appropriately with other individuals and organisations participating in the care of patients with cardiovascular disorders; • access and analyse local health data to assess the cardiovascular health needs of the local community; • reflect on the challenges of applying research to practice in relation to these procedures and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5

Topic	Community Cardiology	Assessment methods	GSP reference
			3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the differing roles and perspectives of individuals and organisations at different points on the patient pathway.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

Procedures and Investigations
1(xiii): Evidence-Based Non-Invasive Diagnostics

Topic	Evidence-Based Non-Invasive Diagnostics	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to a range of cardiac investigations, will be able to critically analyse, synthesise, evaluate and apply knowledge, select, report and interpret the results from a range of diagnostic investigations contextualised to the individual adult or paediatric patient and demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply knowledge of cardiac investigations, including the:
	• the evidence base underpinning the clinical use of non-invasive cardiac diagnostics;
	• physiology of exercise;
	• indications, analysis, reporting and interpretation of:
	  ▪ electrocardiograms (ECG, including high resolution)
	  ▪ ambulatory ECG
	  ▪ exercise testing
	  ▪ chest X-ray (CXR)
	  ▪ ambulatory blood pressure (BP)
			1.1.4
			1.1.5
			3.1.5
			3.1.8

Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to select appropriately and interpret correctly a range of diagnostic investigations in the context of individual adult and/or paediatric patients for the diagnosis and assessment of patients. They will also demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and with respect to: • ECGs • ambulatory ECG		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1

Topic	Evidence-Based Non-Invasive Diagnostics	Assessment methods	GSP reference
	• exercise testing • ambulatory BP. The Clinical Scientist in HSST will also be expected to supervise, analyse and interpret exercise tests and to reflect on the challenges of applying research to practice in relation to these procedures and suggest improvements, building on a critique of available evidence.		3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the limitations of non-invasive investigations; • appreciate the sensitivity, specificity and predictive accuracy of exercise tests.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(xiv): Echocardiography

Topic	Echocardiography	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to core echocardiography, will be able to critically analyse, synthesise, evaluate and apply knowledge, perform, interpret and report a range of echocardiographical procedures on adults and/or paediatric patients as appropriate to the clinical role and recognise the indications for advanced echocardiography, e.g. transoesophageal and stress echocardiography, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of echocardiography in adult and/or paediatric patients, including: • indications for echocardiography in emergency, inpatient and outpatient settings; • ethics and sensitivities of patient care; • principles of ultrasound imaging, spectral and colour flow Doppler, instrumentation and scanning. • standard methods of measurement and analysis; • the echocardiographic assessment of ventricular structure and function in normal and abnormal cases; • the echocardiographic assessment of the cardiac valves in normal and abnormal cases, including prosthetic heart valves; • echocardiographic assessment of the thoracic aorta in normal (e.g. screening) and abnormal cases; • use of echocardiography to assess the right heart; • measurement of pulmonary artery pressure; • role and echocardiographic assessment of patients with suspected or confirmed endocarditis, intracardiac mass, or pericardial disease; • indications for and limitations of advanced echocardiography: tissue		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Echocardiography	Assessment methods	GSP reference
	Doppler/strain analysis, contrast echo, 3D echocardiography, transoesophageal echocardiography, stress echocardiography, perioperative echocardiography.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills in adult and/or paediatric patients and will: • use appropriate echo probes, machines and applications to obtain standard views and measurements and optimise controls; • undertake appropriate care of echo machine; • performance of a complete, comprehensive transthoracic echocardiogram in adults, in the emergency, inpatient and outpatient settings; • interpret, measure and analyse a transthoracic echocardiogram in adults, in the emergency, inpatient and outpatient settings; • produce a comprehensive echocardiogram report; • reflect on the challenges of applying research to practice in relation to the clinical use of echocardiography and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST Consultant Clinical Scientist working within the limits of professional		1.1.1 1.1.2 1.1.3 1.1.4

Topic	Echocardiography	Assessment methods	GSP reference
	competence, referring as appropriate to senior staff, and will: • interact appropriately with patients; • appreciate the role and limitations of echocardiography; • work with and where appropriate educate cardiac physiologists.		1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(xv): Heart Rhythm Management: Pacing Management

Topic	Heart Rhythm Management: Pacing Management	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to heart rhythm management and pacing, will be able to critically analyse, synthesise, evaluate and apply knowledge with respect to the fundamentals of cardiac stimulation, the equipment used for cardiac pacing, guidelines and troubleshooting. They will be expected to perform a range of clinical skills in adults and/or paediatric patients as appropriate to the clinical role and consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of heart rhythm in adult and/or paediatric patients, including: • the anatomy of the conduction system and the propagation of impulses throughout the heart; • techniques, modalities, indications, interpretation and the diagnostic yield of non-invasive monitoring techniques such as conventional 12-lead ECG, Holter and event monitoring, implantable loop recorders; • causes and prevention of stroke; • assessment of stroke risk (scoring systems) and anticoagulant therapy and application to the pacemaker population; • relevant physics laws, measurements and units; • the causes of syncope and pre-syncope; • the influence of drugs on bradyarrhythmias; • the anatomy of the main components of the peripheral venous system commonly used for vascular access during pacemaker implantation; • the indications and international and national guidelines for correct pacemaker prescription, including pacing mode selection; • detrimental effects of right ventricular pacing;		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Heart Rhythm Management: Pacing Management	Assessment methods	GSP reference
	• recognition of lead problems and programming issues specifically related to leads; • the principles of programming pacemakers to maximise therapeutic benefit and minimise complications; • the principles of the management of ICD malfunction and troubleshooting; • the fundamentals of cardiac stimulation; • pulse generator and pacemaker lead characteristics; • published guidelines for implantation and device/mode selection; • principles of pacemaker programming to maximise clinical benefit and minimise complications; • pacemaker malfunction and troubleshooting.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills in adult and/or paediatric patients and will: • clinically evaluate (history, physical exam) patients with rhythm disorders; • assess heart failure status and stroke risk; • integrate the results from different diagnostic techniques into the individual care of patients; • interpret and assess electrograms, markers, intervals, Holter features, and other storage and diagnosis capabilities; • implement appropriate programming and/or medical intervention in response to new findings; • evaluate device diagnostic data in the clinical context and in reference to other non-invasive or invasive techniques; • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients requiring pacemaker implantation,		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12

Topic	Heart Rhythm Management: Pacing Management	Assessment methods	GSP reference
	building on a critique of available evidence.		3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • educate patients about the treatment options available to them and explain the treatment strategies; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.; • appreciate the psychological impact of the patient's arrhythmia illness on the patient and their family, and manage it sensitively; • recognise and remain up to date with developments in the field.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(xvi): Heart Rhythm Training: Electrophysiology

Topic	Heart Rhythm Management: Electrophysiology	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to electrophysiology, will be able to critically analyse, synthesise, evaluate and apply knowledge while performing a range of clinical skills with respect to electrophysiology studies, demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of electrophysiology in adult and/or paediatric patients, including:
	• the anatomy of the conduction system;
	• impulse formation and conduction within the heart – sinus node function, atrial conduction and refractoriness, atrioventricular nodal and His Purkinje physiology, ventricular conduction and refractoriness;
	• normal and abnormal cardiac electrophysiology, including:
	  • cellular electrophysiology: action potential and ion channels
	  • refractory periods (effective, relative and functional)
	• mechanisms of rhythm disorders: automaticity, triggered activity, re-entry;
	• autonomic nervous system influences;
	• mechanisms underlying syncope and sudden death;
	• techniques, modalities, indications, interpretation, and the diagnostic yield of non-invasive techniques such as conventional 12-lead ECG, Holter and event monitoring, implantable loop recorders;
	• autonomic, pharmacological and electrical manoeuvres and techniques for terminating arrhythmias (Valsalva, carotid sinus massage, cardioversion, defibrillation, overdrive pacing) and the significance of recordings obtained for diagnosis of the arrythmias;
	• commanded pace termination of tachycardias via implanted devices and the
			1.1.4
			1.1.5
			3.1.5
			3.1.8

Topic	Heart Rhythm Management: Electrophysiology	Assessment methods	GSP reference
	efficacy of different anti-tachycardia pacing modes; • the effect of tachycardia rate on pace termination; • ECG-pharmacological tests for unmasking arrythmogenic syndromes (including Type I drugs for unmasking Brugada ECG, adrenaline for unmasking congenital long QT syndrome).		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills in adult and/or paediatric patients and will: • clinically evaluate (history, physical exam) patients with rhythm disorders; • integrate the results from different diagnostic techniques into the individual care of patients; • perform and interpret a range of non-invasive techniques such as conventional 12-lead ECG, Holter and event monitoring, implantable loop recorders exercise testing; • interpret ECG or electrogram features that reveal the potential mechanism and type of an arrhythmia in a logical and hierarchical approach – mode of initiation and termination, identification of atrial activity, atrio-ventricular/ventricular-atrio relationship, QRS and P wave axis and morphology, cycle length variations.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2

Topic	Heart Rhythm Management: Electrophysiology	Assessment methods	GSP reference
			3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • foster a team approach to pacing, including a close relationship with implanters; • commit to the audit of long-term outcomes, including infection and lead complications; • adopt a critical attitude towards a safe pacing programme in the hospital and to support patients in their community with adequate pacing follow-up; • educate patients about the treatment options available to them and explain the treatment strategies; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.; • appreciate the psychological impact of the patient's arrhythmia illness on the patient and their family, and manage it sensitively; • recognise and remain up to date with developments in the field.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

1(xvii): Imaging Physics in Cardiology

Topic	Imaging Physics	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to a range of imaging techniques including nuclear cardiology, cardiac computerised tomography (CT) and cardiac magnetic resonance imaging (CMR), will be able to critically analyse, synthesise, evaluate and apply knowledge spanning the indications for nuclear cardiology investigations in adult and/or paediatric patients. This will include the clinical significance and how cardiac imaging is integrated into the management of patients with cardiac disease while evaluating and interpreting images. They will consistently demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of imaging physics in adult and/or paediatric patients, including the:
	• indications for myocardial perfusion scintigraphy (MPS) and equilibrium gated radionuclide ventriculography (ERNV);
	• importance of radiation protection;
	• methods of stress used in MPS;
	• radiopharmaceuticals and protocols used in MPS and ERNV;
	• equipment and techniques used in nuclear cardiology imaging;
	• clinical value of MPS and ERNV in different clinical settings;
	• cardiac CT techniques including contrast administration modalities:
	  • ultra-fast CT
	  • coronary angiogram (including grafts and stents)
	• indications for:
	  • calcium score
	  • CT coronary angiography
	• indications and contraindications to cardiac magnetic resonance imaging (CMR);
	• CMR safety (including consideration of cardiac implants);
			1.1.4
			1.1.5
			3.1.5
			3.1.8

Topic	Imaging Physics	Assessment methods	GSP reference

	• CMR image acquisition and image processing, including:
	  • CMR imaging protocols (anatomical imaging and functional imaging)
	  • limitations of CMR
	  • results of MPS and ERNV studies and integrate them with those of other investigations in clinical practice.		

Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills in adult and/or paediatric patients and will: • evaluate CT examinations in the clinical context with the basic understanding of 2D and 3D analysis; • interpret images from CMR sequences; • relate normal and abnormal CMR reports to underlying normal and abnormal cardiac anatomy.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2

Topic	Imaging Physics	Assessment methods	GSP reference
			3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the strengths and limitations of nuclear cardiology investigations in routine clinical practice; • recognise the roles of the various healthcare professionals involved in nuclear cardiology and be able to interact with them; • adopt a cooperative approach to radiologists and radiographers; • be aware of the side effects of contrast media and recognise the risk of radiation to patient and personnel; • be aware of the limitations of non-invasive imaging; • appreciate the importance of understanding cardiac anatomy in 3D; • seek expert advice when appropriate; • appreciate the importance of providing detailed information about the procedure and its potential complications to patients; • appreciate the importance of team work with radiologists, radiographers, anaesthetists and technical staff.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

STAGE 2 – EXPERT CARDIAC SCIENTIFIC PRACTICE

Dependent on the site and nature of their clinical practice during higher specialist scientist training, Clinical Scientists in HSST will follow the Stage 2 Cardiac Science curriculum in either an adult or CHD/paediatric cardiac setting and the relevant **three** modules will be selected (see Section 2.3).

STAGE 2: ADULT CARDIAC SCIENCE

STAGE 2: ADVANCED RHYTHM MANAGEMENT
2A(i): Pacemaker Therapy

Topic	Pacemaker Therapy	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to pacemaker therapy, will be able to critically analyse, synthesise, evaluate and apply knowledge while leading a pacemaker service, including responsibility for the quality assurance and training of other staff and demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of pacemaker therapy, including: • techniques, modalities, indications, interpretation and the diagnostic yield of non-invasive monitoring techniques such as conventional 12-lead ECG, Holter and event monitoring, implantable loop recorders; • causes and prevention of stroke; • assessment of stroke risk (scoring systems) and anticoagulant therapy; • application to the pacemaker population; • relevant physics laws, measurements and units; • the causes of syncope and pre-syncope; • the influence of drugs on bradyarrhythmias; • cardiac and thoracic anatomy, especially with respect to venous access, including the cephalic, subclavian and internal jugular vein approach; • the indications and international and national guidelines for correct pacemaker prescription, including pacing mode selection; • published data regarding detrimental effects of right ventricular pacing; • management of lead problems and programming issues specifically related to		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Pacemaker Therapy	Assessment methods	GSP reference
	leads; • rate-modulated pacing and sensor technology; • medico-legal issues concerning provision of information, and driving restrictions and end of life issues; • management of peri-procedural complications, e.g. cardiac tamponade, and pneumothorax; • potential clinical benefits of telemedicine.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • clinically evaluate (history, physical exam) patients with rhythm disorders; • assess heart failure status and stroke risk; • integrate the results from different diagnostic techniques into the individual care of patients; • programme pacemakers to maximise therapeutic benefit and minimise complications; • programme algorithms for atrial tachycardia prevention and termination, minimising ventricular pacing and prevention of vaso-vagal syncope; • manage pacemaker malfunction and troubleshooting; • assess current drain and battery longevity; • interpret and assess electrograms, markers, intervals, Holter features and other storage and diagnosis capabilities, and appropriate programming and/or medical intervention in response to new findings; • evaluate device diagnostic data in the clinical context and in reference to other non-invasive or invasive techniques.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15

Topic	Pacemaker Therapy	Assessment methods	GSP reference
			3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • foster a team approach to pacing, including a close relationship with implanters; • commit to the audit of long-term outcomes, including infection and lead complications; • develop a critical attitude towards a safe pacing programme in the hospital and to support patients in their community with adequate pacing follow-up; • educate patients about the treatment options available to them and explain the treatment strategies; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.; • appreciate the psychological impact of the patient's arrhythmia illness on the patient and their family, and manage it sensitively. • recognise and remain up to date with developments in the field.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

2A(ii): Implantable Cardioverter-Defibrillator Therapy

Topic	Implantable Cardioverter-Defibrillator Therapy	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to implantable cardioverter-defibrillator (ICD) therapy, will be able to critically analyse, synthesise, evaluate and apply knowledge, and lead a pacemaker service, including taking responsibility for the quality assurance and training of other staff, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of ICD therapy, including: • techniques, modalities, indications, interpretation and the diagnostic yield of non-invasive monitoring techniques such as conventional 12-lead ECG, Holter and event monitoring, implantable loop recorders; • signal-averaged ECG, heart rate variability, T-wave alternans and ECG-drug infusion tests (ajmaline, adrenalin etc.); • causes and prevention of stroke; assessment of stroke risk (scoring systems) and anticoagulant therapy; application to the ICD population; • ensuring the correct patient is selected for implantation; • the principles of defibrillation and the engineering of device and of defibrillating leads; • the medical treatment of tachyarrhythmias, including interaction of drugs with defibrillation threshold and arrhythmia cycle length, the pro-arrhythmic effect of antiarrhythmic drugs and their effect on left ventricular function; • cardiac and thoracic anatomy, especially in respect of venous access, including the cephalic, subclavian and internal jugular vein approach; • the indications and international and national guidelines for correct ICD implantation; • management of complications of ICD implantation, including pneumo-haemothorax and lead perforation;		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Implantable Cardioverter-Defibrillator Therapy	Assessment methods	GSP reference
	• management of acute complications and during long-term follow-up; • medico-legal issues concerning consent, provision of information and driving restrictions; • the evidence base for programming of ICDs following implantation in different patient groups; • indications, techniques, performance and response interpretation of therapy modalities in heart rhythmology other than ablation.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • clinically evaluate (history, physical exam) patients with rhythm disorders; • assess heart failure status and stroke risk; • integrate the results from different diagnostic techniques into the individual care of patients; • explain to patients and relatives the potential complications and possible effects on the patient's lifestyle; • programme ICDs to maximise therapeutic benefit and minimise complications; • programme detection and therapy zones with reference to published data; • programme algorithms for tachycardia discrimination and termination, and for minimising right ventricular pacing; • manage pacemaker malfunction and troubleshooting; • assess current drain and battery longevity; • interpret and assess electrograms, markers, intervals, Holter features, and other storage and diagnosis capabilities; • implement appropriate programming and/or medical intervention in response to new findings; • evaluate device diagnostic data in the clinical context and in reference to other		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15

Topic	Implantable Cardioverter-Defibrillator Therapy	Assessment methods	GSP reference
	non-invasive or invasive techniques; • reflect on the challenges of applying research to practice in relation to the use of ICD therapy in clinical practice and suggest improvements, building on a critique of available evidence.		3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • appreciate the importance of and the need to explain lifestyle issues and driving restrictions to the patient; • be self-confident and recognise limitations; • commit to the audit of long-term outcomes, including mortality, infection, lead complications, therapy rates and outcomes; • develop a critical attitude towards a safe preventive programme in the hospital and to support patients in their community with adequate ICD follow-up; • educate patients about the treatment options following therapy delivery and explain the treatment strategies; • recognise and remain up to date with developments in the field.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

2A(iii): Cardiac Resynchronisation Therapy

This module is the same as 2CHD(v): Cardiac Resynchronisation Therapy

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to cardiac resynchronisation therapy, will be able to critically analyse, synthesise, evaluate and apply knowledge, and utilise a range of clinical skills to support the use of CRT therapy in a range of patients, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of cardiac resynchronisation therapy, including: • the indications and international and national guidelines for correct CRT device pacemaker prescription, including pacing mode; • management of peri-procedural complications, e.g. cardiac tamponade, and pneumothorax; • potential clinical benefits of telemedicine.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • take a relevant history and assess the efficacy of CRT therapy; • assess heart failure status; • recognise and triage implant or device behaviour complications; • optimise therapy delivery, including proper programming of stimulation; • analyse and use the diagnostic data coming from the implanted device; • identify patients likely to benefit from CRT and be aware of limitations of these techniques;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
	• deal with common problems associated with implantation techniques; • recognise and respond to potential complications; • assist with a CRT implant in a safe and logical manner; • recognise the nature of implant difficulties and take the appropriate action to overcome these; • appreciate when an alternative technique or approach may be required (e.g. surgical device implantation); • programme the devices appropriately, and advise on optimisation using recognised techniques such as echocardiography; • evaluate device diagnostic data in the clinical context and with reference to other non-invasive or invasive techniques; • reflect on the challenges of applying research to practice in relation to the use of CRT and suggest improvements, building on a critique of available evidence.		3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • foster a team approach to pacing, including a close relationship with implanters; • commit to the audit of long-term outcomes, including infection and lead complications; • develop a critical attitude towards a safe pacing programme in the hospital and support patients in their community with adequate pacing follow-up; • educate patients about the treatment options available to them and explain the treatment strategies; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.; • appreciate the psychological impact of the patient's arrhythmia illness on the		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
	patient and their family, and manage it sensitively; • work closely with other healthcare professionals, particularly palliative care; • evaluate the psychological impact of the patient's arrhythmia illness, device implantation and therapy on the patient and their family and manage it sensitively; • take a sensible, professional attitude to CRT and learn under supervision with appropriate requests for advice; • appreciate the importance of team-working with nursing, radiographic, anaesthetic, and, if appropriate, industrial staff; • work closely with other healthcare professionals as necessary, being aware of the importance of a multidisciplinary team in heart failure management and in maximising the benefit of CRT: cardiologists, infection control, care of the elderly, internal medicine specialists, etc.; • deal appropriately with patients in whom CRT implantation has not been effective; • appreciate the psychological impact of the patient's illness on the patient and their family and manage it sensitively; • recognise and remain up to date with developments in the field.		

STAGE 2: ELECTROPHYSIOLOGY

2A(iv): Cardiac Electrophysiology 1

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to cardiac electrophysiology (EP), will be able to critically analyse, synthesise, evaluate and apply knowledge, and perform a range of clinical skills to clinically evaluate a range of patients with rhythm disorders, choose and perform diagnostic techniques, and interpret and integrate the results to develop individual care plans for patients, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their knowledge of cardiac electrophysiology, including:
	• 12-lead ECG interpretation;
	• haemodynamics;
	• cellular electrophysiology; ion channel function and regulation; and the effects of ionic imbalance on cardiac EP;
	• underlying mechanisms of arrhythmias: normal automatic behaviour, abnormal automatism, triggered activity, micro-reentry, macroreentry and other mechanisms;
	• mechanisms of syncope and sudden death;
	• EP principles:
	  • measurement of local activation time and voltage
	  • interval measurements
	  • conduction velocity and tissue wavelength
	  • concealed conduction
	  • gap phenomenon
	• cardiac anatomy relevant to the genesis and treatment of arrhythmias, including
			1.1.4
			1.1.5
			3.1.5
			3.1.8

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference

	detailed anatomy of the thoracic veins, of the right and left atria and inter-atrial septum, right and left outflow tracts, aortic root, coronary artery and coronary venous systems, the AV junction (triangle of Koch, tricuspid annulus, mitral annulus) and associated accessory pathways;
	• normal and abnormal electrophysiology of the different heart chambers and the major thoracic vessels;
	• autonomic system influences on electrophysiology and arrhythmias;
	• conditions predisposing to arrhythmias:
	  • ischaemic cardiomyopathy
	  • non-ischaemic cardiomyopathies:
	  – idiopathic dilated cardiomyopathies
	  – valvular-related cardiomyopathies
	  • congenital diseases
	  • channelopathies and other inherited syndromes:
	  – long and short QT syndromes
	  – Brugada syndromes
	  – hypertrophic cardiomyopathies
	  – right ventricular arrhythmogenic cardiomyopathies
	  – neuromuscular cardiomyopathies (myotonic dystrophy)
	  – catecholaminergic polymorphic ventricular tachycardia
	  – Ryanodine syndromes
	  – congenital conduction disorders
	  • autonomic disorders (carotid sinus hypersensitivity, neurocardiogenic syncope)
	  • other (Chagas disease, etc.)
	  • other situations leading to rhythm disorders
	• selection and indications for the different non-invasive diagnostic techniques used in assessing heart rhythm abnormalities;
	• arrhythmia epidemiology and prognosis (genetics, pathophysiology, risk		

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference

	evaluation);
	• techniques, modalities, indications, interpretation and the diagnostic yield of general cardiology non-invasive and imaging techniques, such as:
	  • exercise testing
	  • echocardiography, including transoesophageal echocardiography (TOE)
	  • cardiac magnetic resonance imaging
	  • cardiac computed tomography imaging
	  • nuclear cardiology
	  • blood sampling and other laboratory analysis
	  • genetic analysis
	• techniques, modalities, indications, interpretation and the diagnostic yield of non-invasive arrhythmia assessment techniques, such as:
	Electrocardiography:
	  • conventional 12-lead ECG
	  • ECG monitoring (Holter, event monitoring, implantable event and loop monitoring)
	  • signal-averaged ECG and body surface mapping
	  • heart rate variability and baroreflex sensitivity
	  • T-wave and micro-T-wave alternans
	  • ECG-drug infusion tests (flecainide, etc.)
	  • transoesophageal electrical recording
	Autonomic nervous system evaluation:
	  • carotid sinus massage
	  • tilt testing
	• clinical presentation, ECG and electrophysiology of the different types and variants of cardiac arrhythmias, conduction disturbances, arrhythmic clinical syndromes, genetic disorders and autonomic system-mediated disorders (induction, cardiac activation, responses to electrical stimulation and to drug administration, cardiac activation, EP diagnosis):		

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference
	• sinus node and atrial impulse formation and conduction disorders • AV nodal and His-Purkinje conduction disorders • atrial flutter • junctional and AV node ectopy and tachycardias • accessory pathway-mediated tachycardias • atrial (and thoracic vein) ectopy and tachycardias • atrial fibrillation • ventricular ectopy and tachycardias • ventricular fibrillation • patient and procedure-type selection for specific arrhythmia management strategies/targets (risks and benefits); • indications, techniques, performance and response interpretation of therapy modalities in electrophysiology other than ablation, such as: • medical therapy • autonomic system manoeuvres • cardioversion and defibrillation • anti-tachycardia pacing and device therapies • pharmacological tests and modulation, for example: • adenosine • type I drugs for unmasking Brugada ECG • adrenaline for unmasking congenital long QT syndrome.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • clinically evaluate patients with rhythm disorders (history, physical exam); • perform and interpret the different non-invasive diagnostic techniques specifically related to arrhythmia management (operate non-invasive cardiology equipment – ECG machines, Holter ECG monitoring systems and recorders, etc.) and evaluate		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference
	each diagnostic procedure in the clinical context and in reference to other non-invasive or invasive techniques; • choose the diagnostic techniques, modalities and protocols in a clinically useful and cost-effective way, avoiding over- and under-utilisation of tests; • integrate the results of the different diagnostic techniques into the individual care of patients with rhythm disorders; • interpret the results of general cardiology non-invasive and imaging techniques.		3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence referring as appropriate to senior staff and will: • recognise and minimise the anxiety of patients before, during and after procedures, and appreciate the psychological impact of the patient's arrhythmogenic disease/syndrome on the patient and their family, and manage it sensitively; • communicate diagnostic and procedure results to patients and relatives in an understandable, objective and calm manner;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2

Topic	Cardiac Electrophysiology 1	Assessment methods	GSP reference
	• educate patients about the treatment options available to them and explain the treatment strategies; • develop a critical attitude towards therapeutic techniques in EP and contribute to the selection of the best available therapy according to procedure results, clinical evidence and practice guidelines; • commit to the audit of long-term outcomes and procedural complications and strive to continuously improve the quality of services and safeguard high standards of care; • provide an example of good scientific practice and foster an environment in which excellence will flourish; • foster a team approach to procedures, including a close relationship with clinicians and other healthcare professionals, and cooperate with cardiologists and other physicians to maximise patient management; • attend official national/international subspecialty meetings of scientific societies in the field; • recognise and remain current with developments in the field of arrhythmogenic diseases and syndromes and emerging therapies; • respond to medico-legal issues concerning care provision, consent and information for patients and their families; • establish solid concepts of ethics in professional practice; • adopt a positive attitude to understanding and applying cost-effective strategies; • adopt a positive attitude to implementing guidelines in clinical practice; • adopt a positive attitude and consistently behave in an ethical manner; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.		5.1.3

2A(v): Cardiac Electrophysiology 2

Topic	Cardiac Electrophysiology 2	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to cardiac electrophysiology (EP), will be able to critically analyse, synthesise, evaluate and apply knowledge, perform complex protocols of extra-stimulation that generate intracardiac electrogram recordings, and demonstrate the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of cardiac electrophysiology, including: • EP laboratory equipment (fluoroscopy, catheters, sheaths, EP signal recording systems, navigation systems, programmed electrical stimulation systems, other); • ECG and EP signals (differential amplifier: noise, gain, clipping, filters, bipolar/unipolar, voltage/timing/ morphology); • programmed electrical stimulation techniques (pulse width/amplitude, unipolar/bipolar, continuous/extra-stimulus stimulation, atrial/ventricular/other location stimulation, pacing algorithms); • complications and adverse effects of EP studies: pathophysiology, diagnosis, prevention, management; • use of imaging techniques that allow selection of catheters/procedural equipment and a technical approach sufficient for the safe and expeditious diagnosis/treatment of cardiac arrhythmias; • normal and abnormal anatomical formations that govern the approach to intracardiac catheter placement; • catheter placement techniques including cardiac access (transvenous, pericardial, other) and guiding means (fluoroscopic and non-fluoroscopic); • intracardiac catheter positioning and electrophysiological pacing techniques that elucidate the arrhythmia mechanism;		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Cardiac Electrophysiology 2	Assessment methods	GSP reference

	• electrogram activation patterns and their changes in response to planned electrophysiological perturbations that allow determination of arrhythmia mechanism;
	• use of stimulators, catheters, mapping systems and lesions creation technologies sufficient for their safe application in patient treatment;
	• use of 3D non-fluoroscopic navigation system (Carto, Ensite Velocity, etc.);
	• remote navigation;
	• angiography (e.g. pulmonary veins);
	• oral and intravenous drug administration:
	  • antiarrhythmic drugs
	  • non-antiarrhythmic drugs with antiarrhythmic effects
	  • general drugs used in cardiology, such as anticoagulants and inotropic drugs
	  • sedative drugs
	• cardiac and antiarrhythmic surgery;
	• the psychological impact of the patient's arrhythmia illness on the patient and their family.		

Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • interpret clinical invasive cardiac EP studies; • manage the technical equipment (EP systems, programmable stimulator, ablation systems, 3D mapping, haemodynamic monitoring systems, pacing and defibrillation systems, etc.); • integrate the results of clinical invasive cardiac EP studies with those from different diagnostic techniques into the individual care of patients with rhythm disorders; • interpret EP recording findings and stimulation responses; • recognise and manage the complications and the adverse effects of EP studies;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6

Topic	Cardiac Electrophysiology 2	Assessment methods	GSP reference
	• appreciate the limitations and the potential risks of therapies; • perform resuscitation and life support as appropriate; • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients requiring cardiac EP procedures and suggest improvements, building on a critique of available evidence; • educate patients about the treatment options available to them and explain treatment strategies; • deliver education about arrhythmias to patients relatives and other healthcare professionals to demonstrate/diagnose/confirm any given arrhythmia mechanism and the critical components by a combination of pattern recognition and electrical interaction with the arrhythmia mechanism (e.g. extra-stimulation/entrainment).		3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • recognise and minimise the anxiety of patients before, during and after procedures, and appreciate the psychological impact of the patient's arrhythmogenic disease/syndrome on the patient and their family, and manage it sensitively; • communicate diagnostic and procedure results to patients and relatives in an understandable, objective and calm manner; • educate patients about the treatment options available to them and explain the treatment strategies; • develop a critical attitude towards therapeutic techniques in EP and contribute to the selection of the best available therapy according to procedure results, clinical evidence and practice guidelines; • commit to the audit of long-term outcomes and procedural complications and strive		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

Topic	Cardiac Electrophysiology 2	Assessment methods	GSP reference
	to continuously improve the quality of services and safeguard high standards of care; • provide an example of good scientific practice and foster an environment in which excellence will flourish; • foster a team approach to procedures, including a close relationship with clinicians and other healthcare professionals, and cooperate with cardiologists and other physicians to maximise patient management; • attend official national/international subspecialty meetings of scientific societies in the field; • recognise and remain current with developments in the field of arrhythmogenic diseases and syndromes and emerging therapies; • work within the medico-legal issues concerning care provision, consent and information for patients and their families; • establish solid concepts of ethics in professional practice; • adopt a positive attitude to understanding and applying cost-effective strategies; • adopt a positive attitude to implementing guidelines in clinical practice; • adopt a positive attitude and consistently behave in an ethical manner; • develop a close working relationship with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.		

STAGE 2: CARDIAC IMAGING

2A(vi): Advanced Transthoracic Echocardiography

Topic	Advanced Transthoracic Echocardiography	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to advanced transthoracic echocardiography, will be able to critically analyse, synthesise, evaluate and apply knowledge while developing advanced skills in transthoracic echocardiography and reporting and interpreting complex transthoracic studies. The Clinical Scientist in HSST will be able to lead a transthoracic echocardiographic service, including responsibility for the quality assurance and training of other practitioners, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of advanced transthoracic echocardiography, including:
	• instrument settings;
	• calculation of left ventricular (LV) mass and volume, including abnormal geometry with normal mass, and the prognostic importance of LV geometry;
	• quantitative Doppler techniques including PISA, resistance, regurgitant fractions;
	• types, normal function and abnormalities of prosthetic heart valves;
	• the principles of 3D echocardiography;
	• the principles of speckle tracking, including strain imaging;
	• the role of intravascular contrast agents for opacification of the left ventricular cavity and assessment of wall motion;
	• the principles of Doppler tissue imaging including strain imaging.
	• national and international recommendations and guidelines for the following:
	  • indications for echocardiography
	  • standards for performing and reporting of echocardiograms
	  • institutional accreditation for echocardiography departments
			1.1.4
			1.1.5
			3.1.5
			3.1.8

Topic	Advanced Transthoracic Echocardiography	Assessment methods	GSP reference
	• the roles of clinical and technical leadership in echocardiography departments • training and supervision.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • assess complex heart valve disease, including severity, suitability for repair/percutaneous procedures and effects on ventricular function; • assess prosthetic valve dysfunction; • assess complex CHD in adults; • perform a detailed assessment in heart failure; • perform a detailed assessment of ventricular structure and function in inherited and acquired heart muscle disease; • assess mechanical dyssynchrony, suitability for cardiac resynchronisation therapy and perform echo-optimisation of biventricular pacemakers.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations consistently		1.1.1 1.1.2

Topic	Advanced Transthoracic Echocardiography	Assessment methods	GSP reference
	demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • collaborate with specialists in other imaging modalities; • reflect on practice; • judge a test result in the clinical context; • plan and deliver practical and theoretical education and training in echocardiography, evaluating each session and developing action plans to improve teaching; • take a leadership role in the organisation and administration of cardiac services; • lead training and clinical supervision; • work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, echocardiographers and nurses.		1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

2A(vii): Transoesophageal Echocardiography

Topic	Transoesophageal Echocardiography	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to transoesophageal echocardiography, will be able to critically analyse, synthesise, evaluate and apply knowledge, perform and interpret transoesophageal echocardiograms and be able to take a leadership role in a TOE service, including the quality assurance and training of other staff, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist working in a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of transoesophageal echocardiography, including: • indications, contraindications and limitations of TOE; • principle of disinfection, probe maintenance and storage; • principles of assessment of anaesthetic risk; • TOE views, image planes and echo-anatomic correlations; • the effects of anaesthesia and cardiopulmonary bypass on the heart; • the principles and techniques of 3D transoesophageal echocardiography; • national and international recommendations and guidelines for the following: (i) indications for echocardiography; (ii) standards for performing and reporting of echocardiograms; (iii) institutional accreditation for echocardiography departments; (iv) the roles of clinical and technical leadership in echocardiography departments; (v) training and supervision; • current research and emerging advances.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • assess anaesthetic risk and plan and monitor the procedure appropriately;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5

Topic	Transoesophageal Echocardiography	Assessment methods	GSP reference
	• perform a complete, comprehensive transoesophageal echocardiogram in conscious sedated or anaesthetised adult patients; • interpret, measure and analyse a transoesophageal echocardiogram in an adult and produce a comprehensive echocardiogram report; • assess complex heart valve disease, including severity, suitability for repair/percutaneous procedures and assess valve disease post- procedure; • assess acute aortic syndromes (dissection, intramural haematoma); • use TOE in the investigation of stroke or embolic events, including detection of patent foramen ovale, intracardiac thrombus, tumour; • detect and assess simple congenital heart defects, e.g. atrial septal defect (ASD) (including sinus venous defects); • perform TOE in the critical care setting, to assess ventricular function, filling and inotropic status; • perform TOE during percutaneous cardiac interventional procedures, e.g. patent foramen ovale (PFO) closure, percutaneous valve intervention and assess valve disease post-procedure; • perform perioperative TOE during cardiac surgery, assess efficacy of valve repair, identify perioperative complications, interpretation of findings in the setting of cardiopulmonary bypass.		1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • adequately explain the procedure to the patient and maintain trust; • explain the results adequately; • work with echocardiographers, cardiac surgeons, anaesthetists and		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1

Topic	Transoesophageal Echocardiography	Assessment methods	GSP reference
	interventional cardiologists; • integrate the results of TOE with the clinical context to produce recommendations; • collaborate with specialists in other imaging modalities; • critically reflect on your clinical practice; • audit results; • adopt leadership roles in organisation and administration; • develop leadership skills in training and clinical supervision; • work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, echocardiographers and nurses.		1.3.1 5.1.2 5.1.3

2A(viii): Stress Echocardiography

Topic	Stress Echocardiography	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to stress echocardiography, will be able to critically analyse, synthesise, evaluate and apply knowledge, and develop advanced skills in stress echocardiography, including reporting. They will be able to take a leadership role in a stress echocardiogram service, including the quality assurance and training of other staff, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist in a patient-focused service.		
Knowledge	By the end of this module training period the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of stress echocardiography, including: • the principles, indications and clinical role of stress echocardiography; • the pathophysiology and biochemical and mechanical changes associated with hibernation, infarction and ischaemia; • different stressors, including dobutamine, exercise, pacing, atropine, adenosine and dipyridamole; • the physical properties and side effects of intravascular contrast agents for opacification of the LV cavity and myocardial perfusion; • the effects of flow on the left ventricle, the heart valves and the right heart in patients with valve disease; • the methods of reporting a stress echocardiogram, including wall motion analysis, contrast assessment and long axis function; • the evidence for stress echocardiography in the detection of coronary disease, coronary risk stratification and the detection of viable myocardium; • the use of stress echocardiography in valve disease; • the cost-effectiveness of stress echocardiography; • the comparison of echocardiography with other techniques; • the principles of myocardial contrast;		1.1.4 1.1.5 3.1.5 3.1.8

Topic	Stress Echocardiography	Assessment methods	GSP reference
	• national and international recommendations and guidelines for the following: (i) indications for echocardiography; (ii) standards for performing and reporting of echocardiograms; (iii) institutional accreditation for echocardiography departments; (iv) e roles of clinical and technical leadership in echocardiography departments; (v) training and supervision.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills and will: • prepare and administer pharmacological stressors safely; • prepare and administer contrast agents safely; • manage complications, including allergic reactions and arrhythmias, and be able to resuscitate in the event of cardiac arrest; • set up an echocardiography machine appropriately for stress echocardiography; • record echocardiograms during a stress study; • recognise subtle abnormalities of wall motion and differentiate wall thickening and wall motion; • perform stress studies in patients with valve disease; • reflect on the challenges of applying research to practice in relation to an aspect of stress echocardiography and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2

Topic	Stress Echocardiography	Assessment methods	GSP reference
			3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • adequately explain the procedure to a patient and maintain trust; • work with sonographers, cardiac surgeons and interventional cardiologists; • collaborate with specialists in other imaging modalities; • integrate the stress study with the clinical context to produce recommendations; • critically reflect on your practice; • audit results; • compare different techniques, including cardiac magnetic resonance and nuclear perfusion imaging; • integrate results from a variety of techniques, including coronary angiography, to produce an appropriate synthesis; • develop leadership role in organisation and administration; • develop leadership skills in training and clinical supervision; • work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, echocardiographers and nurses.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

2A(ix): Adult Congenital Heart Disease

This module is the same as 2CHD(viii): Adult Congenital Heart Disease

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply their expert knowledge of: (i) the requirement for long-term follow-up in patients with CHD and the multidisciplinary approach required to achieve this; (ii) the impact of acquired heart disease on ageing patients and how to assess this; (iii) the impact and contraindications of lifestyle choices on patients with CHD; and (iv) the specific imaging requirements around the time of surgery and when to use complementary modalities. In addition they will gain and apply their expert knowledge of the importance of: (i) pre-pregnancy counselling and the maternal risks associated with pregnancy in patients with CHD; (ii) the specialised multidisciplinary approach to care during the antenatal, delivery and postnatal periods; and (iii) the genetics involved in CHD and the implications of inheritance. The Clinical Scientist in HSST will be expected to manage patients suitable for follow-up in a physiologist-led service. Their knowledge will also span the requirement and requisites of a well-coordinated transition service to prepare the patient for the change between paediatric and adult services. They will also be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of the long-term follow-up of adult CHD and acquired heart disease, including:
	
	Underpinning clinical science:
	• the natural history of various CHD, native and repaired, and the level and range of care available to support patient management, including:
	  • quaternary/tertiary care
	  • district general hospitals with specialist interest physicians
	  • physiologist-led clinics within a tertiary centre
			1.1.4
			1.1.5
			1.1.6
			3.1.5
			4.1.1

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	• specialist dental care
	• obstetric care
	• CHD conditions that can be safely followed up in Clinical Scientist-led clinics, including:
	  • aortopathy patients (e.g. Marfan syndrome and Ehlers-Danlos syndrome) and haemodynamically insignificant ventricular septal defects (VSDs) or patent arterial ducts
	  • abnormal valves with mild functional impairment (e.g. bicuspid aortic valve)
	• when patients being looked after in a Clinical Scientist-led clinic require referral back to physician care;
	• psychosocial issues associated with CHD and support services;
	• the increased morbidity and mortality associated with complex CHD patients with the increased longevity;
	• the specific arrhythmias that may be associated with particular lesions and surgeries;
	• the impact of acquired heart disease on pre-existing congenital heart lesions (e.g. coronary artery disease in a univentricular system);
	• the natural progression of acquired heart disease (e.g. coronary artery disease);
	• the need for care within a multidisciplinary centre for non-cardiac pathology that may need cardiology input;
	• the prevalence of the 'loss to follow-up' phenomenon and its importance to maintaining good health;
	• the importance of clinical audit in adult CHD patients and its impact on evolving healthcare provision;
	• the complex interdependent relationships that sometimes exist between patients and carers;
	• the findings of investigations carried out and the impact of the results.
	Transition services:		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	• the national and international guidelines for transition services and the requirements and quality management of transition services;
	• the need for liaison with members of the wider multidisciplinary team to discuss strategies for preparing patient for investigations, procedures, etc.;
	• needs of learning disabled young people during transition and transfer into adult services;
	• the range of services available to provide appropriate follow-up care, e.g. quaternary/tertiary centre or in a smaller centre with physicians with a specialist interest;
	• the current guidelines relating to lifestyle relevant to this adolescent population (e.g. exercise, tattoos, body piercing and contraceptive advice);
	• the implications of becoming 'lost to follow-up';
	• how to support patients with issues related to body perception and privacy in adolescent patients;
	• why more complex patients with multisystem involvement and/or neurocognitive impairment may require several appointments until all concerned are comfortable with the transition.
	Counselling for lifestyle:
	• the importance of a healthy lifestyle on adult CHD patients and encouraging, under advisement, activity and sport to maintain general cardiovascular health;
	• the importance of taking responsibility for their own health and the impact of becoming lost to follow-up;
	• the increased risk of endocarditis in adult patients with CHD and activities that may increase risk further. including:
	  • body piercing
	  • tattoos
	  • poor dental hygiene
	• current endocarditis treatment guidelines and the prophylactic use of antibiotics;		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• the potential psychological impact on adolescents/adults of lifestyle choices, e.g. further education, alcohol consumption, sexual activity; • the issues surrounding birth control (certain types of contraceptives are not advisable with certain cardiac lesions); • the implications of unexpected and unplanned pregnancies; • the potential impact on obtaining health/life insurance, mortgages and certain types of employment; • the co-existing cognitive and developmental delay that may impact on their lifestyles choices and available support services; • guidelines on assessment of endocarditis and when to further investigate with TOE imaging; • the limitations of echocardiography and the appropriate use/referral for assessment using other imaging modalities; • the relevance of exercise and cardiopulmonary exercise testing (CPET) testing in monitoring patients long term, especially for non-subjective symptom assessment and timings of interventions. **Imaging considerations for pre-, peri- and postoperative adult patients:** • invasive procedures required and the information needed prior to the procedure; • the role and limitations of TTE in preoperative assessment; • the role and limitations of TOE in preoperative assessment; • the role and limitations of computed tomography and magnetic resonance imaging in assessment for surgery; • the need for interoperative imaging and suitable image acquisition; • imaging requirements in the postoperative period (e.g. assessment for pericardial effusion, patches and baffles, or dehiscence and prosthetic valves); • how to identify when the patient's clinical status may not fit your observations/assessment ;		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	• when and how to seek relevant advice or seek help appropriately.
	Pregnancy risks and considerations and the implications of inheritance:
	• the normal maternal changes to cardiac physiology associated with pregnancy abnormalities detected through echocardiography and ECG;
	• information and counselling for women of reproductive age with CHD, including maternal and fetal morbidity and mortality;
	• risk of inheritance of CHD in the offspring;
	• level of surveillance, treatment and anticipated hospitalisation required during pregnancy;
	• contraception;
	• the general risk factors for women with CHD during pregnancy, including:
	  • New York Heart Association classification >II *or* cyanosis before pregnancy
	  • impaired systemic ventricular function (ejection fraction < 40%)
	  • left heart obstruction (mitral valve area < 2cm^2, aortic valve area < 1.5cm^2, left ventricular outflow tract peak gradient > 30 mm Hg before pregnancy
	  • preconception history of adverse cardiac events such as symptomatic arrhythmia, stroke, transient ischaemic attack and pulmonary oedema
	• the stratification of different lesions into low-, moderate- and high-risk groups:
	  • low risk: atrial septal defects, ventricular septal defects (haemodynamically insignificant), repaired coarctation and repaired tetralogy of Fallot
	  • moderate risk: mitral or aortic stenosis, systemic right ventricles (congenitally corrected transposition of the great arteries [ccTGA] and atrial switches for TGA), Fontan's patients, cyanotic patients without pulmonary hypertension
	  • high risk: Marfan syndrome with dilated aorta and patients with Eisenmenger's syndrome
	• medications commonly needed for heart disease patients are contraindicated in pregnancy:
	  • angiotensin converting enzyme inhibitors, angiotensin-II receptor antagonists		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	and the risk of neonatal renal failure and hypotension, renal tubular dysgenesis, intrauterine growth restriction, decreased skull ossification • warfarin and the risk of skeletal defects, abnormalities of the central nervous system, intracranial haemorrhage • amiodarone, which may be used in special circumstances, but with the risk of hypothyroidism and potential brain damage • phenytoin with the risk of heart defects, intrauterine growth restriction, orofacial abnormalities • spironolactone with the possible risk of anomalies of the external genitalia (animal studies only) • pregnancy physiology in relation to standard investigations, i.e. physiological response of pregnant woman lying flat on her back for an hour for an echocardiogram; • radiation risk (breast cancer and fetus) with respect to CT and angiography during pregnancy; • the potential complications following birth and the potential risks to maternal life (e.g. aortic dissection in high-risk Marfan's patients). **Implications of inheritance:** • the syndromes associated with CHD (including aortopathy-inducing diseases such as Marfan syndrome and Ehlers-Danlos syndrome); • the commonly occurring chromosomal abnormalities involved; • the associated non-cardiac abnormalities in some syndromes/chromosomal abnormalities; • the increased risk of CHD with first-degree relatives; • the importance of early antenatal screening in parents with CHD; • associated congenital lesions that are more likely to occur together; • the increase in need for specialised fetal screening through echocardiography with an increasing adult population;		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• the potential value of genetic counselling and refer, after discussion with relevant professionals, to specialist genetic teams; • the potential benefits to emotional and psychological counselling and seek referral where appropriate; • the importance of audit to the evaluation of inheritance risk and the further adequate provision of services for the future.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals. They will be able to perform and master each technique, adapting their response to meet the varying and complex challenges that will arise reliably, and will be able to: • gain informed consent; • take a relevant history to inform further investigations (e.g. for endocarditis); • perform a TTE as part of the assessment of endocarditis and if appropriate refer for further investigation, which may include oesophageal echocardiography. **Transition services:** • provide a supportive and informative clinical atmosphere in which the young person can raise sensitive issues about their CHD and associated issues in their own right, in particular being aware of safeguarding issues in this group of adolescents; • discuss the process of transition and the importance of maintaining their own health and attending appointments with the patient, and if appropriate parents/carers, answering any concerns of the patient or referring to colleagues; • disseminate relevant information during the handover of patients from the paediatric to adult team and present it accurately and succinctly;		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4 4.1.1 4.1.2

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• produce an accurate handover report detailing the anatomy and physiology of the heart highlighting any abnormalities that require further investigations. **Imaging considerations for pre-, peri- and postoperative adult patients:** • gain informed consent; • perform transthoracic and transoesophageal echocardiography; • adapt normal techniques to the logistics of theatre and intensive care environments; • make clinically relevant observations in a succinct manner to other healthcare professionals. **Pregnancy risks and considerations and the Implications of inheritance:** • gain informed consent; • take a relevant history to inform further investigation or referral; • perform investigations to a high standard; echocardiography and rhythm assessment/management.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, echocardiographers and nurses, and will: • recognise the young person's need for advice and information about their CHD, including advice on the genetic aspects of the condition; • recognise the difficulties young people face with engaging in healthcare at the time of transfer and seek to ensure seamless transfer of care; • recognise the young person's desire to be autonomous and to be involved in		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	decision making; • recognise the role of parents, family members, carers, partners and friends in supporting the young person at the time of transition and transfer; • recognise and value the information available from other agencies and services and respect young people's preferences in accessing information during transition; • recognise and value opportunities for peer support at transition through local networks and other agencies; • recognise the patient's need for confidentiality; • have a positive approach towards change to achieve continuous improvement of services, with particular reference to auditing practice, evidence-based practice, innovation and new and improved technologies; • appreciate the psychological complexity relating to the change from paediatric to adult services and respond to patients accordingly; • encourage the patients to take ownership and responsibility for their health while ensuring that the parents feel involved and informed; • appreciate the emotional difficulties encountered by patients with CHD with respect to passing on cardiac lesions to any children they may have, and respond accordingly; • appreciate the psychological impact of the potential inheritance of adult CHD on patients and their families; • support the decisions of the patients without bias with respect to child-bearing.		

STAGE 2: CONGENITAL HEART DISEASE AND PAEDIATRIC CARDIAC EXPERT SCIENTIFIC AND CLINICAL PRACTICE

2CHD(i): Congenital Heart Disease: Expert Scientific and Clinical Practice

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply knowledge of: (i) the history and development of congenital heart disease (CHD); (ii) cardiac disease in syndromes and genetic disorders; (iii) the epidemiology of CHD; (iv) the morphology, physiology and modes of presentation of cardiac disease in the neonatal and postnatal periods; (v) cardiomyopathies and the associated diseases and syndromes and acquired cardiomyopathies; (vi) heart failure in paediatric cardiology, including the natural history, physiology and clinical features in the paediatric and CHD population; (vii) the pathology and natural history of infective endocarditis, Kawasaki disease, rheumatic fever and collagen vascular disease affecting the cardiovascular system; (viii) the modes of presentation and investigation of common arrhythmias presenting in infants and children; (ix) the common drugs used in the management of paediatric cardiac disease; and (x) the anatomy and physiology of the Fontan circulation, its demands on the circulation, complications and long-term outcomes. The Clinical Scientist in HSST will also be able to analyse, synthesise, critically evaluate and apply knowledge of catheterisation in structurally abnormal hearts. They will be expected to perform and master complex protocols of interventional and diagnostic cardiac physiology as applied to patients with CHD. In this patient-focused service they will need to be responsive to the needs of children and their parents/guardians at different stages of their journey through an illness or injury, from prevention through timely assessment, treatment, rehabilitation and long-term support, and aware that hospital services and the staff delivering them need to meet those requirements. The Clinical Scientist in HSST will be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of CHD, including: **Genetics, genomics, pathology and epidemiology:**		1.1.4 1.1.5 1.1.6 3.1.5

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference

	• the genetics of normal cardiac development;
	• recurrence risks in families where one member has CHD;
	• the cardiac abnormalities found in genetic disorders and syndromes, which may include:
	  • Down syndrome
	  • 22q11 deletion (DiGeorge)
	  • Turner syndrome
	  • Noonan syndrome
	  • Williams syndrome
	  • Alagille syndrome
	  • Marfan syndrome
	  • CHARGE association
	  • VACTERL association
	  • trisomy 18
	  • trisomy 13
	  • storage disorders
	  • neuromuscular diseases
	  • hyperlipidaemias
	  • long QT syndrome
	• the historical development of the specialty and changes in outcomes and survival in CHD over time;
	• the prognosis of genetic syndromes and their associated cardiac defects;
	• the epidemiology and survival rates in congenital and inherited cardiac disease;
	• the impact and role of genomics and precision/personalised medicine for patients with CHD.
	Structural lesions in CHD:
	• the anatomical and characteristic clinical features, natural history and physiology of different forms of CHD;
			4.1.1

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference

	• transitional cardiac physiology from fetus to neonate;
	• how to distinguish cardiac and non-cardiac causes of collapse in infancy;
	• the physiology of the duct-dependent systemic circulation and the duct-dependent pulmonary circulation;
	• the ECG, CXR and echocardiographic findings of typical congenital heart lesions presenting with collapse in infancy;
	• the principles of acute and long-term management of lesions presenting with collapse in infancy;
	• how to distinguish cardiac and non-cardiac causes of cyanosis in the newborn period;
	• the physiology of cyanosis caused by:
	  • right heart obstruction
	  • right to left shunting
	  • parallel circulation
	  • common mixing lesions
	• acyanotic CHD:
	  • left to right shunting lesions
	  • duct-dependent systemic circulation
	  • obstructive left heart lesions
	  • acyanotic obstructive right heart lesions.
	Cardiomyopathies and myocarditis:
	• causes, physiology, prognosis and clinical features of cardiomyopathy and myocarditis;
	• indications for treatment and understand the role of cardiac transplantation;
	• genetics of inherited cardiomyopathies;
	• aetiology, natural history and prognosis of viral myocarditis;
	• the complex mechanisms: understand both immune- and viral-mediated (independent of an immune response) cardiac damage;		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference
	• the various ways acute myocarditis can present, including as a cause of sudden death in an otherwise healthy young adult; • how to recognise electrocardiographic findings in patients with myocarditis; • the limitations of echocardiography; • the Dallas criteria for biopsy evidence of active myocarditis. **Introduction to heart failure in paediatric cardiology:** • the health economics of paediatric heart failure management and the differences compared with adults; • the diverse aetiology of heart failure in children (which includes volume overload, pressure overload, cyanosis, primary myocardial disease of either or both ventricles, metabolic abnormalities and genetic mutations); • the different modes of clinical presentation, depending on patient age; • heart failure classification definition within a spectrum of severity and that the well-established New York Heart Association (NYHA) Heart Failure Classification is not applicable to most of the paediatric population; • the differences between the Ross Heart Failure Classification, the modified Ross Classification and the New York University Paediatric Heart Failure Index for children and adolescents; • the changes in physiology during the postnatal period, and its effects on the presentation of heart failure dependent on patient age. **Acquired heart disease** **Infective endocarditis (IE):** • the association of IE with substantial morbidity and mortality; • the epidemiology of IE resulting from the increased survival rate of children with CHD and the decrease in rheumatic valvular heart disease; • the complexities of management of neonatal patients and patients requiring paediatric intensive care;		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference
	• the increased risks of catheter-related IE, including the long-term risk of postoperative IE after correction of complex CHD; • the pathogenesis of IE; • the Duke criteria for IE; • the clinical symptoms and signs of IE and be aware that the presentation is generally indolent; • the variability of cardiac examination dependent on the type of heart disease present and the particular site of infection; • the organisms most frequently responsible for IE; • two-dimensional transthoracic echocardiography (TTE) as the main modality for detecting IE; • indications for repeat TTE and/or from transoesophageal echocardiography (TOE); • the complications of IE and the indications for surgery. **Other acquired diseases:** • the possible causes, symptoms and clinical presentation of Kawasaki disease; • the pathology of vasculitis and the progressive disease process; • the prominence of cardiovascular manifestations in the acute phase and the impact on long-term morbidity and mortality. **Cardiac investigations:** • the role of echocardiography for cardiac assessment for the detection of abnormalities of the proximal left main coronary artery (LMCA) and right coronary artery (RCA); • the role of different imaging modalities such as echocardiography, CT, MRI and angiography; • evaluation of the cardiovascular sequelae using serial cardiac ultrasound studies.		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference

	Common arrhythmias:
	• the features of a normal 12-lead ECG and changes with age from prematurity to adulthood;
	• the common arrhythmias in fetal life, infancy, childhood and adolescence, and their natural history, presentation and clinical features;
	• ECG changes in CHD, acquired heart disease and cardiac surgery-associated arrhythmias;
	• the mechanisms in the genesis of cardiac dysrhythmias;
	• the genetic disorders associated with cardiac rhythm disturbance;
	• investigating common arrhythmias;
	• management strategies (pharmacological vs ablation);
	• the indications, limitations and risks of invasive electrophysiology studies and radiofrequency ablation.
	Single ventricle circulation:
	• why the physiology of the Fontan circulation is essential for successful patient management as numbers of patients with a Fontan circulation are increasing and reaching adulthood;
	• the indications for a Fontan for single ventricle physiology;
	• the surgical approach at each stage:
	  • Stage 1: systemic-pulmonary shunt
	  • Stage 2: superior cardiopulmonary connection (Glenn/hemi-Fontan operation)
	  • Stage 3: completion of the Fontan circulation (extracardiac conduit vs lateral tunnel)
	• complications of a Fontan circulation:
	  • diminished exercise tolerance
	  • ventricular dysfunction
	  • arrhythmias		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference

	• shunts
	• protein-losing enteropathy
	• coagulopathy
	• patient management:
	  • preoperative assessment
	  • monitoring
	  • postoperative care
	• why possible problems must be actively searched for and resolved before becoming clinically relevant and that the absence of a clinical problem does not equal satisfactory haemodynamics;
	• why heart function in the pregnant Fontan patient deteriorates throughout pregnancy, and the associated physiological and haemodynamic changes;
	• how 'old'-style Fontan circuits compare with current operations and how this will change patient management in the next decades;
	• the diagnostic imaging approach to the failing Fontan;
	• current guidelines and recommendations and provide updates to team members;
	• the psychosocial impact of CHD on individuals and families.
	Neonatal, paediatric, adolescent and critical care:
	• how to deliver effective, evidence-based and safe care to children and their families;
	• why families should be encouraged to be active partners in decisions about their children's health and care, and, where possible, be able to exercise choice;
	• the importance of care being provided in an appropriate location and in an environment that is safe and well suited to the age and stage of development of the child or young person;
	• the role of play and recreation for children visiting or staying in hospital that should be met routinely in all hospital departments, including siblings;		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference

	• the importance of play for therapeutic purposes as part of the child's care plan to help the child to assimilate new information, adjust to and gain control over a potentially frightening environment, and prepare to cope with procedures and interventions;
	• the importance of respecting a child's need for privacy;
	• how to identify significant mental health problems and refer them appropriately to the correct support team;
	• how to provide for a young person's changing needs as they grow up, including preparation for the move to adult services;
	• the duty of staff to understand and meet their legal responsibilities towards the children and young people they are caring for (*Children Act 1989 (21)*), including the legal and ethical position on real or potential conflicts between the interests of the child and those of the parents;
	• special considerations for infection control among children and that emphasis is needed on cross-infection control, focusing on common childhood infections such as respiratory infection, gastroenteritis and chicken pox;
	• linkage of guideline development into a programme of staff education and training;
	• the importance of the monitoring, review and version control of protocols.
	Catheterisation in structurally abnormal hearts
	The Clinical Scientist in HSST will also critically analyse, synthesise, evaluate and apply their expert knowledge of catheterisation in structurally abnormal hearts, including:
	• variations in cardiac and coronary radiographic anatomy in CHD hearts, including:
	  • how landmarks differ compared with a normal heart
	  • identification of both common and rare congenital defects on fluoroscopy		

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference
	• identification of intracardiac devices, clips, sternal wires and stents on fluoroscopy • the need for continuous transoesophageal (or transthoracic) echo monitoring to guide certain catheter procedures • specific arrhythmias associated with congenital cardiac lesions and previous surgery: • how to distinguish a patient's baseline ECG pattern (which will look abnormal in CHD) from pathological changes during the catheter procedure • the purpose of pacing during a procedure and how to prepare and use the equipment • haemodynamic monitoring in CHD patients, including: • recognition of the various pressure waveforms in normal and pathological states • the effects of sedation and general anaesthesia on patients with CHD and the presentation on haemodynamic and electrocardiographic monitoring; • the selection of appropriate devices/stents/balloons for a procedure and the different products on the current market, and the associated pros and cons for device selection.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will apply their expert scientific and clinical knowledge of CHD as they perform and master a range of technical and clinical skills in adult and paediatric patients appropriate to the clinical setting in which they are training. They will also be expected to critically reflect on their clinical practice in paediatric cardiology. They will use a range of advanced clinical and communication skills to advise and communicate effectively with patients, parents, carers, relevant clinicians, the public and other healthcare professionals. They should be able to identify significant mental health problems and refer them to the correct support team. They will apply their expert knowledge of CHD and paediatric practice to		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 –

Topic	Congenital Heart Disease: Expert Scientific and Clinical Practice	Assessment methods	GSP reference
	prioritise patient safety and compassionate care as they complete the programme-specific modules in this Stage 2 programme.		3.1.17 3.2.1-3.2.4 4.1.1 4.1.2
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to be empathic working with patients and their families, treating them with kindness and compassion and communicating effectively. They should treat patients and their families with respect and provide support and information to enable them to understand and cope with their illness and the treatment needed. • ensure that staff have an understanding of how to assess and address the emotional wellbeing of children; • work effectively within a multidisciplinary team in the management of children, adolescents and young adults; • recognise and minimise the anxiety of patients before, during and after procedures; • appreciate the psychological impact of the patient's CHD/syndrome on the patient and their family, and manage it sensitively; • develop a critical attitude towards techniques in catheterisation and contribute to the selection of the best available techniques according to procedure results, clinical evidence and practice guidelines; • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients requiring cardiac interventional procedures and suggest improvements, building on a critique of available evidence.		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

STAGE 2: FETAL CARDIOLOGY AND FETAL SCREENING PROGRAMMES

2CHD(ii): Fetal Screening Programmes

Topic	Fetal Screening Programmes	Assessment methods	GSP reference
Learning objective	Congenital heart disease is the most common congenital anomaly found in the human, occurring in 2% of live-born children and a higher percentage of unborn fetuses. By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply knowledge of fetal anomaly screening programmes, including: (i) the underpinning evidence base; (ii) the purpose of the screening programmes; (iii) the importance of screening programmes for cardiac diagnosis; (iv) cross-programme generic screening issues such as information giving and facilitating choice; and (v) national and international fetal screening programmes. The Clinical Scientist in HSST will be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of fetal screening programmes, including: **Evidence base for prenatal detection of CHD:** • the impact of CHD as a major cause of morbidity and premature death; • the impact of fetal echocardiography on the outcome of some cardiac lesions but not others; • the incidence of different lesions during fetal life and among live-born children; • factors influencing the estimation of the true incidence of CHD, e.g. termination of pregnancy and silent lesions that close spontaneously in childhood (e.g. tiny muscular VSDs); • the timing of fetal echocardiography, including early (12–14 weeks) and mid-trimester; • cardiac lesions where prenatal diagnosis has been shown to offer a survival advantage;		1.1.4 1.1.5 1.1.6 3.1.5 4.1.1

Topic	Fetal Screening Programmes	Assessment methods	GSP reference
	• which cardiac lesions are particularly difficult to diagnose with certainty during fetal life; • the affect of advances in medicine and science on improving CHD patient survival and the impact on future incidence. **Genetics and genomics:** • the importance of precisely orchestrated spatial and temporal gene expression in cardiovascular development; • the difference between chromosomal defects, such as aneuploidy and monosomy; • genetic abnormalities that involve excesses or deficiencies in multiple genes, or single gene defects that currently account for 3% of CHD; • the particular genetic association of particular forms of CHD; • how fetal diagnosis may improve the physiological state after birth and surgical outcome if appropriate planning has been made for selected lesions; • the role of appropriate counselling well before birth, which can allay parental fears, improve psychological state and augment coping abilities following fetal diagnosis. **Fetal screening programmes:** • epidemiology of CHD; • the rationale and organisation of screening programmes for CHD; • national and international screening programmes, including the UK Fetal Anomaly Screening Programme (FASP); • antenatal and newborn screening pathways for Down syndrome, sickle cell and thalassaemia, and infectious diseases in pregnancy; • clinical examination of newborn babies and infants; • routine investigations, including newborn blood spot; newborn hearing and pulse oximetry screening;		

Topic	Fetal Screening Programmes	Assessment methods	GSP reference

	• the purpose of antenatal and newborn screening programmes:
	  • the principles of screening
	  • differentiation between screening and diagnosis
	  • the importance of early access to midwifery care
	  • the recommended optimal timing of antenatal and newborn screening tests
	• the importance of providing information, facilitating choice and:
	  • national policies, recommendations and criteria in relation to combined screening
	  • international perspective on fetal anomaly screening and differences between UK policy and other countries.		

Clinical skills	By the end of this module the Clinical Scientist in HSST will have a critical understanding of current evidence and its application to fetal screening programmes. They will be able to perform and master each technique adapting their response to meet the varying and complex challenges that will arise reliably and will be able to: • critically evaluate the evidence base for fetal screening, including: NHS resources, recommendations and guidelines; international practice guidelines • plan, deliver and evaluate teaching sessions for colleagues • critically evaluate information leaflets provided for patients and their family and if appropriate develop new leaflets and methods of communication, i.e. online resources. By the end of this module the Clinical Scientist in HSST will be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4 4.1.1 4.1.2

Topic	Fetal Screening Programmes	Assessment methods	GSP reference
	professionals and will be able to: • gain informed consent, making appropriate arrangements for interpreters or senior support; • provide clear and concise information regarding screening to patients, parents, carers and families, and explaining the outcomes and options without bias with the use of supportive documents.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will overcome communication barriers and consider social, cultural and religious perspectives without bias.		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

2CHD(iii): Fetal Cardiology

Topic	Fetal Cardiology	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply knowledge of: (i) the changing cardiac physiology from fetus to neonate and into childhood; (ii) uniqueness of the fetal echocardiogram requiring a high level of skill and anatomical knowledge to recognise the full spectrum of simple and complex, acquired and CHD, its manifestations and natural history through gestation to understand the limitations of fetal echocardiography; (iii) the potential safety concerns of using ultrasound on a fetus and why special consideration should be given during a fetal echocardiogram; and (iv) the economic consequence of an increased survival in the CHD population and that being able to plan care allows for a smooth transition between pre- and post-natal services that allows for cost effectiveness. The Clinical Scientist in HSST will be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge, including: **Fetal vs neonatal vs later cardiovascular physiology:** • the anatomy and physiology of the cardiovascular system throughout fetal development; • maternal-fetal physiology as well as maternal conditions that may affect the fetus; • the mechanisms of oxygen delivery to the tissues in utero; • the changes immediately post partum to a more 'adult' circulation; • the importance of neonatal heart rate for maintenance of cardiac output and blood pressure and its response to the child's clinical condition; • how the neonatal heart adjusts to the new pulmonary and systemic circuitry and pressures • the vasoconstrictive response of the neonate to haemorrhage or volume depletion;		1.1.4 1.1.5 1.1.6 3.1.5 4.1.1

Topic	Fetal Cardiology	Assessment methods	GSP reference

	• the anatomy, function and changes to the following structures:
	  • ductus arteriosis
	  • ductus
	  • umbilical vein
	  • foramen ovale
	  • umbilical arteries
	  • placenta
	  • lungs
	  • right ventricle
	  • left ventricle
	• why some CHD does not present in utero;
	• cardiac disease progression as the child grows.
	Screening views (advanced versus 'standard' imaging):
	• screening views incorporated into the fetal anomaly ultrasound scan;
	• additional modalities incorporated into the detailed fetal echocardiogram;
	• use of a range of echo modalities, including two-dimensional, M-mode, pulse wave Doppler, continuous-wave Doppler and colour-flow mapping;
	• use of advanced imaging modalities such as 3D/4D echocardiography and speckle tracking and interpretation of results;
	• the position on the fetus and the left/right/anterior/posterior orientations, abdominal situs and cardiac position;
	• how to achieve visualisation of each essential component (if possible) using all the conventional tomographic planes and sweeps;
	• the limitations of echocardiography in terms of fetal position or activity in the uterus;
	• the spectrum of fetal arrhythmias and use of the spectrum of echocardiographic modalities to demonstrate and assess them;
	• the latest developments in obstetrical diagnostics, including invasive and non-		

Topic	Fetal Cardiology	Assessment methods	GSP reference
	invasive tests available throughout pregnancy; • the growing field of invasive fetal intervention and its effect on the cardiovascular system; • management strategies and current outcomes for treatment of congenital and acquired heart disease. **Risk:** The theoretical risks of: • ultrasound energy expenditure of each modality; • power output and time of exposure, i.e. 'as low as reasonably achievable' (the 'ALARA' principle); bioeffects of ultrasound energy, i.e. thermal or mechanical; and the parameters to monitor the effects, e.g. the Thermal Index (TI) assigned for either soft tissue (TIS) or bone (TIB); • the evidence base underpinning these effects; • the uncertainty with respect of the potential risks of newer modalities, including 3D/4D echocardiography and the need to continue monitoring bioeffects. **Health economics:** • the benefits and risks of screening with respect to outcome, cost-benefit ratio, mortality and long-term importance of prenatal diagnosis to optimise perinatal care; • the limitations of cost-benefit analysis due to possible errors in diagnosis; • how to assess the cost-benefit of further prenatal cardiac/extra-cardiac imaging in the presence of an anomaly (e.g. fetal MRI) or the need for pre-natal intervention; • the social, psychological and emotional consequences for the family of postnatal treatment in complex CHD and the potential impact on counselling, including the ethical considerations; • the non-surgical costs/out-of-hospital care needs of the CHD patient.		

Topic	Fetal Cardiology	Assessment methods	GSP reference
	Ultrasound: • the need for a standardised approach using recognised guidelines; • ultrasound equipment and how to achieve high-quality scans; • the increased demand for spatial and temporal resolution given the minute size of fetal cardiac structures and high heart rate; • why transducers should be changed to optimise imaging.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current evidence and its application to fetal screening programmes. They will be able to perform and master a range of techniques, adapting their response to reliably meet the varying and complex challenges that will arise and will: • reassure the patient and their family and clearly explain the process and purpose of the fetal echocardiogram, supporting parents/carers who may be extremely anxious; • gain informed consent, making appropriate arrangements for interpreters or senior support as required; • take a history prior to undertaking fetal echocardiogram; • provide a safe and clean environment for examination and appropriately clean equipment after each use; • perform a detailed fetal echocardiogram consistent with published guidelines as efficiently as possible and recognise when to discontinue the scan due to imaging difficulties so as to avoid potential harm to the fetus; • achieve optimum frame rates of 80–100Hz by adjusting ultrasound equipment to minimise persistence and spatial averaging; utilising Harmonic imaging when acoustic penetration is difficult (e.g. with maternal obesity); • appropriately use all Doppler modalities, including colour, pulse, continuous, high pulse repetition frequency and tissue Doppler imaging; • appropriately change between transducers to optimise imaging;		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4 4.1.1 4.1.2

Topic	Fetal Cardiology	Assessment methods	GSP reference
	• adjust ultrasound equipment and optimise imaging to produce the nest images with minimal potential risk; • appropriately use ultrasound modalities when necessary; • interpret the findings and produce a logical and clinically relevant report; • explain in clear and concise terms the finding of the scan and support with approved literature, and seek support from senior and counselling staff when necessary; • accurately and concisely document findings and discussions and communicate these efficiently and effectively with team members, as well as other relevant health professionals; • appropriately address any concerns the patient/family might have regarding fetal echocardiography safety; • accurately and concisely document findings and discussions and communicate these efficiently and effectively with team members, as well as other relevant health professionals; • recognise when the involvement of senior medical staff, e.g. fetal cardiologist, is required and refer appropriately; • convey information to parents related to scan findings according to agreed institutional policy.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • work in an empathic and calm manner to support anxious parents and families; • adopt a conscientious approach to all aspects of practice; • be open and have a non-judgemental approach to practice;		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5

Topic	Fetal Cardiology	Assessment methods	GSP reference
	• contribute to the multidisciplinary team, recognising the contribution of all those involved with supporting a patient with CHD; • communicate in an effective and timely manner with healthcare professionals, patients, parents and families; • overcome communication barriers and consider social, cultural and religious perspectives without bias or prejudging parental views; • reassure patients without disregarding the potential risks and thus scanning with appropriate skill and brevity not disregarding patient concerns.		1.3.1 5.1.2 5.1.3

STAGE 2: CONGENITAL AND PAEDIATRIC CARDIAC ELECTROPHYSIOLOGY AND RHYTHM MANAGMENT

2CHD(iv): Cardiac Electrophysiology and Pacing

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
Learning objectives	By the end of this module the Clinical Scientist in HSST will be able to support interventional electrophysiology (EP) and cardiac pacing procedures, including complex three-dimensional mapping procedures of structurally normal and abnormal hearts in children and adults with CHD. They will be able to interpret baseline, exercise and ambulatory ECG recordings in patients with CHD, including acquired arrhythmia syndromes. They will be able to support the cardiac surgical team in the process of epicardial surgical pacemaker implantation. They will be able to support implant of and perform follow-up assessment and optimal programming of implantable cardiac devices, including those for diagnosing and treating bradycardias, tachycardias and cardiac resynchronisation devices. They will be able to develop and run a regional follow-up service for patients with these devices, including remote follow-up via industry-provided devices.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of cardiac EP and pacing, including: **Non-invasive investigation of rhythm abnormalities:** • the range of cardiac rhythm abnormalities that present in children and adults with congenital cardiac disease, and those who present in childhood with acquired cardiac disease that affects the conduction system of the heart; • the genetic implications of familial arrhythmia syndromes, and know how these present in children; • the indications for non-invasive electrophysiological testing in children and adults with CHD; • the expected abnormalities of the ECG in patients with arrhythmia syndromes, including the changes in the ECGs of these patients with exercise testing and diagnostic drug testing; • how to interpret the 12-lead ECG, including the knowledge of normal variation and		1.1.4 1.1.5 1.1.6 3.1.5 4.1.1

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference

	patterns of abnormality through infancy and childhood;
	• arrhythmia epidemiology and prognosis (genetics, pathophysiology, risk evaluation) techniques, modalities, indications, interpretation, and the diagnostic yield of general cardiology non-invasive and imaging techniques such as:
	  • exercise testing
	  • echocardiography including TOE
	  • cardiac MRI
	  • cardiac CT imaging
	  • nuclear cardiology
	  • blood sampling and other laboratory analysis
	  • genetic analysis
	• techniques, modalities, indications, interpretation and the diagnostic yield of non-invasive arrhythmia assessment techniques such as:
	  • electrocardiography:
	  – conventional 12-lead ECG
	  – ECG monitoring (Holter, event monitoring, implantable event and loop monitoring)
	  – signal-averaged ECG and body surface mapping
	  – heart rate variability and baroreflex sensitivity
	  – T-wave and micro-T-wave alternans
	  – ECG-drug infusion tests (flecainide, etc.)
	  • autonomic nervous system evaluation:
	  – carotid sinus massage
	  – tilt testing
	Invasive investigation and treatment of rhythm abnormalities:
	• which heart rhythm problems in patients with arrhythmia syndromes require acute medical or interventional treatment, and how to access this treatment in a timely manner;		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference

	• autonomic system influences on EP and arrhythmias;
	• channelopathies and other inherited syndromes:
	  • long and short QT syndromes
	  • Brugada syndromes
	  • hypertrophic cardiomyopathies
	  • right ventricular arrhythmogenic cardiomyopathies
	  • neuromuscular cardiomyopathies (myotonic dystrophy)
	  • catecholaminergic polymorphic ventricular tachycardia
	  • ryanodine syndromes
	  • congenital conduction disorders
	  • other (Chagas disease, etc.)
	• clinical presentation, ECG and EP of the different types and variants of cardiac arrhythmias, including:
	  • conduction disturbances
	  • arrhythmic clinical syndromes
	  • genetic disorders
	  • autonomic system-mediated disorders (induction, cardiac activation)
	  • responses to electrical stimulation and to drug administration, cardiac activation, EP diagnosis
	  • sinus node and atrial impulse formation and conduction disorders – AV nodal and His-Purkinje conduction disorders
	  • atrial flutter
	  • junctional and AV node ectopy and tachycardias
	  • accessory pathway-mediated tachycardias
	  • atrial (and thoracic vein) ectopy and tachycardias
	  • atrial fibrillation
	  • ventricular ectopy and tachycardias
	  • ventricular fibrillation
	• patient and procedure-type selection for specific arrhythmia management		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference

	strategies/targets(risks and benefits).
	Electrophysiology procedures:
	• the indications for invasive testing in the EP laboratory;
	cellular EP; ion channel function and regulation, and the effects of ionic imbalance on cardiac EP;
	• cardiac anatomy relevant to the genesis and treatment of arrhythmias, including detailed anatomy of the thoracic veins, of the right and left atria and inter-atrial septum, right and left outflow tracts, aortic root, coronary artery and coronary venous systems, the AV junction (triangle of Koch, tricuspid annulus, mitral annulus) and associated accessory pathways;
	• underlying mechanisms of arrhythmias: normal automatic behaviour, abnormal
	• automatism, triggered activity, micro-reentry, macroreentry, and other mechanisms;
	• EP principles, including
	  • measurement of local activation time and voltage
	  • interval measurements
	  • conduction velocity and tissue wavelength
	  • concealed conduction
	  • gap phenomenon
	• normal and abnormal electrophysiology of the different heart chambers and the major thoracic vessels;
	• EP laboratory equipment (fluoroscopy, catheters, sheaths, EP signal recording systems, navigation systems, programmed electrical stimulation systems);
	• ECG and EP signals (differential amplifier: noise, gain, clipping, filters, bipolar/unipolar, voltage/timing/morphology);
	• programmed electrical stimulation techniques (pulse width/amplitude, unipolar/bipolar, continuous/extra-stimulus stimulation, atrial/ventricular/other location stimulation, pacing algorithms);		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference

	• complications and adverse effects of EP studies: pathophysiology, diagnosis, prevention, management;
	• catheter placement techniques, including cardiac access (transvenous, pericardial, other), guiding means (fluoroscopic and non-fluoroscopic);
	• intracardiac catheter positioning and electrophysiological pacing techniques that elucidate the arrhythmia mechanism;
	• electrogram activation patterns and their changes in response to planned electrophysiological perturbations that allow determination of arrhythmia mechanism;
	• use of stimulators, catheters, mapping systems and lesions creation technologies sufficient for their safe application in patient treatment;
	• three-dimensional mapping using a range of computerised mapping technologies, and when this would be useful to support an invasive study;
	• the potential for diagnostic use of medication during an electrophysiology study to induce arrhythmias or reveal conduction disease;
	• the usefulness of TOE in guiding the interventional trans-septal puncture during an ablation procedure if required, and will have knowledge of the equipment required to perform the scan and the anatomy involved. They would not be required to perform the scan;
	• the haemodynamic data obtained during a catheterisation procedure, including the potential effects of cardiac arrhythmia on the haemodynamics;
	• interpretation of therapy modalities in EP other than ablation, such as:
	  • medical therapy
	  • autonomic system manoeuvres
	  • cardioversion and defibrillation
	  • anti-tachycardia pacing and device therapies
	• pharmacological tests and modulation, for example:
	  • adenosine		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	• type I drugs for unmasking Brugada ECG • adrenaline for unmasking congenital long QT syndrome **Cardiac device implantation:** • indications for cardiac device implantation, be aware of the issues involved in device implantation in children compared with adults and be able to support a clinician in implanting an appropriate device to treat the relevant rhythm issues; • the published international guidelines regarding patient selection for device implantation; • how to assess data on individual patients to determine evidence-based treatment for each individual patient; • management of lead problems and programming issues specifically related to leads; • rate-modulated pacing and sensor technology; • management of peri-procedural complications, e.g. cardiac tamponade, and pneumothorax. • the principles of defibrillation and the engineering of device and of defibrillating leads; • the medical treatment of tachyarrhythmias, including interaction of drugs with defibrillation threshold and arrhythmia cycle length, the pro-arrhythmic effect of antiarrhythmic drugs and their effect on left ventricular function; • indications, techniques, performance and response interpretation of therapy; • medico-legal issues concerning provision of information, and driving restrictions and end of life issues. • specific issues regarding lead longevity in young children with the associated growth that they will undergo following implantation; • the reasons for, usefulness of and limitations behind epicardial pacing in small children and postoperative patients where access to the cardiac chambers via typical transvenous routes may not be possible;		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	• differences of professional expert opinion on the best method of pacemaker implantation in very young or small children (epicardial/endocardial systems); • the paucity of evidence on which to base decisions/guidelines due to the small and diverse population of children requiring pacemakers, leading to guidelines based on consensus expert opinion. **Device follow-up:** • the indications for and frequency required for appropriate follow-up across the range of ages and devices; • the wide range of devices available to allow for optimal programming, including the need for potential programming or device changes relating to a child's growth or developmental needs. • the need to optimise devices to achieve the best balance of function and longevity, given the requirement for children and young people to undergo device changes (frequently under general anaesthesia) over a much longer period than is usual in the adult-acquired heart disease pacing population; • potential issues with long-term pacemaker dependency and cardiac dysfunction, which may relate to lead position; • why careful attention should be taken to position leads optimally at implant as per current best evidence or opinion; • how to perform remote monitoring of devices using near patient technology rather than requiring patients to always attend hospital for review; • cardiac anatomy, including those patients with operated and unoperated structural congenital heart defects, and the bearing that the anatomy and/or surgery may have on the types of arrhythmia and their treatment options; • the appearance of images obtained during a standard angiographic assessment of cardiac structure and function; • the impact of general anaesthesia on the inducibility of cardiac arrhythmias and the haemodynamic changes that may occur related to sedation or general anaesthetic;		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	• the use of defibrillation in resuscitation and in the techniques of basic and intermediate life support; • the potential effects that a diagnosis of cardiac arrhythmia may have on a child or young person and their family, and initial and ongoing emotional or psychological support that may be required as they come to terms with the diagnosis and its implications, including the effect of potential treatment options; • the possible risk of sudden cardiac death that some arrhythmic syndromes carry and that may have no currently available treatment options (which may be very distressing for the patients, family and the team treating them); • the rapid advances in EP and cardiac rhythm management and the new treatments may become available in the future; • potential clinical benefits of telemedicine for device follow-up; • the breadth of available devices and the indications for choosing to implant one over another through regular contact with industry device providers; • keep up to date about the development and release of new devices that would potentially benefit patients in the congenital group.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals, and will be able to: • determine whether standard exercise testing, cardiopulmonary exercise testing, ambulatory monitoring or tilt-table testing would be the most appropriate investigation modality; • interpret 12-lead ECGs in the clinical context; • interpret invasive and non-invasive (such as standard exercise testing, cardiopulmonary exercise testing, ambulatory monitoring or tilt-table testing and		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	12-lead ECGs) EP testing and produce expert reports on the results of these investigations; • interpret the results from a range of invasive testing, including cardiac catheterisation studies and EP procedures; • perform external defibrillator and planned direct current (DC) cardioversion. **Cardiac electrophysiology:** • interpret clinical invasive cardiac EP studies; • interpret images relating to catheter position in relation to the conduction system of the heart; • use test results to plan further treatment and discuss these plans with a multidisciplinary team to ensure that the patient is treated in the most appropriate method and in a timely manner; • liaise during procedures with EP clinicians and communicate during the procedure to ensure appropriate treatment; • interpret the results of three-dimensional mapping to guide interventional treatment with ablation; • manage the technical equipment (EP systems, programmable stimulator, ablation systems, 3D mapping, haemodynamic monitoring systems, pacing and defibrillation systems, etc.); • recognise and manage the complications and the adverse effects of EP studies; • appreciate the limitations and the potential risks of therapies; • reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients requiring cardiac EP procedures and suggest improvements, building on a critique of available evidence; • educate patients about the treatment options available to them and explain treatment strategies; • deliver education about arrhythmias to patients relatives and other healthcare professionals to demonstrate/diagnose/confirm any given arrhythmia mechanism		4.1.1 4.1.2

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	and the critical components by a combination of pattern recognition and electrical interaction with the arrhythmia mechanism (e.g. extra-stimulation/entrainment). **Cardiac pacing/device therapy:** • use the results of investigations to plan appropriate cardiac device implantation as per published international guidelines regarding patient selection; • assess ECGs of patients with known or suspected inherited or genetic cardiac disease and determine a treatment plan based on the outcomes of baseline ECGs and those obtained during diagnostic drug testing; • assist with the insertion of temporary and permanent pacing wires, techniques and skills involved; • use a temporary pacing box during procedures and following cardiac surgery to optimise haemodynamics; • programme and optimise implantable devices from a range of device companies, including pacemakers, defibrillators, loop recorders and cardiac resynchronisation devices; • perform overdrive pacing using temporary epicardial pacing wires in postoperative patients and implement device programming changes to stop abnormal cardiac rhythms in patients with implantable devices for treatment of cardiac tachyarrhythmias; • manage device malfunction and troubleshooting; • assess current drain and battery longevity; • interpret and assess electrograms, markers, intervals, Holter features and other storage and diagnosis capabilities and appropriate programming and/or medical intervention in response to new findings; • evaluate device diagnostic data in the clinical context and in reference to other non-invasive or invasive techniques; • critically reflect on the challenges of applying research to practice in relation to the diagnosis and management of patients requiring cardiac EP procedures and		

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	suggest improvements, building on a critique of available evidence; • communicate the results of testing with families and patients and discuss the various treatment options with them in the light of multidisciplinary discussion regarding their appropriateness.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • recognise and minimise the anxiety of patients and their parents or families before, during and after procedures, and appreciate the psychological impact of the patient's CHD/syndrome on the patient and their family and manage it sensitively; • educate patients and their parents or families about cardiac rhythm disease, treatment strategies and outcomes, including risks and benefits of interventional treatment. Tailor this education individually to the level of understanding of the child or young person, including those with learning difficulties; • update patients and families regarding technical advancements in device technology and how these might be relevant to the specific patient; • liaise with patients and their families regarding appropriate follow-up, including contact with patients after requests for review of data from near-patient remote monitoring systems. This will include the need for discussion regarding abnormal findings that could cause the patient or their family to become increasingly anxious, and the management of this situation. This may also involve breaking bad news such as the need for further interventional procedures or the deterioration of a patient's overall condition and a potential reduced life expectancy; • liaise appropriately and in a timely manner with consultant EP team members when abnormal findings are demonstrated to ensure that appropriate patient review and treatment are performed if required;		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

Topic	Cardiac Electrophysiology and Pacing	Assessment methods	GSP reference
	• develop a critical attitude towards techniques in invasive EP and cardiac device implantation and contribute to the selection of the best available techniques according to procedure results, clinical evidence and practice guidelines.		

2CHD(v): Cardiac Resynchronisation Therapy

This module is the same as 2A(iii)

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST, with respect to cardiac resynchronisation therapy, will be able to critically analyse, synthesise, evaluate and apply knowledge, and utilise a range of clinical skills to support the use of CRT therapy in a range of patients, while demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of cardiac resynchronisation therapy, including: • the indications and international and national guidelines for correct CRT device pacemaker prescription, including pacing mode; • management of peri-procedural complications, e.g. cardiac tamponade, and pneumothorax; • potential clinical benefits of telemedicine.		1.1.4 1.1.5 3.1.5 3.1.8
Clinical skills	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of current research and its application to the performance, adaptation and mastery of a range of clinical and communication skills, and will: • take a relevant history and assess the efficacy of CRT therapy; • assess heart failure status; • recognise and triage implant or device behaviour complications; • optimise therapy delivery, including proper programming of stimulation; • analyse and use the diagnostic data coming from the implanted device; • identify patients likely to benefit from CRT and be aware of limitations of these techniques;		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 3.1.1 3.1.3 3.1.4 3.1.5

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
	• deal with common problems associated with implantation techniques; • recognise and respond to potential complications; • assist with a CRT implant in a safe and logical manner; • recognise the nature of implant difficulties and take the appropriate action to overcome these; • appreciate when an alternative technique or approach may be required (e.g. surgical device implantation); • programme the devices appropriately, and advise on optimisation using recognised techniques such as echocardiography; • evaluate device diagnostic data in the clinical context and with reference to other non-invasive or invasive techniques; • reflect on the challenges of applying research to practice in relation to the use of CRT and suggest improvements, building on a critique of available evidence.		3.1.6 3.1.7 3.1.8 3.1.9 3.1.10 3.1.11 3.1.12 3.1.13 3.1.14 3.1.15 3.2.1 3.2.2 3.2.4
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations, consistently demonstrating the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will • foster a team approach to pacing, including a close relationship with implanters; • commit to the audit of long-term outcomes, including infection and lead complications; • develop a critical attitude towards a safe pacing programme in the hospital and support patients in their community with adequate pacing follow-up; • educate patients about the treatment options available to them and explain the treatment strategies; • work closely with other healthcare professionals as necessary: cardiologists, infection control, care of the elderly, etc.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.7 1.1.9 1.1.10 1.2.1 1.3.1 5.1.2 5.1.3

Topic	Cardiac Resynchronisation Therapy (CRT)	Assessment methods	GSP reference
	• appreciate the psychological impact of the patient's arrhythmia illness on the patient and their family, and manage it sensitively; • work closely with other healthcare professionals, particularly palliative care • evaluate the psychological impact of the patient's arrhythmia illness, device implantation and therapy on the patient and their family, and manage it sensitively; • take a sensible, professional attitude to CRT and learn under supervision with appropriate requests for advice; • appreciate the importance of team-working with nursing, radiographic, anaesthetic, and, if appropriate, industrial staff; • work closely with other healthcare professionals as necessary, being aware of the importance of a multidisciplinary team in heart failure management and in maximising the benefit of CRT: cardiologists, infection control, care of the elderly, internal medicine specialists, etc.; • deal appropriately with patients in whom CRT implantation has not been effective; • appreciate the psychological impact of the patient's illness on the patient and their family, and manage it sensitively; • recognise and remain up to date with developments in the field.		

STAGE 2: CONGENITAL HEART DISEASE AND PAEDIATRIC ECHOCARDIOGRAPHY

2CHD(vi): Transthoracic Echocardiography in Congenital Heart Disease

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply their knowledge of echocardiography for advanced CHD in adults and children, spanning transthoracic, three-dimensional (3D) and echocardiographic techniques for the quantitative evaluation of cardiac mechanics. **Transthoracic echocardiography** (TTE) will include: (i) indications for detailed paediatric echocardiogram; (ii) standardised approaches to scanning neonates, infants and children; and (iii) anatomical and functional assessment of the normal and abnormal heart. **3D echocardiography** will include: (i) the indications for 3D transthoracic (3D TTE); and (ii) 3D assessment of aortic valves, atrial and ventricular septal defects **Echocardiographic techniques for the quantitative evaluation of cardiac mechanics** will include: (i) techniques used to assess local wall dynamics; and (ii) physiologic measurements of left and right atrial and ventricular function. The recommended indications for the clinical use of each technique, together with the strengths, weaknesses and limitations, will also be included. The Clinical Scientist in HSST will also be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge, including:
	
	All techniques:
	• national and international recommendations and guidelines, including:
	  • indications for echocardiography
	  • standards for performing and reporting of echocardiograms
	  • institutional accreditation for echocardiography departments
			1.1.4
			1.1.5
			1.1.6
			3.1.5
			4.1.1

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference

	• current training guidelines and regulations for paediatric echocardiography:
	  • the roles of clinical and technical leadership in echocardiography departments
	  • training and supervision
	• Doppler methods and their application to the assessment of cardiovascular physiology;
	• echocardiographic methods available for assessment of global and regional ventricular function and the strengths and weaknesses of each technique;
	• how to recognise and characterise rare and complex congenital and acquired cardiovascular abnormalities in a variety of clinical settings;
	• recent advances in the field of non-invasive cardiac imaging.
	
	Underpinning ultrasound physics, including:
	The principles of:
	• Doppler tissue imaging, including strain imaging;
	• 3D echocardiography;
	• tissue Doppler imaging (TDI);
	• speckle tracking, including strain imaging;
	• the role of intravascular contrast agents for opacification of the left ventricular cavity and assessment of wall motion.
	
	3D echocardiography:
	• instrumentation, including the types of matrix array transducer and how they work;
	• modes of 3D data acquisition, image display including cropping, post-acquisition display, volume rendering, surface rendering, 2D multiplanar reconstruction;
	• 3D colour Doppler acquisition cropping methods, orientation and display and limitations);
	• transthoracic 3D examination protocol;
	• management and work flow;
	• assessment of the left and right ventricle, including anatomy and limitations of 2D		

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	assessment, data acquisition and cropping, orientation and display, analysis methods, clinical validation and application, future perspectives; • mitral apparatus, the aortic and pulmonary valves and roots, and the tricuspid valve, including anatomy and limitations of 2D assessment, data acquisition, comprehensive exam, clinical validation and application, colour regurgitation; • the right and left atria and left atrial appendage, including anatomy and limitations of 2D assessment, data acquisition, clinical validation and application; • 3D anatomy of great vessels and their orientation in some types of CHD (e.g. double outlet right ventricle [DORV]); acquisition methods, data acquisition, analysis methods, orientation and display in multiplanar reconstruction, clinical validation and application; • 3D stress echocardiography (acquisition methods, data acquisition, analysis methods, orientation and display, clinical validation and application); • indications for the echocardiogram; • limitations of 3D TTE. **Echocardiographic techniques for the quantitative evaluation of cardiac mechanics:** • terms, definitions and basic parameters of myocardial function; • techniques used to assess local wall dynamics; • the indications for the echocardiogram. **Tissue Doppler imaging (TDI)** **TDI acquisition:** • spectral Doppler, including the settings, sample volume size and position to capture the data for the area of interest; • colour Doppler, including how to get the highest frame rates by adjusting ultrasound settings. **TDI image analysis:**		

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	• spectral and colour Doppler, including the different ways of displaying and post processing. **Colour Doppler measurements of myocardial function:** • velocity (v), displacement (d), strain (ε) and strain rate (SR); • the possibility of erroneous results that arise due to poor application technique; • the strengths and weaknesses of TDI. **Two-dimensional (2D) speckle-tracking echocardiography (STE)** **2D STE image acquisition:** • how to obtain the best frame rates. **2D STE analysis of myocardial mechanics:** • the four parameters (velocity, displacement, SR and strain) of myocardial mechanics by tracking groups of intramyocardial speckles (d or v or myocardial deformation (ε or SR) in the imaging plane; • how the assessment of 2D strain by STE can be applied to both ventricles and atria; • longitudinal, radial and circumferential strain; • the timing at which peak strain is measured; • the possibility of erroneous results that arise due to poor application technique; • the strengths and weaknesses of TDI. **Three-dimensional (3D) STE** **3D STE image acquisition:** • how to obtain sufficient 3D image for 3D STE to be applied. **3D STE analysis of myocardial deformation:** • the pyramidal data sets displayed by the 3D STE software; • the possibility of erroneous results that arise due to poor application technique;		

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	• strengths and weaknesses of 3D STE. **Integrated backscatter (IBS) analysis:** • IBS signal acquisition; • IBS analysis of myocardial dynamics; • the possibility of erroneous results that arise due to poor application technique; • strengths and weaknesses of IBS analysis. **Physiologic measurements of left ventricular (LV) function:** • LV architecture and vectors of myocardial deformation; • the cardiac micro and macro architecture is useful in understanding the relative contributions of different myocardial layers to the 3D components of myocardial deformation and how this information is used for optimising motion analysis using TDI and STE; • longitudinal, circumferential mechanics, radial and twist mechanics of the heart. **Clinical use of LV displacement, velocity, strain and strain rate** **LV rotation:** • ability of the LV's rotating or twisting motion as its role in LV systolic and diastolic function; • how to quantify LV rotational deformation by using colour TDI with high temporal resolution; • unresolved issues and research priorities in this area. **LV dyssynchrony:** • the different techniques that can influence LV dyssynchrony; • unresolved issues and research priorities in this area. **LV diastolic function:** • how myocardial strain and SR are sensitive parameters for quantification of diastolic function;		

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	• unresolved issues and research priorities in this area. **Myocardial ischaemia:** • fibre thickening across the different layers of the myocardial wall to differentiate the various patterns of contractile abnormalities that may occur during acute or chronic myocardial ischaemia; • unresolved issues and research priorities. **Fibrosis and viability:** • the detection of myocardial fibrosis and viability that is dependent on the evaluation of both myocardial tissue characteristics and myocardial shape change within the cardiac cycle; • the various echocardiographic techniques to help diagnose fibrosis; • normal values, published findings, unresolved issues and research priorities. **Physiologic measurements of right ventricular and left and right atrial function** **Right ventricle:** • the differences between the RV and LV myocardium and their different shapes; • the different measurements to quantitative approach to assess longitudinal RV function (tricuspid annular plane systolic excursion - TAPSE, TDI, STE); • normal values, published findings, unresolved issues and research priorities. **Left atrium (LA):** • the four basic mechanical functions of the LA; • global and regional LA function; • normal values, published findings, unresolved issues and research priorities. **Right atrium (RA):** • the three phases of the RA; • normal values, published findings, unresolved issues and research priorities.		

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
Clinical skills	By the end of this module the Clinical Scientist in HSST will have a critical understanding of current evidence and its application to the full range of advanced TTE procedures. They will be able to perform and master each technique, adapting their response to reliably meet the varying and complex challenges that will arise and will be able to: • perform a detailed paediatric echocardiogram consistent with European Society of Echocardiography and American Society of Echocardiography published guidelines (sequential segmental analysis); • assess complex heart disease, including severity, timing and suitability for repair/percutaneous procedures and effects on ventricular function; • assess complex CHD in adults; • perform a detailed assessment in heart failure; • perform a detailed assessment of ventricular structure and function in inherited and acquired heart muscle disease; • assess prosthetic valve dysfunction; • assess mechanical dyssynchrony, suitability for cardiac resynchronisation therapy and perform echo-optimisation of biventricular pacemakers. **3D echocardiography:** • perform 3D echocardiography to obtain high-quality 3D datasets, cropping and displaying the datasets to enable colleagues to understand the anatomy using a range of display methods; • guide surgeons and interventionists during a range of anatomical repairs and closures; • assess LV function with 3D global LV volume rendering; • interpret the results from 3D echocardiography and generate a clinical report. **Echocardiographic techniques for the quantitative evaluation of cardiac mechanics:**		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4 4.1.1 4.1.2

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	• assess the effects of cardiac conditions on ventricular function; • perform a detailed assessment of patients with heart failure by using TDI and speckle tracking on the basis of displacement measurements; • perform a detailed assessment of ventricular structure and function in inherited and acquired heart muscle disease; • assess mechanical dyssynchrony, suitability for cardiac resynchronisation therapy and perform echo-optimisation of biventricular pacemakers; • interpret the results and generate a clinical report. The Clinical Scientist in HSST will also be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals, and for each of the echocardiographic techniques in this module will be able to: • arrange for interpreters and seek senior support where required; • gain informed consent for each procedure as required; • take a patient history prior to undertaking paediatric echocardiography; • support parents, who may be extremely anxious; • document findings accurately and concisely and interpret the results; • discuss and communicate findings efficiently, appropriately and effectively with team members and other relevant health professionals; • recognise when the involvement of senior medical staff is required, e.g. paediatric cardiologist, and refer appropriately; • prepare and present echocardiographic data at clinical case conferences and scientific and clinical meetings and conferences.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a		1.1.1 1.1.2 1.1.4

Topic	Transthoracic Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • overcome communication barriers and consider social, cultural and religious perspectives without prejudging parental views; • communicate clearly, effectively and in a timely fashion with patients, parents, carers and healthcare professionals; • adopt a calm and empathic manner to support anxious parents and families; • adopt a conscientious approach to all aspects of practice; • recognise the role of each of the people involved in the diagnosis, treatment and long-term management of patients with CHD and contribute to the multidisciplinary team; • take a leadership role in the organisation and administration of cardiac services, including training and clinical supervision; • work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, other echocardiographers, and nurses and specialists in other imaging modalities as required.		1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

2CHD(vii): Transoesophageal Echocardiography in Congenital Heart Disease

Topic	Transoesophageal Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply their knowledge of transoesophageal echocardiography (TOE), including three-dimensional imaging (3D), in patients with CHD. They will master the technique of TOE in paediatric and adult patients to acquire, analyse, display and interpret various cardiac structures. The Clinical Scientist in HSST will be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		
Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge, including: • instrumentation and equipment; • patient safety issues and probe safety issues; • standards of probe cleaning technique and probe inspection; • individual hospital policy and protocols regarding probe cleanliness and disinfection; • how the different TOE probes work, including biplane and omniplane probes; • TOE probes including neonatal, paediatric and adult probes; • conventional standardised image planes to perform a comprehensive TOE examination; • how to recognise normal anatomy, normal variants and pathological states; • management and work flow for image storage; • the indications and contraindications for TOE; • the current and potential clinical applications of TOE; • 2D TOE and its application to assessment of cardiac function and structure. **3D TOE in CHD:**		1.1.4 1.1.5 1.1.6 3.1.5 4.1.1

Topic	Transoesophageal Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	• the indications and contraindications for 3D TOE; • the unique and dynamic 3D spatial information that 3D TOE provides that cannot be obtained by 2D TOE or fluoroscopy; • how to acquire good 3D datasets appropriate to the anatomy being interrogated; • 3D normal anatomy, congenital heart anatomy and postoperative anatomy; • the purpose of 3D LV volume rendering and function assessment and its advantages and limitations compared with other function assessment techniques; • how to use live 3D imaging versus full volume datasets; • the impact of 3D TOE on surgical decision making; • technical and process advancements in cardiology and imaging research; • the weight boundaries for 3D TOE probes. **TOE in CHD for catheter procedure guidance:** • which imaging planes are best for guiding particular procedures; • the limitations of the guidance that can be offered to the interventionalist; • the indications and contraindications for TOE in the catheter lab.		

Clinical skills	By the end of this module the Clinical Scientist in HSST will have a critical understanding of current evidence and its application to the full range of TOE in patients with CHD. They will be able to perform and master each technique, adapting their response to reliably meet the varying and complex challenges that will arise and will be able to:
	• introduce a TOE probe safely in paediatric and adult patients;
	• perform TOE using standardised conventional image planes and producing high-quality images across a range of patients, including:
	  • neonates, paediatric patients and adults with CHD;
	  • under general anaesthesia;
	  • under intravenous and local sedation;
	  • guide surgeons and interventionists with various anatomical repairs and
			1.1.3
			1.1.5
			1.1.6
			1.3.1
			1.3.2
			1.3.3
			1.4.5
			2.1.1 – 2.1.6
			2.3.1-2.3.4
			3.1.1 – 3.1.17
			3.2.1-3.2.4

Topic	Transoesophageal Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	closures; • assess surgical results with intraoperative TOE • perform TOE in CHD for catheter procedure guidance; • use the various 3D display methods on the ultrasound machine; • crop and display the 3D datasets anatomically 'on-cart' for rapid assessment; • crop images off-line on reporting software; • interpret the findings in relation to the anatomy, recognising normal anatomy, normal variants and pathological states. **TOEin CHD for catheter procedure guidance:** • guide diagnostic and interventional procedures across a range of paediatric and adult patients; • take the appropriate pictures in the appropriate order and relay the findings immediately to the interventional team; • adjust imaging as required by the interventionalists; • interpret findings in relation to anatomy, recognising normal anatomy, normal variants and pathological states. By the end of this module the Clinical Scientist in HSST will also be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals, and will be able to: • use provided resources and make arrangements for interpreters and senior support where required; • gain informed consent for each procedure appropriate to their role; • accurately and concisely document findings, interpreting these to provide a clinical opinion; • discuss and communicate the findings from TOE efficiently and effectively with		4.1.1 4.1.2

Topic	Transoesophageal Echocardiography in Congenital Heart Disease	Assessment methods	GSP reference
	team members, as well as other relevant health professionals.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will: • take a leadership role in the organisation and administration of cardiac imaging and 3D reconstruction services, leading training and clinical supervision; • collaborate with specialists in other imaging modalities; • evaluate each session and develop action plans to improve teaching; • work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, other echocardiographers and nurses; • be decisive and concisely communicate findings to the team; • lead training and clinical supervision in the catheter lab; • work collaboratively with cardiologists, cardiac surgeons and other medical staff to support procedural success.		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

2CHD(viii): Adult Congenital Heart Disease

This module is the same as 2A(ix): Adult Congenital Heart Disease

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise, critically evaluate and apply their expert knowledge of: (i) the requirement for long-term follow-up in patients with CHD and the multidisciplinary approach required to achieve this; (ii) the impact of acquired heart disease on ageing patients and how to assess this; (iii) the impact and contraindications of lifestyle choices on patients with CHD; and (iv) the specific imaging requirements around the time of surgery and when to use complementary modalities. In addition they will gain and apply their expert knowledge of the importance of :(i) pre-pregnancy counselling and the maternal risks associated with pregnancy in patients with CHD; (ii) the specialised multidisciplinary approach to care during the antenatal, delivery and postnatal periods; and (iii) the genetics involved in CHD and the implications of inheritance. The Clinical Scientist in HSST will be expected to manage patients suitable for follow-up in a physiologist-led service. Their knowledge will also span the requirement and requisites of a well-coordinated transition service to prepare the patient for the change between paediatric and adult services. They will also be expected to apply their knowledge in their scientific and clinical practice while consistently demonstrating the attitudes and behaviours necessary for the role of a Consultant Clinical Scientist within a patient-focused service.		

Knowledge	By the end of this module the Clinical Scientist in HSST will critically analyse, synthesise, evaluate and apply their expert knowledge of the long-term follow-up of adult CHD and acquired heart disease, including:
	
	Underpinning clinical science:
	• the natural history of various CHD lesions, native and repaired, and the level and range of care available to support patient management, including:
	  • quaternary/tertiary care
	  • district general hospitals with specialist interest physicians
	  • physiologist-led clinics within a tertiary centre
			1.1.4
			1.1.5
			1.1.6
			3.1.5
			4.1.1

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	• specialist dental care
	• obstetric care
	• CHD conditions that can be safely followed up in Clinical Scientist-led clinics, including:
	  • aortopathy patients (e.g. Marfan syndrome and Ehlers-Danlos syndrome) and haemodynamically insignificant ventricular septal defects (VSDs) or patent arterial ducts
	  • abnormal valves with mild functional impairment (e.g. bicuspid aortic valve)
	• when patients being looked after in a Clinical Scientist-led clinic require referral back to physician care;
	• psychosocial issues associated with CHD and support services;
	• the increased morbidity and mortality associated with complex CHD patients with the increased longevity;
	• the specific arrhythmias that may be associated with particular lesions and surgeries;
	• the impact of acquired heart disease on pre-existing congenital heart lesions (e.g. coronary artery disease in a univentricular system);
	• the natural progression of acquired heart disease (e.g. coronary artery disease);
	• the need for care within a multidisciplinary centre for non-cardiac pathology that may need cardiology input;
	• the prevalence of the 'loss to follow-up' phenomenon and its importance to maintaining good health;
	• the importance of clinical audit in adult CHD patients and its impact on evolving healthcare provision;
	• the complex interdependent relationships that sometimes exist between patients and carers;
	• the findings of investigations carried out and the impact of the results.		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	Transition services:
	• the national and international guidelines for transition services and the requirements and quality management of transition services;
	• the need for liaison with members of the wider multidisciplinary team to discuss strategies for preparing patient for investigations, procedures etc.
	• needs of learning disabled young people during transition and transfer into adult services;
	• the range of services available to provide appropriate follow-up care, e.g. quaternary/tertiary centre or in a smaller centre with physicians with a specialist interest;
	• the current guidelines relating to lifestyle relevant to this adolescent population (e.g. exercise, tattoos, body piercing and contraceptive advice);
	• the implications of becoming 'lost to follow-up';
	• how to support patients with issues related to body perception and privacy in adolescent patients;
	• why more complex patients with multisystem involvement and/or neurocognitive impairment may require several appointments until all concerned are comfortable with the transition.
	Counselling for lifestyle:
	• the importance of a healthy lifestyle on adult CHD patients and encouraging, under advisement, activity and sport to maintain general cardiovascular health;
	• the importance of taking responsibility for their own health and the impact of becoming lost to follow-up;
	• the increased risk of endocarditis in adult patients with CHD and activities that may increase risk further, including:
	  • body piercing
	  • tattoos
	  • poor dental hygiene		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• current endocarditis treatment guidelines and the prophylactic use of antibiotics; • the potential psychological impact on adolescents/adults of lifestyle choices, e.g. further education, alcohol consumption, sexual activity; • the issues surrounding birth control (certain types of contraceptives are not advisable with certain cardiac lesions); • the implications of unexpected and unplanned pregnancies; • the potential impact on obtaining health/life insurance, mortgages and certain types of employment; • the co-existing cognitive and developmental delay that may impact on their lifestyle choices and available support services; • guidelines on assessment of endocarditis and when to further investigate with TOE imaging; • the limitations of echocardiography and the appropriate use/referral for assessment using other imaging modalities; • the relevance of exercise and cardiopulmonary exercise testing (CPET) in monitoring patients long term, especially for non-subjective symptom assessment and timings of interventions. **Imaging considerations for pre-, peri- and postoperative adult patients:** • invasive procedures required and the information needed prior to the procedure; • the role and limitations of TTE in preoperative assessment; • the role and limitations of TOE in preoperative assessment • the role and limitations of computed tomography and magnetic resonance imaging in assessment for surgery; • the need for interoperative imaging and suitable image acquisition; • imaging requirements in the postoperative period (e.g. assessment for pericardial effusion, patches and baffles, or dehiscence and prosthetic valves); • how to identify when the patient's clinical status may not fit your		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference

	observations/assessment ;
	• when and how to seek relevant advice or seek help appropriately.
	Pregnancy risks and considerations and the implications of inheritance:
	• the normal maternal changes to cardiac physiology associated with pregnancy abnormalities detected through echocardiography and ECG;
	• information and counselling for women of reproductive age with CHD, including maternal and fetal morbidity and mortality;
	• risk of inheritance of CHD in the offspring;
	• level of surveillance, treatment and anticipated hospitalisation required during pregnancy;
	• contraception;
	• the general risk factors for women with CHD during pregnancy, including:
	  • New York Heart Association classification >II *or* cyanosis before pregnancy
	  • impaired systemic ventricular function (ejection fraction < 40%)
	  • left heart obstruction (mitral valve area < 2 cm^2, aortic valve area < 1.5cm^2, left ventricular outflow tract peak gradient > 30 mm Hg before pregnancy
	  • preconception history of adverse cardiac events such as symptomatic arrhythmia, stroke, transient ischaemic attack and pulmonary oedema
	• the stratification of different lesions into low-, moderate- and high risk-groups;
	  • low risk: atrial septal defects, ventricular septal defects (haemodynamically insignificant), repaired coarctation and repaired tetralogy of Fallot
	  • moderate risk: mitral or aortic stenosis, systemic right ventricles (congenitally corrected transposition of the great arteries [ccTGA] and atrial switches for TGA), Fontan's patients, cyanotic patients without pulmonary hypertension
	  • high risk: Marfan syndrome with dilated aorta and patients with Eisenmenger's syndrome
	• medications commonly needed for heart disease patients are contraindicated in pregnancy:		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• angiotensin converting enzyme inhibitors, angiotensin-II receptor antagonists and the risk of neonatal renal failure and hypotension, renal tubular dysgenesis, intrauterine growth restriction, decreased skull ossification • warfarin and the risk of skeletal defects, abnormalities of the central nervous system, intracranial haemorrhage • amiodarone, which may be used in special circumstances, but with the risk of hypothyroidism and potential brain damage • phenytoin with the risk of heart defects, intrauterine growth restriction, orofacial abnormalities • spironolactone with the possible risk of anomalies of the external genitalia (animal studies only) • pregnancy physiology in relation to standard investigations, i.e. physiological response of pregnant woman lying flat on her back for an hour for an echocardiogram; • radiation risk (breast cancer and fetus) with respect to CT and angiography during pregnancy; • the potential complications following birth and the potential risks to maternal life (e.g. aortic dissection in high-risk Marfan's patients). **Implications of inheritance:** • the syndromes associated with CHD (including aortopathy-inducing diseases such as Marfan syndrome and Ehlers-Danlos syndrome); • the commonly occurring chromosomal abnormalities involved; • the associated non-cardiac abnormalities in some syndromes/chromosomal abnormalities; • the increased risk of CHD with first-degree relatives; • the importance of early antenatal screening in parents with CHD; • associated congenital lesions that are more likely to occur together; • the increase in need for specialised fetal screening through echocardiography with		

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	an increasing adult population; • the potential value of genetic counselling and refer, after discussion with relevant professionals, to specialist genetic teams; • the potential benefits to emotional and psychological counselling and seek referral where appropriate; • the importance of audit to the evaluation of inheritance risk and the further adequate provision of services for the future.		
Clinical skills	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect on their clinical practice. They will apply in practice a range of advanced clinical and communication skills to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals. They will be able to perform and master each technique, adapting their response to meet the varying and complex challenges that will arise reliably, and will be able to: • gain informed consent; • take a relevant history to inform further investigations (e.g. for endocarditis); • perform a TTE as part of the assessment of endocarditis and if appropriate refer for further investigation, which may include oesophageal echocardiography. **Transition services:** • provide a supportive and informative clinical atmosphere in which the young person can raise sensitive issues about their CHD and associated issues in their own right, in particular being aware of safeguarding issues in this group of adolescents; • discuss the process of transition and the importance of maintaining their own health and attending appointments with the patient, and if appropriate parents/carers, answering any concerns of the patient or referring to colleagues; • disseminate relevant information during the handover of patients from the paediatric to adult team and present it accurately and succinctly;		1.1.3 1.1.5 1.1.6 1.3.1 1.3.2 1.3.3 1.4.5 2.1.1 – 2.1.6 2.3.1-2.3.4 3.1.1 – 3.1.17 3.2.1-3.2.4 4.1.1 4.1.2

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	• produce an accurate handover report detailing the anatomy and physiology of the heart, highlighting any abnormalities that require further investigations. **Imaging considerations for pre-, peri- and postoperative adult patients:** • gain informed consent; • perform transthoracic and transoesophageal echocardiography; • adapt normal techniques to the logistics of theatre and intensive care environments; • make clinically relevant observations in a succinct manner to other healthcare professionals. **Pregnancy risks and considerations and the implications of inheritance:** • gain informed consent; • take a relevant history to inform further investigation or referral; • perform investigations to a high standard: echocardiography and rhythm assessment/management.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to critically evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attributes and insights required of a Clinical Scientist in HSST working within the limits of professional competence, referring as appropriate to senior staff, and will work collaboratively with cardiologists, cardiac surgeons, other medical staff, healthcare science practitioners, echocardiographers and nurses, and will: • recognise the young person's need for advice and information about their CHD, including advice on the genetic aspects of the condition; • recognise the difficulties young people face with engaging in healthcare at the time of transfer and seek to ensure seamless transfer of care; • recognise the young person's desire to be autonomous and to be involved in		1.1.1 1.1.2 1.1.4 1.1.7 1.1.8 1.1.9 1.1.10 1.1.11 1.2.1 1.2.5 1.3.1 5.1.2 5.1.3

Topic	Adult Congenital Heart Disease	Assessment methods	GSP reference
	decision making; • recognise the role of parents, family members, carers, partners and friends in supporting the young person at the time of transition and transfer; • recognise and value the information available from other agencies and services and respect young people's preferences in accessing information during transition; • recognise and value opportunities for peer support at transition through local networks and other agencies; • recognise the patient's need for confidentiality; • have a positive approach towards change to achieve continuous improvement of services, with particular reference to auditing practice, evidence-based practice, innovation and new and improved technologies; • appreciate the psychological complexity relating to the change from paediatric to adult services and respond to patients accordingly; • encourage the patients to take ownership and responsibility for their health while ensuring that the parents feel involved and informed; • appreciate the emotional difficulties encountered by patients with CHD with respect to passing on cardiac lesions to any children they may have, and respond accordingly; • appreciate the psychological impact of the potential inheritance of adult CHD on patients and their families; • support the decisions of the patients without bias with respect to child-bearing.		

STAGE 2 VERTICAL STRAND – Generic Healthcare Science

(i) Innovation in Healthcare Science

Topic	Innovation in Healthcare Science	Assessment methods	GSP reference
Learning objectives	Innovation is defined as an idea, product, or service new to the NHS or applied in a novel way that has the potential to significantly improve the quality of health and care wherever it is applied (Innovation Health and Wealth: Accelerating Adoption and Diffusion in the NHS, 2011). By the end of this module the Clinical Scientist in HSST will be able to analyse and synthesise their understanding of service development and improvement and the role of innovation as creative and enterprising researchers, entrepreneurs and problem solvers. They will apply their expert scientific knowledge to improve or develop new clinical services, identifying opportunities to innovate and creating a culture where innovation flourishes. They will work with colleagues and patients as they plan, evaluate and deliver new services or diagnostic approaches. The Clinical Scientist in HSST will be expected to disseminate their innovative work, evaluating the impact on patients and health services as applicable. In some healthcare science specialisms, the Clinical Scientist in HSST will be expected to develop a plan to market successful, regulatory-compliant devices and diagnostics products or service innovation. The Clinical Scientist in HSST will also be expected to be able to keep up to date and analyse and synthesise their understanding of key and emerging technologies that underlie recent innovations in healthcare science. The Clinical Scientist in HSST will be expected to demonstrate the ability to critically reflect on their performance and evaluate their own response to both normal and complex situations. They will consistently demonstrate the professional attitudes and behaviours expected of a Consultant Clinical Scientist and place the patient and their safety at the centre of care.		
Knowledge	By the end of the training period the Clinical Scientist in HSST will be able to analyse, synthesise and critically apply their expert scientific knowledge with respect to the contribution of innovation in improving and developing healthcare and the steps required to identify innovative solutions and methods within their specialism, and will: • identify recent successful innovation projects that have been implemented within the specialism that have improved patient outcomes, and critically evaluate the		4.1.1 4.1.2 4.1.3

Topic	Innovation in Healthcare Science	Assessment methods	GSP reference

	enablers and barriers to successful innovation in healthcare;
	• evaluate how technology and innovation are managed within the NHS, comparing and contrasting this with the private sector;
	• discuss the legal principles governing law and intellectual property, patents and trademarks, and evaluate the options that are available to protect new ideas, concepts, written material, images, or designs in the context of health and healthcare science;
	• assess market opportunities, including specifying the unmet need, describing the market space, competitors, etc., funding sources for new technology and the regulatory framework within which new technologies must be developed;
	• critically evaluate proposals that consider each of the key aspects of introducing a new technology to the NHS or an alternative organisation, including dealing with issues around intellectual property rights, patenting, professional codes of practice and the establishment of appropriate economic, legal and social frameworks;
	• describe and evaluate a range of methods/tools and frameworks that underpin:
	  • the identification of ideas for service development and innovation
	  • the exploration of ideas and solutions
	  • the promotion of individual and group creativity
	  • the evaluation of ideas to transform an idea into something useful
	  • the development of a structured approach to problem solving and delivering solutions
	  • the development of a business case for the provision of a new service, including a cost-benefit analysis
	  • the promotion of effective collaboration while working with colleagues, patients and other people and organisations, and the value of the contribution from all partners
	  • the communication and discussion of information in a timely and effective manner
	  • effective communication with a variety of audiences, including lay and non-science		

Topic	Innovation in Healthcare Science	Assessment methods	GSP reference
	• strategies to secure success attracting support • leadership in innovation • the implementation of a new technology/enterprise • evaluating innovation • dissemination of innovative solutions to promote the uptake of new methods of service delivery, new technology, etc., across healthcare.		

Practical skills	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect and apply in practice a range of skills to identify potential ideas for service development and innovation, exploring ideas and solutions at all stages of an innovation pathway (i.e. create, refine, evaluate, appraise, use) to secure success and will:
	• identify potential ideas for service development and innovation, exploring ideas and solutions;
	• use a range of tools to promote creativity to:
	  • promote individual creativity
	  • promote group creativity
	  • evaluate ideas
	  • transform an idea into something useful
	• solve problems using a structured approach to problem solving by:
	  • defining problems
	  • managing problems
	  • framing problems
	  • delivering solutions
	• write a plan to introduce a new technology to the NHS or an alternative organisation spanning the key aspects that must be considered, including intellectual property rights, patenting, professional codes of practice and the establishment of appropriate economic, legal and social frameworks;
	• develop a business case for the provision of the new service, including a cost-benefits analysis;
			4.1.1
			4.1.2
			4.4.1
			4.1.4
			4.1.5
			4.1.6
			4.1.7
			4.1.8
			4.1.9

Topic	Innovation in Healthcare Science	Assessment methods	GSP reference

	• work with colleagues, patients and other people and organisations:
	  • valuing others
	  • collaborating effectively
	  • keeping up to date
	  • communicating in a timely and effective manner
	• utilise a range of strategies to secure success, including:
	  • taking the initiative
	  • testing the water
	  • attracting support
	  • leading a new enterprise
	• communicate effectively with a variety of audiences, including lay and non-science.		

Behaviours and attitudes	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and in the context of research and innovation will: • promote a sustainable, engrained culture of innovation in an individual, department and organisation; • solve problems; • take the initiative and provide leadership for the promotion and implementation of innovation; • keep up to date with developments in healthcare and healthcare science; • approach unfamiliar tasks and problems with an open and creative outlook; • use effective questioning techniques; • develop professional networks; • make and maintain connections; • explore opportunities and solutions to problems; • be resilient and resourceful.		4.1.2 4.1.10 5.1.1 5.1.2 5.1.3 5.1.4 5.1.6 5.1.7 5.1.8 5.1.9 5.1.11 5.1.12

(i) Clinical Bioinformatics, Genomics and Precision/Personalised Medicine

Topic	Clinical Bioinformatics, Genomics and Personalised Medicine	Assessment methods	GSP reference
Learning objective	Diseases and disease processes are complex and involve many interactions within the genome, across metabolic pathways and between the individual and the environment. Such considerations are important if the consequences of variations observed within an individual's genome are to be effectively assessed. Rapid advancements in areas such as functional genomics and systems biology are now providing new insights into such processes. This module builds and extends the knowledge of the Clinical Scientist in HSST with respect to the epidemiology and genetic basis of disease while introducing and developing areas such as clinical bioinformatics, precision/personalised medicine, e-health, health informatics and genomics applied within a healthcare science specialism. By the end of this module the Clinical Scientist in HSST will be able to analyse and synthesise their understanding of clinical bioinformatics, genomics and precision/personalised medicine, and apply their knowledge to the practice of their HSST specialism. They will be able to identify opportunities to apply their learning to develop and improve services and the information provided to patients, and critically evaluate their own response to both normal and complex situations using the professional attributes and insights required of a Consultant Clinical Scientist.		
Knowledge	By the end of the training period the Clinical Scientist in HSST will be able to analyse, synthesise and critically apply their expert knowledge with respect to genomics and precision/personalised medicine and health informatics applied to their specialism, including: • governance and ethical frameworks in place within the NHS and how they apply to bioinformatics; • fundamental bioinformatic principles, including the scope and aims of bioinformatics and its development; • how bioinformatic tools and resources and genetic information can be integrated into the interpretation and reporting of test results from patients; • the use of precision/personalised medicine in health and delivery of medical care and rehabilitation services;		1.1.4 1.1.5 2.1.6 2.2.5 3.1.5 4.1.5 4.1.6

Topic	Clinical Bioinformatics, Genomics and Personalised Medicine	Assessment methods	GSP reference
	• functional genomics and systems biology strategies and the ways in which they can be applied in their HSST specialism for improved patient care; • e-health developments in healthcare science and the wider healthcare setting; • supporting computer principles, e.g. hardware and software requirements for large datasets, cloud computing, network management, etc.		
Technical and clinical skills and procedures	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect and apply in practice a range of clinical and communication skills with respect to genomics in order to advise and communicate effectively with patients, relevant clinicians, patients and the public, and other healthcare professionals, and will utilise and apply, as appropriate, knowledge of genomics and clinical bioinformatics within clinical practice keeping abreast of development that apply to their area of specialist practice as a Consultant Clinical Scientist.		1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 1.1.8 1.2.4 1.2.5 1.3.1 1.3.2 1.4.1 1.4.6 2.1.1 2.1.2 2.1.3 2.1.4 2.1.5 2.1.6 2.2.1 2.2.6 2.2.9 2.3.1 5.1.1

Topic	Clinical Bioinformatics, Genomics and Personalised Medicine	Assessment methods	GSP reference
			5.1.7 5.1.12
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and will: • work within data governance regulations; • support colleagues to promote the understanding of data governance regulations; • work within a multidisciplinary setting, transferring data appropriately; • keep up to date with advances in genomics, clinical bioinformatic and precision/personalised medicine and other emerging technologies.		1.1.1 1.1.2 1.1.9 1.1.10 1.1.11 1.3.3 1.3.4

(iii) Doctoral-level Research

Topic	Doctoral-level Research	Assessment methods	GSP reference
Learning objective	The Clinical Scientist in HSST will be expected to undertake doctoral-level research that either (i) meets the research requirements of the doctoral-level training programme or (ii) results in a coherent body of papers that reaches the standard suitable for publication in peer-reviewed journals, undertaken during the HSST programme. They will also be expected to contribute to the preparation and submission of a grant proposal and present and defend their research at national/international scientific conferences. All research undertaken must comply with current ethical and governance requirements.		
Knowledge	By the end of this module the Clinical Scientist in HSST will be able to create and interpret new knowledge through original research and will systematically acquire and understand a substantial body of knowledge that is at the forefront of scientific, clinical, or professional practice, together with a detailed understanding of applicable techniques for research.		1.1.4 3.1.5 4.1.1 4.1.6 4.1.7
Technical and clinical skills and procedures	By the end of this module the Clinical Scientist in HSST will be expected to conceptualise, design and implement a research project(s) that leads to the generation of significant new knowledge in areas such as the development of new techniques, new approaches to service delivery and organisation, or the generation of ideas or approaches and/or understanding within the appropriate healthcare science HSST specialism, adjusting the project design in the light of unforeseen problems. The Clinical Scientist in HSST will be expected to demonstrate the ability to contribute to the writing and submission of grant applications, lead research and to present and disseminate their research orally and in writing appropriate to both specialist and non-specialist audiences, including patients and the public.		1.1.1 1.1.2 1.1.3 1.1.5 1.1.6 1.1.7 1.2.3 1.2.4 1.3.1 2.3.1 4.1.2 4.1.3

Topic	Doctoral-level Research	Assessment methods	GSP reference
			4.1.4 4.1.5 4.1.8 4.1.9
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations with respect to research, from inception to dissemination, demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and will: • exercise personal responsibility and largely autonomous initiative in complex and unpredictable situations, in professional or equivalent environments; • work within a multiprofessional research setting, optimising input and contributions from the whole of the research team; • make informed judgements on complex issues in specialist fields; • be innovative and resilient in their approach to tackling and solving problems; • communicate ideas and conclusions clearly and effectively to specialist and non-specialist audiences.		1.1.1 4.1.10 5.1.2 5.1.3 5.1.7

(M) Teaching, Learning and Assessment

Topic	Teaching, Learning and Assessment	Assessment methods	GSP reference
Learning objective	This module introduces key theories of teaching, learning and assessment to underpin the role of the Consultant Clinical Scientist as a teacher/trainer/leader, according to the best contemporary clinical and educational standards. The Clinical Scientist in HSST will acquire an understanding of the theoretical basis of teaching, learning and assessment, and will be expected to demonstrate the practical application of these skills in the work base. The Clinical Scientist in HSST will be expected to apply their knowledge, skills and experience of teaching, learning and assessment in their specialist area and the wider healthcare setting.		
Knowledge	By the end of this module the Clinical Scientist in HSST will be able to critically evaluate, analyse and synthesise their understanding of teaching, learning and assessment, and will be expected to apply their knowledge to plan, deliver and evaluate a range of teaching, learning and student support processes, including: • contemporary theories and the evidence base underpinning student-centred adult learning; • teaching, learning and assessment within the clinical and scientific work base to design, deliver and evaluate education and training programmes that meet the best clinical and educational standards; • models of supervision, mentoring and coaching; • the importance of feedback and methods of student-centred feedback.		1.4.1 1.4.2 1.4.3 1.4.4 1.4.5 1.4.6 2.3.1 2.3.2 3.1.1
Technical skills and procedures	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect and apply in practice a range of teaching, learning and assessment skills. They will also be expected to supervise, mentor and coach colleagues using advanced communication skills and will: • critically evaluate information to enable the provision of evidence-based teaching, learning and assessment in a healthcare setting; • plan, deliver and evaluate teaching (individual sessions and/or a		1.1.1 1.1.2 1.1.3 1.1.10 1.1.11 2.3.1 2.3.2 3.1.3

Topic	Teaching, Learning and Assessment	Assessment methods	GSP reference
	programme/module) using a range of teaching methods (including, where applicable, bedside teaching) and incorporating the principles of active learning, including lecture-based, small group teaching, practical skills teaching, problem-based learning, simulation, e-learning; • develop and extend generic capabilities, including communication skills, giving and receiving feedback, questioning techniques and peer, student and personal review of teaching; • critique a range of assessment methods; • plan, deliver and evaluate a range of assessments appropriate to the learning outcomes in each of the domains of knowledge, skills and attitudes/behaviour; • maintain a professional development portfolio to underpin individual personal development and life-long learning; • provide mentorship to healthcare scientists earlier in their career; • critically reflect and evaluate personal performance as part of a continuing professional development plan.		4.1.6
Clinical skills	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect and apply in practice a range of clinical and communication skills with respect to teaching, learning and assessment, and support colleagues and students in supervision, mentoring and coaching situations: • plan, deliver and evaluate communication skills teaching; • evaluate the use of portfolios in clinical education and methods of assessing portfolios; • evaluate a range of methods for teaching and assessing critical reflection; • master a range of techniques for giving and receiving meaningful feedback; • master a range of communication skills, including listening, observing,		1.1.1 1.1.2 1.1.3 1.1.10 1.1.11 2.3.1 2.3.2 2.3.3 2.3.4 3.11 3.1.3

Topic	Teaching, Learning and Assessment	Assessment methods	GSP reference
	motivating; • identify personal conflict style and use that information to develop and demonstrate skills in negotiating and mediating in conflict situations; • support team members using a range of tools, including coaching, mentoring and supervision; • prioritise the safety of patients during clinical teaching.		3.1.5 4.1.6
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations that arise during teaching, learning and assessment situations, demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and will: • prioritise the safety of the patient and learner in teaching, learning and assessment situations; • recognise different types of learner and acknowledge that not all learners are made equal; • recognise and reflect on the learning needs of a range of healthcare professionals; • critically reflect on strategies to promote teaching, learning and assessment; • critically reflect on personal progress and assess personal learning needs with support from a personal or work-based mentor; • communicate effectively in writing and orally, listening actively and using appropriate questioning techniques; • support colleagues, students and trainees, etc., as required; • maintain confidentiality appropriate to the range of teaching, learning and assessment situations encountered.		1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6 1.1.7 1.1.8 1.1.9 1.1.11 2.2.9 2.3.1 2.3.2 5.1.3

(v) Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science

Topic	Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science	Assessment method	GSP reference
Learning objective	Involving patients, service users, carers and the public across the NHS and social care in healthcare and healthcare science is essential. Patients and the public should be involved in developing guidance, advice and quality standards, and supporting their implementation. A number of initiatives to support this aim, including: • Health and Social Care Act (DH, 2012) • NHS Constitution (DH, 2012) • 'Putting People at the Heart of Care' (DH, 2009) • 'Essential Standards of Quality and Safety' (CQC, 2010) The aim of this HSST module is therefore to ensure that the Clinical Scientist in HSST understands the importance and relevance of involving patients and the public, and organisations representing their interests in health and healthcare science. Patient and public involvement also includes providing opportunities for patients and the public to contribute to the development, accreditation, implementation and monitoring of education and training programmes for healthcare science and the wider healthcare community, e.g. by contributing to: curriculum development, teaching, learning and assessment activities, the accreditation of education and training programmes, recruitment to programmes and posts, developing guidance, advice and quality standards, and supporting their implementation. The Clinical Scientist in HSST will be expected to critically appraise the underpinning academic evidence base and gain experience of working with patients and the public and evaluating the impact on service delivery, education, research and innovation.		
Knowledge	By the end of this module the Clinical Scientist in HSST will comprehend, apply, analyse, synthesise and evaluate the evidence base underpinning the involvement of patients and members of the public across a range of areas and activities within healthcare and healthcare science. They will also be expected to be aware of the key areas where changes in healthcare will provide patients/carers and the public with access to their data, including medical records and test results, and how healthcare science services can		

Topic	Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science	Assessment method	GSP reference

	optimise the positive impact of involving patients/carers and the public.
	Patient and public involvement in health and healthcare:
	• patient involvement and engagement in terms of individuals as patients, citizens and tax payers;
	• current NHS strategies and policies to promote patient and public involvement in healthcare and the development of public policies;
	• different perspectives of engagement and involvement in health and healthcare;
	• incorporation of the patient and public interest to ensure that matters affecting patient safety are not overlooked;
	• patient involvement in commissioning services;
	• evidence base underpinning the involvement of patients and the public in health and healthcare;
	• barriers to effective patient involvement and potential solutions;
	• design, implementation and evaluation of patient pathways and services;
	• role and impact of patients and the public in NHS governance structures;
	• the importance of agreeing principles around the roles and responsibilities of patients who are involved in these areas;
	• how patients use information resources of varying backgrounds, e.g. those developed by the NHS and healthcare professionals; those developed by charities and advocacy groups; peer support and social networks; commercial sites; and wikis (notably Wikipedia*)*;
	• online health-related resources supporting:
	  • provision of information on healthcare interventions (treatments, operations and procedures)
	  • public health and patient advisory/support resources
	  • patient engagement and involvement solutions (such as Patient Opinion, Patients		

Topic	Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science	Assessment method	GSP reference
	Like Me, etc.) • impact of new technology that enables patient/public involvement in their own health; • issues and standards relating to the design and implementation of technology solutions to be used by members of the public; • implications of patient access to records and clinical information for interprofessional practice and multidisciplinary care; • access to medical records and test results online, and the benefits and challenges; • governance implications for individuals and organisations of information sharing and communication between professionals and patients. **Patient and public involvement (PPI) in research** Involving patients and members of the public in research can lead to better research, clearer outcomes and faster uptake of new evidence. The Clinical Scientist in HSST will therefore be expected to discuss and evaluate PPI in: • the role of the Collaborations for Leadership in Applied Health Research and Care (CLARCHs), Academic Health Science Networks (AHSNs) and other relevant organisations and their approach to PPI; • commissioning and reviewing of research proposals; • identifying the important questions that health and social care research needs to answer as part of setting research priorities; • giving their views on research proposals alongside clinical scientists, clinicians, methodologists, scientists, and public health and other professionals; • helping assess proposals for funding; • taking part in clinical trials and other health and social care research studies, not just as subjects but as active partners in the research process; • publicising and contextualising the results.		

Topic	Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science	Assessment method	GSP reference

	Patient and public involvement in education and training
	
	Recent years have seen a shift in expectations of the public in the delivery of healthcare, perhaps best captured by the NHS's *No Decision About Me Without Me* maxim, along with the introduction of the Choice agenda. Involving patients and the public in the education and training of the current and future workforce is important to ensure that there is a shared understanding of the expectations of the patients and public and the roles and responsibilities of healthcare science and healthcare staff. The Clinical Scientist in HSST will be expected to critically evaluate the impact of PPI across a range of teaching and learning activities, including:
	
	• role of patients and the public with respect to:
	  • programme design and curriculum development
	  • course management and quality assurance
	  • recruitment, training and support of patients and the public
	  • recruitment and selection of students/trainees
	  • teaching
	  • student/trainee feedback
	  • assessment
	  • patient feedback as part of staff appraisal
	• influencing resourcing to support teaching, learning and assessment;
	• evidence base underpinning the involvement of patients and the public in education and training.		

Technical and clinical skills and procedures	By the end of this module the Clinical Scientist in HSST will be expected to critically reflect on the current level of patient and public engagement and involvement in their own practice and the services they lead. They will be expected to apply in practice a range of skills to work in partnership with patients and will: • review current national and local strategies, including that of the local employer, with		

Topic	Patient and Public Involvement, Engagement and Partnership in Healthcare and Healthcare Science	Assessment method	GSP reference
	respect to patient engagement and partnership and identify where this can be strengthened; • in partnership with patients, use the outcome of the review to develop, implement and evaluate a new initiative to strengthen patient involvement in your area of work and disseminate the findings. The Clinical Scientist in HSST will be expected to reflect on the challenges of involving patients and the public in healthcare and healthcare science and applying research to practice, building on a critique of available evidence.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to consistently demonstrate the values and behaviours required of a Consultant Clinical Scientist working in partnership with patients and the public to ensure staff and services meet the needs of patients, and will: • respect the contribution the patient and public to healthcare and put the quality of the patient experience at the centre of personal practice and service design and delivery; • engage and work in partnership with individuals who are or who have been patients/carers, not always actively seeking the view of the 'well public'; • be creative in the approaches to engaging the population, particularly those groups whose voices are not always heard; • lead services with a culture that seeks and values the views of patients and the public and enables patients and the public to influence decisions in an open, transparent and evidence-based way.		

(vi) Science Communication

Topic	Science Communication	Assessment methods	GSP reference
Learning objective	By the end of this module the Clinical Scientist in HSST will be able to analyse and synthesise their understanding of how scientific and technical information and advice is best communicated within the healthcare organisation and more widely for the benefit of patients and the public. They will be expected to apply their knowledge to influence the direction of policy, standards and guidance, and to provide effective, concise and appropriate advice on scientific and technical issues to management, clinical staff, patients and other stakeholders. Additionally the Clinical Scientist in HSST will be expected to identify effective channels of communication and develop networks of contacts to keep abreast of trends in policy, standards and guidance, and to communicate effectively with the aim of influencing the development of these.		
Knowledge	By the end of this module the Clinical Scientist in HSST will be able to analyse, synthesise and critically apply their expert knowledge with respect to scientific and technical communication, including: • the role of effective communication in influencing policy direction in relation to scientific and technical issues within and outside a healthcare organisation; • the wide range of stakeholders involved in influencing policy direction, standards and guidance development; • the range of channels of communication available and the appropriate format of communication; • how to engage with the media and the wider public to provide effective communication of scientific and technical issues affecting health services.		
Technical and clinical skills and procedures	By the end of this module the Clinical Scientist in HSST will be able to demonstrate a critical understanding of the skills of effective science communication and will: • summarise complex information at an appropriate technical level for the intended audience;		

Topic	Science Communication	Assessment methods	GSP reference
	• write effective position papers, business cases, technical and scientific notes, papers and grant applications; • influence opinion formers.		
Attitudes and behaviours	By the end of this module the Clinical Scientist in HSST will be expected to evaluate their own response to both normal and complex situations, demonstrating the professional attributes and insights required of a Consultant Clinical Scientist working within the limits of professional competence, referring as appropriate to senior staff, and will: • lead and champion innovative proposals for policy, regulation, standards and guidance; • proactively engage with the wider scientific and technical community in an area of activity.		1.1.1 1.1.2 1.1.3 1.2.1 1.2.3 1.2.4 1.3.1 1.3.2 1.3.4 1.3.6

APPENDICES

Appendix 1: Abbreviations

AHCS	Academy for Healthcare Science
AHSN	Academic Health Science Network
AoMRC	Academy of Medical Royal Colleges
CBD	case-based discussion
CCHST	Certificate of Completion of Higher Scientist Training
CLARCHs	Collaborations for Leadership in Applied Health Research and Care
COSHH	Control of Substances Hazardous to Health
CPPD	continuing personal and professional development
CQC	Care Quality Commission
CSO	Chief Scientific Officer
DH	Department of Health
DOPS	directly observed practical skills
FRB	Final Review Board
FRCPath	Fellow of the Royal College of Pathologists
GCP	Good Clinical Practice
GMC	General Medical Council
GSP	Good Scientific Practice
HEE	Health Education England
HEI	higher education institution
HCPC	Health Care Professions Council
HCS	healthcare science
HSS	Higher Specialist Scientist
HSST	Higher Specialist Scientist Training
ICS	Innovation in Clinical Sciences
LETBs	Local Education and Training Boards
MAHSE	Manchester Academy for Healthcare Science Education
MDT	Multi-Disciplinary Team
MHRA	Medicines and Healthcare products Regulatory Agency
MSC	Modernising Scientific Careers
MSF	multisource feedback
NAI	non-accidental injury
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NSHCS	National School of Healthcare Science
OCE	observed clinical event
OLAT	online learning and assessment tool
OSCSA	Objective Structured Clinical Skills Assessment
OSFA	Objective Structured Final Assessment
PD	Professional Doctorate
PSA	Professional Standards Authority
RCP	Royal College of Physicians
RCPCH	Royal College of Paediatrics and Child Health
RCOphth	Royal College of Ophthalmologists
SAC	Specialist Advisory Committee

STARD	Standards for Reporting of Diagnostic Accuracy STP Scientist Training Programme
WBA	work-based assessment
WPBA	work-placed based assessment

Appendix 2: Organisations and their Functions in Relation to HSST

Health Education England (HEE) was fully established as a Special Health Authority in April 2013. It is responsible for providing national leadership and oversight on strategic planning and development of the health and public health workforce, and allocates education and training resources for local investment to its **Local Education and Training Boards (LETBs)**. HEE promotes high-quality education and training that is responsive to the changing needs of patients and local communities. Through HEE, health and public health providers have a strong input into national strategies and priorities so education and training can quickly adapt to new ways of working and new models of care.

Local Education and Training Boards (LETBs) have been authorised by HEE (13 in total) to plan and commission high-quality education and training that is responsive to the changing needs of patients and local communities. Through the LETBs, health and public health providers have a strong input into national strategies and priorities so education and training can quickly adapt to new ways of working and new models of care. The West Midlands LETB – Health Education West Midlands (HEWM) – is the Lead LETB for healthcare science (HCS) and hosts the National School for HCS (NSHCS). It is responsible for commissioning the underpinning doctoral programme for HSST and works in partnership with the academic providers of the programme to ensure that academic outcomes are fit for purpose.

Healthcare Science Implementation Network Group (HCS ING) shapes strategic developments, reviews projects and risks, and provides oversight of all aspects of implementation. All LETBs are represented alongside the National School of HCS (NSHCS), Modernising Scientific Careers (MSC) central programme project leads and partners on this group. Through this group it has been recommended and subsequently agreed that a training allowance is made available to all provider units with both in-service and direct entry Clinical Scientists in HSST.

HCS Health Education England Advisory Group (HCS HEEAG) is the main HCS professional advisory group to HEE on HCS training and education issues.

National School of Healthcare Science (NSHCS) is responsible for oversight, coordination and implementation of MSC training programmes on behalf of HEE. The School manages national appointments for HSST. In partnership with the LETBs and professional bodies, it implements and maintains a quality assurance process for training programmes; it also develops training capacity and delivers train the trainer programmes. The NSHCS monitors the progress of Clinical Scientists in HSST through its workplace based assessment and competence review programme that is stored and managed on its online learning and assessment tool (OLAT).

Academy for Healthcare Science (AHCS) has a UK-wide remit drawing together the HCS workforce. It was established as a joint initiative between

the UK Health Departments and the HCS professional bodies in order to give a unified coherent voice to the profession, and to support the broader HCS agenda. It has been commissioned to undertake the following functions:

- developing consistent regulation for the HCS workforce, e.g. by establishing HCS voluntary registers (VRs) that meet the Professional Standards Authority for Health and Social Care (PSA) standards;
- implementing a system to assess and confer ‘equivalence’ of the existing qualifications and experience individuals mapped to the outcomes of formalised quality assured training curricula and programmes;
- quality assuring education and training in partnership with other stakeholders;.
- developing common standards for HCS practice.

All of these organisations have input from patients and the public into their arrangements.

Appendix 3: Curriculum Development

Development of the HSST curriculum for Cardiac Science has been coordinated by the Royal College of Physicians Specialty Advisory Committee (SAC), including in partnership with the Society for Cardiological Science & Technology, the Society of Echocardiography, the British Cardiovascular Society and the Modernising Scientific Careers team, working in conjunction with NHS colleagues. The professionals who have contributed to the writing of this curriculum include:

Dr Chris Eggett (Lead Editor)	Senior Lecturer Clinical Physiology, Newcastle University

Adult Cardiac Science Syllabus

Dr Brian Campbell	Society for Cardiological Science & Technology
Dr Alison Calver	British Cardiovascular Society representative / Medical advisor
Prof Mark Monaghan	Clinical Scientist advisor
Mrs Andrea Penter	Cardiac Physiologist
Dr Helen Rimington	British Society of Echocardiography / Echocardiography advisor
Mrs Gill Wharton	Adult Congenital Heart Disease advisor
Mr Ian Wright	Cardiac Rhythm Management advisor

Congenital Heart Disease (CHD) and Paediatric Syllabus

Karolina Bilska,	CHD Theme lead; Transoesophageal Echocardiography; Fetal Echocardiography
Debbie Dashwood	Advanced Transthoracic Echocardiography
Dr Dominic Hares	Electrophysiology and Adult Congenital Heart Disease
Saleha Kabir	Adult Congenital Heart Disease
Dr Gareth Morgan	Adult Congenital Heart Disease
Dr Kuberan Pushparajah	CHD Theme lead and Transoesophageal Echocardiography
Dr Kevin Roman	Advanced Transthoracic Echocardiography
Prof John Simpson	Transoesophageal Echocardiography
Prof John Simpson	Fetal Echocardiography

Other contributors: Gillian Riley, Kelly Peacock, Cardiac Physiologists

Professional bodies and specialist societies, other medical royal colleges and patient groups were invited to review this HSST curriculum and their feedback has significantly shaped this document.

British Society of Echocardiography
Heart Rhythm UK
British Cardiovascular Society
Royal College of Physicians Specialist Advisory Group including patient representation
Society for Cardiological Science and Technology

Appendix 4: Post Publication Curriculum Amendments

This section lists the curriculum amendments following first publication.

March 2015

The syllabus for Congenital Heart Disease and Paediatric Practice has been added.

June 2015

Section 1: Introduction to the programme: This section has been updated to provide further clarify including completion of training; the role of the Academy for Healthcare Science and further detail of the assessment programme.

These amendments apply to all Clinical Scientists in HSST commencing training from September 2015.