



ourNHS
our future

Our NHS, Our Future:

the contribution of Healthcare Scientists

January 2008
Department of Health
(Draft - Work in Progress)

Overview

1. Healthcare scientists (HCS) number approx 50,000 in England inclusive of those in highly specialist unique scientific roles and with recognised medical consultant equivalence (some openly competing with medical staff), as well as those in technical/support roles. They make up, for example, nearly 25% of the membership of the Royal College of Pathologists.
2. They are employed in 51 disciplines/professions grouped into Life Sciences (e.g. pathology, genetics), Physiological Sciences (e.g. audiology, cardiac physiology) and Physical Sciences and Clinical Engineering (e.g. Medical Physics, Renal Technology). They are critical to all clinical groupings and national priorities and inform more than 80% of all clinical decisions. They work in acute, secondary, tertiary and increasingly in primary care. It is important to note however, that there currently is and will be further opportunities for cross disciplinary work, with opportunities for scientists from within one Division to undertake diagnostic activities traditionally undertaken in another. This is some of the important new thinking which the local review of **Our NHS, Our Future** should engender.
3. HCS provide cross cutting roles across the care pathways with high clinical risk including:
 - **diagnostics (and some therapeutic)**
 - **health protection, e.g. through the work of the Health Protection Agency, the work of which has a major contribution from healthcare scientists**
 - **safety and quality. This is particularly important with reference to quality assurance of diagnostics, maintenance of equipment in both secondary and perhaps now more challenging, primary care and the delivery of point of care testing nearer the patient**
 - **innovation and the introduction of new technologies. The work of HCS in contributing to new ways of delivering diagnostics through new technological developments which are then translated into patient services is an example of this.**
 - **translational research**
4. Healthcare Scientists contribute to all elements of healthcare in a variety of ways and provide different levels of expertise. Given that many of the Healthcare Science disciplines are small but vital it is important that any changes in care pathways or service targets are appropriately modelled for their potential impact. Furthermore since workforce planning and subsequent training arrangements for many of these disciplines is generally on an identified 'need basis' (some at Trust level only) it is essential that mechanisms are put into place early to prevent shortfalls in the number of competent practitioners available.
5. This document, developed by senior healthcare scientists, outlines the potential role that staff in these disciplines may play in the delivery of the 8 care pathways set out in **Our NHS, Our Future**. It will help the local review process consider for example, the scope for moving more diagnostics into community settings and for deploying the healthcare scientist workforce in a more effective and flexible way.

6. The document gives some illustrative examples from each of the 3 HCS Divisions of the potential contribution that scientists can make to the local review process, to developing and setting up services within the primary care setting and to ensuring that the quality, service and safety of services are maintained. It is not comprehensive and should be considered as a living document which is “work in progress” since HCS professionals and the local review process will continue to add to its further development.
7. For comments or queries please contact Professor Sue Hill or Professor Shelley Heard at msc.info@dh.gsi.gov.uk

Professor Sue Hill
Chief Scientific Officer
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Healthcare Science disciplines

Life Sciences and Genetics	Physiological Sciences	Clinical Engineering and Physical Sciences
Anatomical pathology	Audiology	Biomechanical engineering
Blood transfusion	Autonomic neurovascular function	Clinical measurement
Clinical biochemistry including Paediatric metabolic biochemistry	Cardiology	Equipment management
Clinical cytogenetics	Clinical perfusion	Information technology and management
Clinical embryology	Critical Care Technology	Medical electronics and instrumentation
Clinical immunology	Gastrointestinal physiology	Medical engineering design
Cytopathology including cervical cytology	Hearing therapy	Rehabilitation engineering
Electron microscopy	Neurophysiology	Diagnostic radiology (including MRI)
External Quality Assurance	Ophthalmic science	Nuclear medicine
Haematology	Respiratory physiology	Radiation protection and monitoring
Haemostasis & thrombosis	Sleep Physiology	Radiotherapy physics
Histocompatibility and immunogenetics	Urodynamics	Ultrasound and non-ionising radiation
Histopathology	Vascular technology	Medical illustration
Molecular genetics	Vision science	Maxillofacial prosthetics and reconstruction
		Renal dialysis technology

Microbiology Phlebotomy Tissue Banking Toxicology Transfusion and transplantation science		
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Our NHS, Our Future: the contribution of Healthcare Scientists

Pathology and Laboratory Medicine (Life Sciences)

Introduction

1. The Department of Health recognizes that 70-80% of all clinical decisions are informed by pathology and laboratory medicine data.
2. The Carter review has estimated that in England the total cost of pathology and laboratory medicine services is ~£2.5Bpa and that the annual workload approximates to:
 - >500 million clinical biochemistry tests
 - ~130 million haematology tests
 - >50 million microbiology requests
 - 13 million histopathology slides
 - 4 million cytopathology slidesThese data do not include the workload from the many other disciplines and sub-specialties of pathology and laboratory medicine including:
 - Blood transfusion
 - Immunology
 - Genetics
 - Histocompatibility and immunogenetics
 - Clinical embryology
 - Toxicology
 - Forensic Pathology
3. It follows from the above that literally thousands of clinical situations exist where pathology and laboratory medicine is applied to inform clinical decision making. Laboratory data is used in all of the following applications;
 - Screening
 - Diagnosis
 - Prognosis
 - Selecting therapy
 - Monitoring the response to therapy
 - Predicting relapse and the need for more / altered therapy
4. More than 90% of the staff working in pathology and laboratory medicine are healthcare scientists (HCS). They include clinical scientists, biomedical scientists, cytoscreeners, medical laboratory assistants, phlebotomists, anatomical pathology technologists. They work as a team and in the examples that follow it is taken as read that the correct specimens have been collected and processed by the HCS who operate in career stages 1-4. Currently two groups of HCS are registered with the Health Professions Council:
 - Clinical scientists (HCS career stages 6-9). Many obtain MRCPPath and are medical consultant equivalents
 - Biomedical scientists (HCS career stages 5-8). Many obtain Masters degrees and higher specialist postgraduate qualifications

5. HCS contribute to three distinct but inter-related phases of pathology and laboratory medicine:
 - Pre-analytical: Advice on which test to request and how to take specimens
 - Analytical: Conduct of the test or examination leading to a result
 - Post-analytical: Interpretation of the result coupled with reporting, clinical liaison and clinical advice on how to further manage the patient.
6. In addition to the roles outlined in paragraph 5 HCS are actively involved in the following laboratory and extra-laboratory roles:
 - Quality assurance
 - Laboratory accreditation and clinical governance
 - Clinical audit
 - Maintaining point of care testing devices in many extra-laboratory clinical settings
 - Attending clinics, wards, theatres etc to support doctors and other healthcare professionals in patient investigation
 - Method development
 - Research
 - Acting as a scientific resource for the host organization
 - Managing all levels of the pathology and laboratory medicine service
7. The remaining pages of this report serve to give just a few illustrations of the contribution of pathology and laboratory medicine to the eight care pathways identified in the Darzi review. Wherever possible the examples given are common or high profile. Many more examples could be produced if required.

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 1: Maternity and Newborn Care

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Assisted conception to achieve pregnancy in infertile couple	Oocyte development, harvesting, fertilisation and monitoring. Storage of unused clinical material.	Clinical Embryology	Innovation/ Quality. Only suitable in specialist units
2. Antenatal screening programme for Down Syndrome	Analysis, interpretation, calculation of risk of affected foetus, analysis of amniotic fluid.	Clinical Biochemistry Cytogenetics	Quality/Primary Care. Partnership between secondary and primary care
3. Definition of detailed maternal blood group characteristics	Analysis, interpretation, clinical advice on risk to foetus.	Transfusion Medicine Immunology	Quality/Innovation/Primary Care. Potential for primary care delivery
4. Monitoring pregnancy for risk of developing gestational diabetes	Attendance at clinics, maintenance of POCT equipment, glucose analysis and result interpretation.	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery
5. Assessment of HIV status of mother and risk to foetus	Analysis, interpretation, clinical advice on risk to foetus.	Virology	Quality/Innovation. Potential for primary care delivery
6. Neonatal screening for sickle cell disease / abnormal haemoglobin	Screening and detailed analytical follow-up, interpretation and clinical advice.	Haematology Molecular Genetics	Innovation. Quality National Screening programme
7. Management of lung and other organ function in premature infants	24/7 analysis using very small samples, often at the point of care.	Clinical Biochemistry Haematology	Innovation/Quality. POCT in specialist units

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 2: Staying Healthy

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Screening women for risk of cervical cancer	Screening, interpretation, reporting, clinical advice. Follow up of screening positive cases.	Cytology Histopathology	Quality/Innovation/Primary Care. Potential for primary care for example polyclinics
2. Follow-up of women with positive breast cancer screens	Analysis, interpretation, reporting, clinical advice.	Histopathology	Quality. Provided in hospital units
3. Screening adults for colorectal cancer	Screening, interpretation, reporting, clinical advice. Follow up of screening positive cases.	Clinical Biochemistry Histopathology	Quality/Innovation. Partnership between national screening programme, secondary and primary care
4. Reducing hospital acquired infection (e.g. MRSA, C Difficile)	Screening of elective admissions Surveillance of patients and clinical areas, analysis, interpretation, clinical advice.	Microbiology	Quality/Innovation/Primary Care. Priority for all hospitals, potential for partnership between secondary and primary care
5. Reducing sexually transmitted disease (e.g. Chlamydia, Syphilis, HIV)	Analysis, interpretation, clinical advice.	Microbiology Virology	Quality/Innovation/Primary Care. POCT partnership between primary and secondary care e.g. community hospitals, polyclinics and GP practices
6. Investigating public health epidemics (e.g. E Coli, Norovirus)	Analysis, interpretation, clinical advice.	Microbiology Virology	Quality/Innovation. Hospital and specialist units
7. Lifestyle counselling to reduce obesity, diabetes, hypertension, Cardiovascular risk etc.	Definition of evidence-based guidelines, analysis, interpretation, clinical advice. Maintenance of POCT.	Clinical Biochemistry	Quality/Innovation/Primary Care. Clear opportunity for service provision in primary care e.g. community hospitals, polyclinics and GP practices
8. Supporting rehabilitation of drug addicts	Secure drugs of abuse screening and confirmation, interpretation, clinical advice.	Toxicology Clinical Biochemistry	Quality/Innovation/Primary Care. Partnership between secondary care and <i>primary care</i> e.g. Specialist units in the community and hospital
9. Supporting 'well woman' and 'well man' clinics	Analysis of wide range of parameters, interpretation, clinical advice.	Clinical Biochemistry Haematology Microbiology	Quality/Innovation/Primary Care. Clear opportunity for service provision in primary care e.g. community hospitals, polyclinics and GP practices
10. Allergy testing	Analysis, interpretation, clinical advice.	Immunology	Quality/Innovation/Primary Care. Suitable for primary care provision

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 3: Children's Health

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Diagnosis of meningococcal meningitis	Basic and advanced analysis, interpretation, clinical advice.	Microbiology	Quality/Innovation. Hospital units
2. Diagnosis and management of acute myeloid leukaemia	Basic and advanced analysis, estimation of minimal residual disease, interpretation, clinical advice.	Haematology Molecular genetics	Quality/Innovation. Hospital and specialist units
3. Diagnosis of cystic fibrosis in symptomatic child (as one example of many inborn errors of metabolism)	Conducting sweat test, analysis, interpretation, clinical advice. Detailed follow-up.	Clinical biochemistry Molecular genetics	Quality/Innovation. Hospital and specialist units
4. Investigation of growth retardation and delayed puberty	Advice on test performance, analysis, interpretation, clinical advice.	Clinical biochemistry	Quality/Innovation. Hospital and specialist units

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 4: Acute Pathway

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Blood transfusion for anaemic, haemorrhagic patients	24/7 crossmatching, interpretation, clinical advice, supply of blood.	Transfusion Medicine Haematology	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics
2. Diagnosis of acute myocardial infarct (heart attack)	Evidence-based guideline definition, 24/7 analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality. Hospital units growing role for POCT
3. Diagnosis and monitoring of viral hepatitis	Analysis, interpretation, clinical advice.	Virology Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics
4. Diagnosis of deep vein thrombosis	24/7 analysis, interpretation, clinical advice.	Haematology	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care delivery, e.g. polyclinics
5. Diagnosis of pneumonia	Analysis, interpretation, clinical advice.	Microbiology	Quality/Innovation. Hospital only
6. Diagnosis of prostatic cancer in haematuric patient	Biochemical risk assessment, histopathological confirmation on biopsy sample.	Clinical Biochemistry Histopathology	Quality/Innovation/Primary Care. Potential for primary care delivery of screening e.g. polyclinics confirmation in hospitals
7. Diagnosis and monitoring of acute renal failure	24/7 analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation. Partnership between secondary and primary care
8. Investigation of the poisoned patient – medical detective	Test selection based on history, 24/7 analysis, interpretation, and clinical advice.	Toxicology	Quality. Hospital only
9. Diagnosis and management of diabetic ketoacidosis	24/7 analysis, interpretation, clinical advice, maintenance of POCT equipment.	Clinical Biochemistry Microbiology	Primary Care. Hospital only Screening done in primary care
10. Major organ monitoring and support for subjects with a range of acute illnesses	24/7 analysis, interpretation, clinical advice, maintenance of POCT equipment.	Clinical Biochemistry Haematology	Quality/Primary Care. Partnership between secondary and primary care

Pathology and Laboratory Medicine (Life Sciences))

Care Pathway 5: Mental Health

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Monitoring patients on anticonvulsant therapy	Analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics, GP practices & community hospitals
2. Monitoring patients on lithium therapy for bipolar depression	Analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics, GP practices & community hospitals
3. Diagnosis and management of thyrotoxicosis	Analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics, GP practices & community hospitals
4. Diagnosis and management of porphyria	Analysis, interpretation, clinical advice. Detailed follow-up of cases positive at screening.	Clinical Biochemistry	Quality. Diagnosis in hospital, confirmation in specialist units
5. Risk profiling for Alzheimers disease	Analysis, interpretation, clinical advice.	Clinical Biochemistry Molecular Genetics	Quality/Innovation. Hospital only

Pathology and Laboratory Medicine (Life Sciences))

Care Pathway 6: Planned Care

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Pre-operative work up to assess fitness for surgery	Evidence-based guidelines, analysis, interpretation.	Clinical Biochemistry Haematology	Quality/Innovation/Primary Care. Potential for primary care delivery. Supports all care pathways that have a surgical endpoint.
2. POCT in GP surgery as initial step in haematuria pathway	Analysis, quality management	Haematology, Microbiology, Cytology	Quality/Innovation. 18 week commissioning pathway.
3. Helicobacter Pylori detection in indigestion pathway	Analysis, interpretation, clinical advice	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery. 18 week commissioning pathway
4. BNP in diagnosis of heart failure	Analysis, interpretation, clinical advice	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery. 18 week commissioning pathway
5. 24/7 assessment of troponin as part of investigation of chest pain	Analysis, interpretation, clinical advice	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery. 18 week commissioning pathway
6. Definitive diagnosis based on tissue sample removed at surgery (applies to a large number of conditions)	Preparation, examination, detailed immunohistochemistry and/or molecular diagnosis.	Histopathology	Quality/Innovation. Hospital and specialist units. Supports care pathways that have a surgical endpoint

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 7: Long-term Conditions

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Monitoring chronic renal failure	Evidence-based guidelines, analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care delivery e.g. polyclinics
2. Monitoring diabetes mellitus	Evidence-based guidelines, analysis, interpretation, clinical advice, maintenance of POCT.	Clinical Biochemistry Haematology	Quality/Innovation/Primary Care. Currently provided in both primary care and the home. Patient self testing
3. Monitoring rheumatoid arthritis	Evidence-based guidelines, analysis, interpretation, clinical advice.	Immunology	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care delivery, e.g. polyclinics
4. Monitoring anticoagulation therapy	Evidence-based guidelines, analysis, interpretation, clinical advice, maintenance of POCT.	Haematology	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care delivery growth of patient self testing
5. Monitoring response to therapy in HIV positive patients	Evidence-based guidelines, analysis, interpretation, clinical advice.	Virology	Quality/Innovation. Predominantly Hospital based
6. Monitoring patients with chronic heart failure	Evidence-based guidelines, analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care delivery
7. Monitoring patients with thyroid disease	Evidence-based guidelines, analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g. polyclinics, GP practices & community hospitals
8. Monitoring response to therapy in patients on lipid lowering drugs	Evidence-based guidelines, analysis, interpretation, clinical advice.	Clinical Biochemistry	Quality/Innovation/Primary Care. Currently provided in both primary care and secondary care
9. Monitoring response to therapy in patients with multiple myeloma	Analysis, interpretation, clinical advice.,	Clinical Biochemistry Immunology	Quality/Innovation. Predominantly hospital based
10. Selecting patients with breast cancer for Herceptin therapy	Analysis, interpretation, clinical advice.	Histopathology	Quality/Innovation. Hospital and specialist units

Pathology and Laboratory Medicine (Life Sciences)

Care Pathway 8: End of Life

Application of Pathology and Laboratory Medicine	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Supporting organ function during palliative care	Analysis, interpretation, clinical advice.	Clinical Biochemistry Haematology	Quality/Innovation/Primary Care. Potential for primary care delivery, e.g .Hospices
2. Managing the immediate consequences of death	Preparation and storage of body, bereavement counselling of relatives.	Anatomical Pathology Technologists	Quality. Predominantly hospital based
3. Supporting organ donation programmes	National guidelines, analysis, organ storage, transport, logistics, interpretation, clinical advice.	Histocompatibility And Immunogenetics	Quality/Innovation. Predominantly hospital based
4. Support for post-mortem examinations	Support for medical pathologist.	Histopathology	Quality/Innovation Predominantly hospital based
5. Definitive diagnosis of Alzheimers disease	Tissue preparation, examination, specialised analysis, interpretation.	Histopathology	Quality/Innovation. Hospital and specialist units

Our NHS, Our Future: the contribution of Healthcare Scientists

Physiological Sciences

Introduction

1. The Physiological Sciences encompass those healthcare science disciplines that predominantly focus on assessing the function of major organ systems (e.g. neurophysiology involves investigating the function of the central and peripheral nervous system and the impact of different pathologies). In some instances, these services, which focus on physiological measurements, may also restore function through a range of therapeutic intervention strategies. Locally, the clinical services that are included within this term may be dispersed across provider organisations and are not usually part of a distinct physiological measurement department or unit.
2. Access to diagnostic services is recognised as a major rate-limiting step in achieving the 18-week patient pathway by December 2008, which encompasses all stages that lead up to treatment, including outpatient consultations and diagnostics tests/procedures. Significant focus has now been given to resolving bottlenecks caused by long waits for diagnostics, including Physiological Measurement services.
3. Physiological Science has a wide range of responsibilities that include patient procedures in Audiology, Cardiology, Gastro-intestinal Physiology, Neurophysiology, Respiratory Physiology, Ophthalmology, Vascular Science, Perfusion Science, Sleep Physiology, Critical Care and Urodynamics. Much of the work is carried out in a one-to-one setting at the point of care, although behind-the-scenes procedure analysis, interpretation and reporting compliment their responsibilities. Physiological measurement procedures inform and underpin many areas of clinical decision making in all of the following areas:
 - Screening
 - Diagnosis
 - Prognosis
 - Selecting treatment
 - Delivery of treatment
 - Monitoring the response to treatment
4. These services have traditionally had a low profile and been poorly understood, often embedded within block contract arrangements and not recognised as an integral service entity. However, Physiological Measurement is a major area of the diagnostic service portfolio, providing a wide range of specialist investigations and elements in the care pathway that are essential in achieving more rapid treatment for patients.
5. Those working in Physiological Sciences use their knowledge of the benefits and limitations of various medical equipment technology to optimise clinical data used for diagnosis and treatment. Their work ranges from straightforward acquisition of clinical data to the delivery of treatment and discharge of patients sometimes without the need for further medical staff interaction.
6. There currently are some 7,500 staff directly undertaking clinical physiology procedures, which includes both clinical physiologists and clinical scientists. The latter group who are relatively small in number are regulated by HPC but the former group form part of the aspirant healthcare scientific professions, which are not yet regulated. The workforce has an important role in medical equipment evaluation, selection, acquisition, quality assurance and maintenance. Individual and collaborative research and audit is carried out within Physiological Sciences as part of routine procedure and as specific projects.

7. Crucial to the optimal deployment of these services within the changing context of healthcare delivery is a clear understanding of the demand for and capacity of current services which must involve an exploration of how services can be delivered differently. Service transformation involves synchronising technology, processes and the skills and competences of the workforce, all working together to deliver efficient and effective services for the patient. It also means considering the broader agenda for delivering services closer to patients, and finding longer term, sustainable solutions to service delivery.

8. This document gives just a number of illustrations of the contribution Physiological Sciences makes to the eight care pathways identified in the Darzi review. Many more examples could be produced if required. It should be considered in conjunction with the document What is Physiological Measurement, published in May 2007 by the CSO.

<http://www.18weeks.nhs.uk/cms/ArticleFiles/cdeyg4553khfkgumwddkwezt24082006121414/Files/WhatisPhysiologicalMeasurementtext.doc>

Physiological Sciences

Care Pathway 1: Maternity and Newborn Care

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Assessment of pre and post natal DVT	Delivery, analysis and reporting vascular ultrasound procedures.	Vascular Technology	Innovation. Movement to primary care underpinned with appropriate quality assurance partnership with healthcare scientists.
2. Assessment of neonatal development and behavioural disorders e.g. encephalopathies, neonatal seizures.	Delivery, analysis and interpretation of electroencephalography, evoked potentials.	Neurophysiology	Quality & Safety. Hospital based to ensure safe overlap with paediatricians and neurophysiologists.
3. Assessment of congenital heart disease. EG long QT syndrome, structural abnormalities	Delivery, analysis and interpretation of electrocardiograms and echocardiograms. Cardiac catheterisation	Cardiac Physiology	Innovation/Primary Care. Electrocardiographic screening of newborn (Quality requirement of NSF Cor Ht Dis, Ch 8; A&SCD). Predominantly hospital based but innovation could see first-pass routine screen in Primary care setting utilising electromedical equipment analysis. Screening for suspected structural abnormalities initially may be detected with trans thoracic echocardiography. Partnership arrangements with specialist care providers could move the resource closer to community settings (Paediatric Cardiology clinics in secondary care setting) Cardiac catheterisation will remain in specialist paediatric cardiology centres.
4. Treatment of congenital heart disease. e.g. Fallots tetralogy	Management of cardiopulmonary support during open-heart surgery.	Clinical perfusion	Quality & Safety. Perfusion science will remain embedded in specialist paediatric (cardiothoracic) centres.
5. Post natal care	Pelvic floor retraining/biofeedback, Anorectal physiology, endoanal ultrasound, pudendal nerve motor latency	GI physiology	Innovation/Quality/Primary Care. Movement to primary care with appropriate quality assurance partnership with healthcare scientists. More complex procedures remaining hospital based to ensure appropriate cross-speciality referral / joint clinics.
6. Intensive care of newborn	Carry out near patient testing of biochemical & haematological samples. Support diagnostic techniques.	Critical Care Technology	Quality & Safety. Supporting accurate monitoring and physiological measurement of newborn in secondary and tertiary care.
7. Universal neonatal screening	Carry out hearing screening. Interpret results, manage hearing loss	Audiology	Innovation/Quality & Safety/Primary care. Neonatal hearing will be screened in Primary Care with appropriate MDT aetiological diagnosis and care.

8. Assessment of hearing as newborn	Delivery of screening programme, newborn hearing assessment and diagnostics	Audiology	Innovation/Quality & Safety/Primary care. In line with the NSF for Children target of early identification of childhood disability and with maternal and child health services improvement
9. Assessment of Apparent Life Threatening Event (ALTE), Congenital Central Hypoventilation Syndrome (CCHS)	Diagnosis and treatment using advanced respiratory physiology techniques	Respiratory physiology	Innovation/Quality & Safety. Delivering accurate monitoring and physiological measurement of newborn in secondary and tertiary care.

Physiological Sciences

Care Pathway 2: Staying Healthy

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Investigation of heart palpitations	Selection of appropriate ambulatory electrocardiographic modality, analysis and interpretation including advice on lifestyle changes or referral to other healthcare specialists.	Cardiac Physiology	Innovation/Primary Care. Movement of recording bias to primary care / polyclinic with partnership support from healthcare scientist for quality assurance. Analysis and interpretation with rapid response for identified life-threatening arrhythmias remaining in secondary/tertiary care.
2. Prevention/treatment of incontinence, food intolerance, eradication of helicobacter pylori, reflux disease	Pelvic floor retraining/biofeedback, hydrogen breath test, urea breath test, oesophageal and gastric manometry, ambulatory pH	GI physiology	Innovation/Quality & Safety/Primary Care Movement of some suitable procedures to primary care with appropriate quality assurance partnership with healthcare scientists. More complex procedures remaining hospital based to ensure appropriate cross-speciality referral / joint clinics.
3. Evaluation and diagnosis of sleep disorders – with CPAP treatment	Identifying and/or advising treatment of sleep disorders to minimise social and long-term health affect.	Sleep physiology	Quality & Safety. Specialist hospital environment to ensure quality of diagnosis is maintained and economic resource base. Screening can be developed in primary care with appropriate healthcare scientist partnership arrangements to ensure maintained quality
4. Assessment of fitness to fly; spirometry or peak flow to monitor lung health through life	Undertake, analyse and interpret hypoxic challenge procedure. Perform quality spirometry and practice supports services	Respiratory physiology	Quality & Safety /Primary Care. Flight assessments in specialist hospital environment to maintain quality of diagnosis and economic resource base. Spirometry services to integrate in primary care to support screening and monitoring services.
5. For children identified by newborn hearing screening - Differential diagnosis of hearing function and appropriate hearing aid fitting and monitoring, with potential for cochlear implant candidacy. Direct referral hearing and balance screening	Undertake a range of hearing tests using electrophysiological techniques. Fit new digital signal processing hearing aids and evaluate development. Continue to cochlear implant assessment pathway if tests show lack of benefit Audiological and basic balance assessments, interpretation of results, primary rehabilitation (hearing tactics, aids & physiotherapy)	Audiology	Innovation/Quality & Safety/Primary Care. NSF for children early intervention. Assessing need for services to have critical mass and provide close to home support integrated with family, education and social care support, hence potential for managed clinical network in key locations in London (eg currently 24 separate services in London could be transformed into smaller number of managed clinical networks yet maintain closer to home priority) Establishment of balance service infrastructure in primary care in parallel with direct access hearing services as outlined in 18-week Dizziness Pathway. More complex diagnosis and rehab procedures remaining as secondary care

<p>6. Abdominal Aortic Aneurysm ultrasound assessment scan Screening for peripheral arterial disease</p>	<p>Undertake, analyse and report Abdominal Aortic Aneurysm scan Undertake, analyse and report vascular technology procedures</p>	<p>Vascular Technology</p>	<p>Innovation/Primary Care. Consistent with current view to provide vascular ultrasound assessment in primary care or polyclinic setting. Requires appropriate quality assurance through partnership arrangement with healthcare scientists Part of new national screening program. Ideal for primary care as these scans can be carried out using simple portable ultrasound scanners. Some simple vascular technology tests can be performed in primary care to screen for peripheral arterial disease.</p>
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Physiological Sciences

Care Pathway 3: Children's Health

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Diagnosis and classification of a range of neurological problems identified in childhood. e.g. epilepsy, visual and auditory disorders	Electroencephalography, evoked potentials and electromyography performed and interpreted to inform diagnosis and treatment pathways.	Neurophysiology	Quality & Safety. Secondary/tertiary care provision with appropriate links with paediatrician and neurophysiologist
2. Diagnosis of "sudden death" in young athletes	Perform/analyse/interpret electrocardiographic, echocardiographic and electrophysiological examinations.	Cardiac Physiology	Innovation/Quality & Safety/Primary Care. Secondary/tertiary care provision assures appropriate links with cardiologist paediatrician and geneticist. Consistent with markers of good practice in NSF for Cor Ht Dis, Ch 8 A&SCD Possibility for POCT as community based service as a direct access initial referral or in a hub and spoke service managed in secondary care to ensure the appropriate expertise for each clinic session that is subsequently carried out at a community hospital/ polyclinic with appropriate facilities.
3. Diagnosis and treatment of hearing problems in childhood predominantly due to Glue Ear as given in 18-Week Commissioning Pathway but includes a range of paediatric audiology assessments including balance that could be safely moved to primary care	Undertake an escalating range of audiological procedures, analysis and interpretation to support the diagnosis and treatment of Glue Ear and childhood onset permanent hearing impairment	Audiology	Innovation/Quality & Safety/Primary Care. National 18-week Care Pathway describes involvement with all levels of healthcare delivery

<p>4. identifying cause, diagnosis and treatment of respiratory disease. Cystic Fibrosis the most common genetic condition. Asthma increasing in prevalence, Sleep-disordered breathing in children (increasing obesity & OSA).</p>	<p>Use of lung function in infants, pre-schoolers and school aged children as well as exercise and skin tests analysed and interpreted to inform lifestyle and treatment pathways. Sleep studies to detect OSA and monitor surgical treatment and some CPAP therapy</p>	<p>Respiratory & Sleep physiology</p>	<p>Quality & Safety/Primary Care. Delivery provided in secondary and tertiary care but deserving of evaluation to enable some procedures in primary care settings with appropriate healthcare scientist partnership arrangements to ensure quality is maintained</p>
<p>5. Failure to thrive, Lactose/food intolerance</p>	<p>Oesophageal and gastric manometry, ambulatory pH, impedance monitoring electrogastrography, hydrogen breath test, urea breath test,</p>	<p>GI physiology</p>	<p>Quality & Safety. Secondary/Tertiary care provision safeguards physiological measurement quality and ensures appropriate links with paediatrician</p>
<p>6. Screening for children with Sickle Cell at risk of stroke.</p>	<p>Transcranial Doppler assessments to predict stroke risk, so that preventative treatment in the form of blood transfusions can be undertaken</p>	<p>Vascular Technology</p>	<p>Quality & Safety. Linked with National Sickle Cell Screening Program and Sickle Cell Centres. Requires specialist equipment and scanning skills.</p>

Physiological Sciences

Care Pathway 4: Acute Pathway

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Evaluation and treatment of acute brain and spinal cord disorders e.g. encephalitis. Assessment of mid brain function in coma. Assessment of peripheral nerve and muscle function in weakness and/or sensory loss	Electroencephalography, evoked potentials, electromyography and nerve conduction studies performed and reported to support diagnosis and treatment pathways.	Neurophysiology	Quality & Safety. Ensures accuracy of physiological measurements, data interpretation and reports
2. Support a range of physiological monitoring, diagnostic and treatment procedures in intensive and critical care settings	Carry out near patient testing, of biochemical and/or haematological samples for analysis. Support diagnostic techniques e.g. respiratory therapies, extra corporeal circuits, cardiac output measurement, cannulation, intubation.	Critical care technology	Quality & Safety. Intensive and high dependency care settings. Ensures accuracy of physiological, haematological and clinical chemistry measurement alongside safe support toward diagnostic monitoring and therapy procedures.
3. Support primary percutaneous coronary intervention procedures following myocardial infarction. Evaluation of new chest pain	Provide 24-hour cover for cardiac catheterisation procedures including emergency haemodynamic and cardiac rhythm support through intra aortic balloon pump and cardiac pacemaker treatment. Assess chest pain through history, symptoms ± cardiac stress test	Cardiac Physiology	Quality & Safety/Primary Care. Progressive movement toward secondary care provision bringing immediacy of peri/post MI care closer to patients' home. Consistent with reduction in hospital length of stay. Direct access to rapid assessment of chest pain to support/exclude cardiac cause and accelerate pathway to appropriate care or reassurance
4. Support open-heart surgery procedures	Provide 24-hour cover to manage cardio-pulmonary bypass equipment including regulation of affected haematological and biochemical factors	Clinical perfusion science	Quality & Safety. Tertiary level care in specialist cardiothoracic centres ensure quality provision through expert team delivery

5. Evaluation and diagnosis of vascular incidents. e.g. TIA, Stroke, DVT, Critical limb ischaemia.	Undertake, analyse and report Doppler/duplex vascular ultrasound procedures	Vascular Technology	Innovation/Quality & Safety. Life threatening events managed in secondary care. Deserves evaluation to determine whether some presentations may be managed entirely in primary care.
6. For children identified by newborn hearing screening and differential diagnosis of hearing function and appropriate hearing aid fitting and monitoring, with potential for cochlear implant candidacy Sudden hearing loss, extreme distress and tinnitus, sudden vestibular failure	Undertake a range of hearing tests using electrophysiological techniques. Fit new digital signal processing hearing aids and evaluate development. Continue to cochlear implant assessment pathway if tests show lack of benefit	Audiology	Quality & Safety/Innovation. NSF for children early intervention. Assessing need for services to have critical mass and provide close to home support integrated with family, education and social care support, hence potential for managed clinical network in key locations in London (eg currently 24 separate services in London could be transformed into smaller number of managed clinical networks yet maintain closer to home priority)
7. Sudden hearing loss, extreme distress and tinnitus, sudden vestibular failure	Audio-vestibular and aetiological evaluation	Audiology	Quality & Safety.
8. Assessment for oxygen therapy and/or non-invasive ventilation (NIV). Occasional specialist lung function tests to aid diagnosis/prognosis.	Provide non-invasive blood gas sampling and analysis, provision of NIV assessment and set up. Lung function testing in Guillan-Barre and Goodpasture's Syndrome.	Respiratory physiology	Quality & Safety/Innovation. Life threatening respiratory failure managed in secondary care. Also provide training and development of ward staff to set-up and maintain NIV acutely (24-hour support)
9. Evaluation of wet age-related macular degeneration	Undertake visual acuity assessment. Fluorescein angiography, optical coherence tomography and microperimetry	Ophthalmic Science	Innovation/Quality & Safety/ Primary Care. Treatment of wet AMD with Ranibizumab, an anti-VEG F drug, has been approved by NICE.

Physiological Sciences

Care Pathway 5: Mental Health

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Diagnosis and assessment of patients with cognitive decline, psychosis and/or learning disabilities	Undertake, evaluate and interpret electroencephalography to support diagnosis and treatment plans	Neurophysiology	Quality & Safety. Delivery in secondary care settings ensures quality of physiological measurement standards alongside other appropriate care delivery standards
2. Determine risks associated with anti-psychotic drug therapy	Undertake and assess electrocardiographic data to determine pre and post treatment risks to proarrhythmic drug affect	Cardiac Physiology	Quality & Safety. POCT with appropriate electromedical equipment, physiological data measurement and analysis could support safer delivery of proarrhythmic therapy.
3. Determine hearing and communication status of a range of children and adults with complex needs including learning disabilities	Undertake and evaluate a range of hearing tests including electrophysiological tests to determine need for intervention	Audiology	Quality & Safety/Innovation. Use of Do Once and Share clinical pathways

Physiological Sciences

Care Pathway 6: Planned Care

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Pre operative assessment	Lung function and blood gas analysis, interpretation and reporting to support safe anaesthetic and surgical procedures. Echocardiography to assess murmurs identified at pre-assessment clinics and prior to by echocardiography	Respiratory Physiology and Cardiac Physiology	Innovation/Quality & Safety/Primary Care. Provision of accurate physiological data used to assess and stratify risks associated with individual patients prepared for surgical procedures. Movement of appropriate procedures could be safety transferred to primary care or offered as a direct access service. Safety in any setting that can offer the expert interpretation NCEPOD recommendation that all surgical patients with murmurs have an echo due to the high mortality of anaesthesia in patients with unrecognised aortic stenosis
2. Assessment and instrumental treatment of hearing loss. Assessment of balance , tinnitus disorders	Diagnose and determine effective treatment pathway through appropriate hearing function procedures to select, fit and optimise hearing aids. Identification of presence/ absence of the vestibular deficit with the oculomotor and vestibular tests to provide appropriate rehabilitation strategies or appropriate referral, Assessment of the auditory status , the severity of tinnitus to provide appropriate rehabilitative strategies	Audiology	Quality & Safety/Primary Care. Delivery exists in a range of care settings at all levels of healthcare delivery with opportunities for primary care delivery and for open access services
3. Diagnosis and some therapeutic management for a range of common patient presentations in primary care	Streamlines the early diagnosis and contributes to the management of common conditions, e.g. heart failure, breathlessness, falls	Cardiac Physiology and Respiratory Physiology	Quality & Safety/Primary Care. Initial diagnosis and early treatment, with particular support for triage from primary care to appropriate patient pathway

<p>4. Investigation and treatment of reflux disease, obstructive defaecation, constipation and incontinence. Eradication of helicobacter pylori</p>	<p>Analyse and interpret diagnostic data from a variety of procedures e.g. Oesophageal and gastric manometry, ambulatory pH, impedance monitoring electrogastrography, hydrogen breath test, urea breath test, anorectal physiology, endoanal ultrasound, pudendal nerve motor latency.</p>	<p>GI physiology</p>	<p>Quality & Safety/Primary Care. Provision of accurate physiological measurement alongside patient support delivered in a variety of primary, secondary and tertiary settings</p>
<p>5. Assessment and treatment of cardiac valve disease. Assessment and treatment of atrial fibrillation (18 week pathway)</p>	<p>Evaluation and diagnosis utilising electrocardiography, and echocardiography (TTE/TOE) and cardiac catheterisation leading to treatment with drug therapy, percutaneous valve modification (increasingly, replacement) or referral for cardiothoracic surgery. Application, analysis and interpretation of range of ambulatory monitoring devices To determine established AF and its subsequent control or onward referral to electrophysiology studies</p>	<p>Cardiac Physiology</p>	<p>Innovation/Quality & Safety/Primary Care. Direct and primary care-based access to transthoracic echocardiographic procedures with appropriate partnership arrangements with healthcare scientists assure quality of diagnoses. Percutaneous modification of valve structure to become more commonplace within an aging population and presents safer option and reduced secondary complication in specific cohorts.</p> <p>Supports published 18 week pathway and improves long term outcome of cardiac rhythm disorder</p>
<p>6. Assessment and treatment of cataracts :</p>	<p>Undertaking a range of visual assessments including acuity, slit-lamp examination, fundoscopy and tonometry, focimetry, keratometry, and A-scan ultrasound to assist calculation of the power of the intraocular lens to be implanted.</p>	<p>Ophthalmic Science</p>	<p>Quality & Safety. Provision exists in a variety of healthcare settings at all levels of delivery. Appropriate partnership with healthcare scientist's arrangements ensures accuracy of service provision.</p>

7. Pre, peri and post operative assessment for epilepsy surgery, entrapment neuropathy, tumour reduction	Application, analysis and interpretation of electroencephalography, nerve conduction studies etc to support accurate surgery and determine outcome efficacy	Neurophysiology	Innovation/Quality & Safety/Primary Care. Accuracy of physiological measurement assists accuracy of surgical procedures and reduces risks, morbidity and mortality. Opportunities for nerve conduction studies to be delivered directly in primary care or through direct access services are worthy of further evaluation.
8. Assessment of overnight oximetry for OSA or hypoventilation in obese patients undergoing bariatric surgery	Assessment of sleep-breathing disorders with non-invasive techniques. Provision of CPAP for post-op recovery.	Sleep physiology	Quality & Safety. Provision exists currently in secondary and tertiary healthcare settings but there is no reason why this could not move to primary care with appropriate partnership with healthcare scientists arrangements to ensure accuracy and quality of service provision.
9. Assessment of lower limb arterial disease including assessment for leg ulcers and surveillance after graft or stent intervention. Intraoperative monitoring during carotid endarterectomy. Preoperative assessment for fistula access for renal dialysis	Undertake, analyse and report duplex vascular ultrasound procedures. Management of surveillance programs. Undertake and analyse transcranial Doppler during and after carotid endarterectomy. Undertake, analyse and report duplex assessments prior to fistula surgery	Vascular Technology	Quality & Safety. Potential to move to primary care with good links to vascular surgery. Maintained in secondary/tertiary care for monitoring cerebral blood flow where procedure carried out under general anaesthetic. Appropriate liaison with Renal Units must be established

Physiological Sciences

Care Pathway 7: Long-term Conditions

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Diagnostic assessment of degenerative conditions EG Parkinson's disease, Alzheimer's disease, peripheral neuropathy and HIV	Acquisition, analysis and interpretation of appropriate neurological assessment procedures e.g. electroencephalography, nerve conduction studies, evoked potentials, electromyography	Neurophysiology	Quality & Safety. Accuracy of physiological measurement alongside multidisciplinary team working ensures quality patient and carer support and to provide guidance / assess efficacy of treatment programmes
2. Management of hearing impairment	Identification (through triage / screening), assessment of hearing impairment, fitting of digital signal processing hearing aids and monitoring benefits	Audiology	Innovation/Quality & Safety/Primary Care. Range of services including one stop shop 'assess and fit' hearing aid services based on new technology, moving to primary care assessment, provision and long term support; would benefit from co-location with other services for high prevalence long term conditions for elderly eg polyclinic
3. Evaluation and assessment of treatment	Electroencephalography, nerve conduction studies, electromyograms and nerve conduction studies used to inform, maintain or adjust delivered therapy.	Neurophysiology	Innovation/Primary Care. Procedures remaining mostly secondary tertiary care based but deserving evaluation of some POCT into primary/polyclinic settings
4. Diagnosis and management of urinary tract disorders	Use of intimate, invasive diagnostic procedures to determine appropriate treatment plan	Urodynamics	Quality & Safety. Accuracy of physiological measurement ensures accuracy of diagnosis to guide and/or assess efficacy of treatment programmes
5. Diagnosis and management of swallow disorders, obstructive defaecation, constipation and incontinence.	Oesophageal manometry, anorectal physiology, ultrasound, pudendal nerve motor latency, pelvic floor retraining/biofeedback	GI physiology	Quality & Safety. Accuracy of physiological measurement ensures accuracy of diagnosis to guide and/or assess efficacy of treatment programmes
6. Management of glaucoma	Visual acuity, visual fields, slit-lamp examination, tonometry with corneal pachymetry, imaging of the optic disc and retinal nerve fibre layer	Vision science	Quality & Safety /Primary Care. Accuracy of physiological measurement ensures accuracy of diagnosis to guide and/or assess efficacy of treatment programmes

7. Management of heart failure	Diagnostic procedures including echocardiography, correction and optimisation of cardiac rhythm with implanted pacemakers and cardioverter defibrillators monitoring of this long term condition	Cardiac Physiology	Innovation/Quality & Safety/Primary Care. Range of care delivery at all levels of provision e.g. fluid balance managed locally with as-necessary secondary care referral. Implanted device management and counselling in secondary care may be supplemented by telemedicine to reduce hospital visits.
8. Management of chronic respiratory conditions such as COPD, CF, interstitial lung disease, neuromuscular disease, hypoxaemia and asthma	Supplemental oxygen therapy, drug delivery with nebuliser, CPAP and NIV support. Assessment and delivery of pulmonary rehabilitation in COPD.	Respiratory physiology	Quality & Safety/Primary Care. Accuracy of physiological measurement ensures accuracy of diagnosis to guide and/or assess efficacy of treatment programmes. Some of this work could be moved to primary care once a diagnosis is established.
9. Management of OSA and obesity hypoventilation disorders	Assessment and provision of CPAP or NIV.	Respiratory & Sleep Physiology	Quality & Safety/Primary Care. Accuracy of physiological measurement ensures accuracy of diagnosis to guide and/or assess efficacy of treatment programmes. Some of this work could be moved to primary care once a diagnosis is established.
10. Surveillance of fistula for renal dialysis.	Undertake, analyse and report duplex scans to assess the flow in the fistula and maintain fistula function	Vascular Science	Quality & Safety/Innovation. Currently in tertiary centres, could move to dialysis units in community or secondary care units.

Physiological Sciences

Care Pathway 8: End of Life Care

Application of Physiological Sciences	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Management of heart failure	Optimisation of implanted devices, echocardiographic assessment of cardiac function, termination of implanted device therapy pre and post mortem.	Cardiac Physiology	Quality & Safety/Primary Care. Specialist expertise to optimise implanted device therapy through combined echocardiographic imaging and device parameter adjustment. Therapy termination may be undertaken (sensitively) in any healthcare delivery setting.
2. Management of respiratory failure and hypoxaemia.	Supplemental oxygen therapy and NIV: assessment and provision with routine follow-up.	Respiratory physiology	Quality & Safety/Primary Care. Specialist healthcare scientist input to optimise therapy delivery through accurate physiological measurement of critical parameters in primary and secondary care
3. Management of urinary incontinence	Preserving dignity	Urodynamics	Quality & Safety/Primary Care. Specialist healthcare scientist input to ensure accuracy of physiological measurements necessary in the delivery of optimal care in primary and secondary care
4. Management of faecal incontinence	Preserving dignity	GI physiology	Quality & Safety/Primary Care. Specialist healthcare scientist input to ensure accuracy of physiological measurements necessary in the delivery of optimal care in primary and secondary care

Our NHS, Our Future: the contribution of Healthcare Scientists

Physical Sciences & Engineering

Introduction

1. Healthcare Scientists (HSC) working in Physical Sciences and Engineering (PSE) bring a wide range of scientific, engineering and technical skills to bear, touching every stage of the patient pathway in secondary and tertiary care and are playing an increasing role in primary care. Their role is threefold:
 - To facilitate
 - To innovate
 - To interpret

They have a significant role in enabling the delivery of healthcare by ensuring that the right equipment is in the right place at the right time, performing to nationally and internationally agreed standards of performance. They ensure that medical devices are used according to the best available evidence.

Innovation is key to their role. There are two Nobel prize winners amongst their number (Geoffrey Hounsfield, the inventor of the CT scanner and Sir Peter Mansfield, key to the development of MRI imaging). The day job is innovative service development, such as Intensity Modulated Radiotherapy, the introduction of digital radiology and PACS, and the development of Nuclear Medicine tests on the differential diagnosis of dementia.

HCS provide consultant level advice on the interpretation of complex imaging investigations and test results, they may prescribe, for example, specialist seating or assistive technology and may develop highly-complex treatment plans for the delivery of Radiotherapy. They also provide advice on the interpretation and application of the law, particularly with regard to electrical and radiation safety, acting as Radiation Protection Advisers and Authorising Engineers.

2. HCS in Physical Sciences and Engineering are key to the delivery of the NHS Cancer Reform Strategy. The National Radiotherapy Advisory Group report recommends an increase of 30% in the workforce supporting the delivery of radiotherapy.
3. HCS in Physical Sciences and Engineering work in the following fields:
 - Diagnostic Radiology
 - Radiotherapy
 - Radiation protection
 - Nuclear Medicine
 - Ultrasound
 - MRI
 - Lasers/UV

- Medical Photography
- Clinical Measurement
- Rehabilitation Engineering
- Design & construction of medical devices
- Maxillofacial prosthetics
- Equipment management
- Renal Technology

There are over 6000 staff in the workforce, about 1200 of whom are Clinical Scientists registered with the Health Professions Council.

4. The remaining pages of this report serve to give just a few illustrations of the contribution of pathology and laboratory medicine to the eight care pathways identified in the Darzi review. Wherever possible the examples given are common or high profile. Many more examples could be produced if required.

Physical Sciences & Engineering

Care Pathway 1: Maternity and Newborn Care

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Antenatal ultrasound	Development of ultrasound imaging techniques (e.g. 3D/4D ultrasound). Optimisation of image quality. Quality assurance and calibration of Doppler ultrasound techniques. Staff training	Ultrasound	Quality/Innovation/Primary Care. Suitable in any antenatal setting with appropriately trained operators (image interpretation and knowledge of artefacts a key issue). In some environments HCS deliver the Ultrasound service.
2. Diagnosis of suspected pulmonary embolus	Ventilation/perfusion imaging techniques in Nuclear Medicine. Patient dose reduction and image optimisation in CT pulmonary angiography	Nuclear Medicine Diagnostic Radiology	Quality. Secondary care setting. In Nuclear Medicine HCS provide advice on test performance, analysis, interpretation & report
3. Monitoring fetal heart rate during labour	Development of measurement techniques. Equipment evaluation. Equipment management	Medical electronics and equipment management	Quality/Innovation. Secondary care setting. HCS provide advice on risk management and evidence based use of equipment.
4. Management of equipment in Maternity Theatres for Caesarian delivery	Management of equipment through the whole lifecycle from procurement to disposal	Equipment management	Quality. Secondary care setting. HCS provide advice on risk management and evidence based use of equipment.
5. Management of equipment in Neonatal Intensive Care	Management of equipment through the whole lifecycle from procurement to disposal	Equipment management	Quality. Secondary care setting. HCS provide advice on risk management and evidence based use of equipment.
6. Neonatal screening for cerebral haemorrhage using ultrasound	Image optimisation and quality assurance of ultrasound equipment	Ultrasound	Quality. Secondary care setting
7. Support to the Newborn Hearing Screening Programme	Calibration of audiometers. Follow up testing of auditory evoked potentials	Equipment Management Clinical Measurement	Quality. Secondary care setting. HCS provide on test performance, analysis, interpretation & report.
8. Management of congenital abnormalities of the skull, face and jaws	Design & manufacture of feeding plates and extra-oral splints for facial microsomia, microtia.	Maxillofacial Prosthetics	Quality. Secondary care setting

Physical Sciences & Engineering

Care Pathway 2: Staying Healthy

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Ensuring the provision of high quality mammography images	Quality assurance of mammography equipment used by the NHS Screening Programme. Development and introduction of new digital mammography equipment. Support to modality integration with PACS	Diagnostic Radiology	Quality/Innovation/Primary Care. Suitable for polyclinic setting. HCS provide enabling work that ensure legislative compliance and best practice care.
2. Ensuring the quality of ultrasound images in the proposed aortic aneurysm screening programme	Quality assurance and equipment management of ultrasound equipment	Ultrasound	Quality/Primary Care. Suitable for polyclinic setting with appropriately trained operators
3. Ensuring the accuracy and reliability of non-invasive blood pressure measurement	Calibration and maintenance of non-invasive blood pressure measuring equipment	Equipment Management	Quality/Primary Care. All settings including “well man” and “well woman” clinics. Often not considered necessary by users but is a significant issue
4. Ensuring the accuracy and reliability of thermometry	Evaluation and calibration of thermometers	Equipment Management	Quality/Primary Care. All settings including “well man” and “well woman” clinics. Often not considered necessary by users but is a significant issue (for example some types overdiagnose fever, leading to inappropriate antibiotic prescription and extended hospital stay).
5. Screening for cardiac disease	Maintenance of ECG equipment	Equipment Management	Quality/Primary Care. All settings

Physical Sciences & Engineering

Care Pathway 3: Children's Health

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. The management of paediatric renal disease	Nuclear medicine imaging of the kidney and tests of renal function. Ensuring the quality of ultrasound imaging of the kidney and calibration of Doppler ultrasound Ensuring the quality of X-ray imaging of the kidney. Management of paediatric dialysis equipment and water quality	Nuclear Medicine Ultrasound Diagnostic Radiology Renal Technology	Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests and in the development of ultrasound imaging equipment. HCS provide advice on test performance, analysis, interpretation & clinical advice.
2. The management of cleft lip and palate	Clinical Photography of patients with cleft lip and palate – monitoring change over many years with standardised protocol. Taking impressions during surgery and planning orthognathic surgery	Clinical Photography Maxillofacial Prothetics	Quality. Secondary care setting
3. Supporting the Paediatric Cochlear Implant Programme	Measurement of auditory evoked potentials Monitoring implant performance Calibration of audiometers	Clinical Measurement Equipment Management	Quality. Secondary care setting.
4. Management of childhood cancer	PET imaging of childhood cancer Radiotherapy treatment planning Calibration and quality assurance of Radiotherapy treatments. Immobilisation of patients during treatment. Delivery of treatment using radioactive sources Maintenance of Radiotherapy equipment	Nuclear Medicine Radiotherapy Physics Equipment Management	Quality/Innovation. Secondary care setting. HCS make a unique contribution in signing off treatment plans, providing advice on highly-complex treatment planning and the development of new Radiotherapy techniques such as Image-Guided Radiotherapy and Proton Therapy
4. Management of childhood diseases of bone	DEXA measurement of bone density	Nuclear Medicine	Quality. HCS provide advice on test performance, analysis, interpretation & report
5. Management of equipment in Paediatric Intensive Care	Management of equipment through the whole lifecycle from procurement to disposal	Equipment management	Quality. Secondary care setting

6. Management of epilepsy	PET imaging prior to epilepsy surgery Maintenance of equipment used in Clinical Neurophysiology	Nuclear Medicine Equipment management	Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests and in the development of ultrasound imaging equipment. HCS provide advice on test performance, analysis, interpretation & reports.
7. Congenital disorders	Development of prosthetics for the eye, skull, face or orbit due to congenital disorders	Maxillofacial Prosthetics	Quality. Secondary care setting

Physical Sciences & Engineering

Care Pathway 4: Acute Pathway

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. The management of acute renal failure	Nuclear medicine imaging of the kidney and tests of renal function. Ensuring the quality of ultrasound imaging of the kidney and calibration of Doppler ultrasound Ensuring the quality of X-ray imaging of the kidney. Management of dialysis equipment and water quality	Nuclear Medicine Ultrasound Diagnostic Radiology Renal Technology	Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests and in the development of ultrasound imaging equipment. HCS provide advice on test performance, analysis, interpretation & clinical advice.
2. The management of acute myocardial infarction	Ensuring the optimisation, quality and quantification of imaging in cardiac catheter laboratories. Nuclear Medicine myocardial perfusion imaging Ensuring the optimisation, quality and quantification of cardiac MRI. Management of medical equipment in cardiac catheter laboratories, CCU, cardiac surgery and perfusion Developing and supporting ambulatory monitoring. Developing automated methods of ECG analysis Supporting modality integration with PACS/HISS	Diagnostic Radiology Nuclear Medicine MRI Equipment Management Medical electronics and Clinical Measurement Computer Scientists (ICT)	Quality/Innovation. HCS have a unique role in the development and validation of new ways of imaging the heart and making measurements from those images relevant to the clinical management of the patient.
3. Diagnosis of deep vein thrombosis	Development and maintenance of ultrasound techniques to diagnose DVT	Medical Electronics and Ultrasound	Quality. Suitable for all settings
4. Diagnosis of prostatic cancer in haematuric patients	Support to all imaging modalities uses	Diagnostic Radiology Ultrasound	Quality

<p>5. Emergency care</p>	<p>Making splints for avulsed teeth or broken jaws. Custom made devices for head & neck burns. Support to equipment in Ambulance, A&E, Emergency Surgery and ICU/HDU over the full equipment lifecycle. Development of novel medical devices (e.g. transfer incubators for ambulance care)</p>	<p>Maxillofacial Prosthetics Equipment Management Medical Electronics</p>	<p>Quality/Innovation. HCS have a unique role in the development of novel medical devices.</p>
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Physical Sciences & Engineering

Care Pathway 5: Mental Health

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Differential diagnosis of dementia	Nuclear Medicine imaging for differential diagnosis of dementia	Nuclear Medicine	Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests. HCS provide advice on test performance, analysis, interpretation & clinical advice. Developing evidence based guidelines.
2. Emergency care for mental health patients	Support for equipment in Ambulance and A&E	Equipment Management	Quality. Many mental health patients present first through the emergency pathway
3. Imaging in neurosciences	Development of functional MRI tests	MRI	Quality/Innovation. HCS have a unique role in the development and validation of new imaging techniques
4. Providing assistive technology for patients with learning difficulties	Developing, testing and prescribing assistive technology	Rehabilitation Engineering	Quality/Innovation/Primary Care. HCS have a unique role in developing new assistive technologies

Physical Sciences & Engineering

Care Pathway 6: Planned Care

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Assessment of donor and recipient for kidney transplant	Nuclear Medicine imaging assessment of renal function	Nuclear Medicine	Quality/Innovation. Secondary care setting. HCS provide advice on test performance, analysis, interpretation & clinical advice.
2. Diagnosis, staging and treatment of cancer	<p>Nuclear medicine and PET imaging of cancer for diagnosis and staging</p> <p>Quality assurance and optimisation of all imaging techniques used in cancer pathways (CT/MRI/X-ray/US)</p> <p>Planning radiotherapy treatments</p> <p>Maintenance, calibration and quality assurance of radiotherapy treatment machines.</p> <p>Management of complex computer networks involved planning, verification and delivery of Radiotherapy treatments</p> <p>Imaging to monitor the efficacy of treatment</p> <p>Development of facial prostheses and artificial jaws for patients with Head & Neck cancer</p> <p>Radiation safety</p> <p>Development of aids for living for cancer sufferers</p> <p>Maintenance of chemotherapy equipment</p>	<p>Nuclear Medicine</p> <p>Diagnostic Radiology, MRI, Ultrasound</p> <p>Radiotherapy physics</p> <p>Nuclear Medicine</p> <p>Maxillofacial Prosthetics</p> <p>Radiation Protection</p> <p>Rehabilitation Engineering</p> <p>Equipment Management</p>	<p>Quality/Innovation.</p> <p>Secondary/tertiary care setting. HCS have a unique role in the delivery of Radiotherapy and in the development and implementation of new Radiotherapy treatments (e.g. Image Guided Radiotherapy, Proton Therapy). HCS have a unique role in the rehabilitation of cancer patients in the provision of prosthetics and aids for living following treatment</p> <p>HCS provide a consultant level advisory role with regard to complex radiotherapy treatments and legislative compliance.</p>

3. Support for elective surgery	Management of equipment through the whole lifecycle from procurement to disposal in Theatres, ICU/HDU Development of implantable devices Development of implantable materials (e.g. coatings for hip implants) Management of surgical Lasers Design and manufacture of deep buried implant devices for skull, jaws and body.	Equipment Management Medical Electronics Biomaterials Non-ionising Radiation Maxillofacial Prosthetics	Quality/Innovation. HCS have a unique role in the development of implantable medical devices and biomaterials. HCS provide consultant level advice in the evidence based use of medical devices and lasers, also ensuring legislative compliance
4. Support for renal dialysis services	Management of dialysis equipment. Management of water treatment plant. Support to home dialysis patients.	Renal Technology	Quality. Secondary and primary care settings

Physical Sciences & Engineering

Care Pathway 7: Long-term Conditions

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. The management of chronic heart disease	<p>Ensuring the optimisation, quality and quantification of imaging in cardiac catheter laboratories. Nuclear Medicine myocardial perfusion imaging Ensuring the optimisation, quality and quantification of cardiac MRI. Management of medical equipment in cardiac catheter laboratories, CCU, cardiac surgery and perfusion Developing and supporting home monitoring TeleHealth of heart disease. Developing automated methods of ECG analysis Supporting modality integration with PACS/HISS</p>	<p>Diagnostic Radiology Nuclear Medicine MRI Equipment Management Medical electronics and Clinical Measurement Computer Scientists (ICT)</p>	<p>Quality/Innovation/Primary Care. All settings. HCS have a unique role in the development and validation of new ways of imaging the heart and making measurements from those images relevant to the clinical management of the patient. HCS are involved in the development of Telehealth and evidence based guidelines.</p>
2. Monitoring chronic renal failure	<p>Nuclear medicine imaging of the kidney and tests of renal function. Ensuring the quality of ultrasound imaging of the kidney and calibration of Doppler ultrasound Ensuring the quality of X-ray imaging of the kidney. Management of dialysis equipment and water quality</p>	<p>Nuclear Medicine Ultrasound Diagnostic Radiology Renal Technology</p>	<p>Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests and in the development of ultrasound imaging equipment. HCS provide advice on test performance, analysis, interpretation & reports.</p>
3. Dermatological conditions	<p>Monitoring using medical photography – including myeloma Treatment using UV and electron therapy Splint treatment for Chondrodermitists of the head/face</p>	<p>Clinical Photography Non-ionising Radiation Radiotherapy Maxillofacial Prosthetics</p>	<p>Quality/Innovation. HCS have made a unique contribution to developments in photobiology.</p>

4. Rehabilitation following stroke	Development of Functional Electrical Stimulation (FES) to correct for dropped foot in hemiplegic gait	Rehabilitation Engineering	Quality/Innovation. HCS have made a unique contribution to the development of FES and have contributed to the development of evidence based guidelines on the management of stroke.
5. Support to patients with Chronic Obstructive Airways Disease	Maintenance of Nebuliser/CPAP equipment	Equipment Management	Quality. Suitable for polyclinic sessions
6. Management of patients on long-term corticosteroids	Measurement of bone density	Nuclear Medicine	Quality. Suitable for polyclinic settings. HCS provide advice on test performance, analysis, interpretation & reports.

Physical Sciences & Engineering

Care Pathway 8: End of Life

Application of Physical Sciences and Engineering	Role of Healthcare Scientist	Discipline	Contribution to National Themes and Models of Care
1. Supporting organ function during palliative care	Maintenance of life support systems	Equipment Management	Quality.
2. Differential diagnosis of dementia	Nuclear Medicine imaging for differential diagnosis of dementia	Nuclear Medicine	Quality/Innovation. Secondary care setting. HCS have a unique role in the development and validation of Nuclear Medicine tests. HCS provide advice on test performance, analysis, interpretation & clinical advice. Developing evidence based guidelines.
3. Determination of brain death	Development of new methods of determining brain death using evoked potentials	Clinical Measurement	Quality/Innovation. HCS have a unique role in the development and validation of new methods of clinical measurement
4. Assistive technology for supporting end of life care	Developing and prescribing assistive technology to support end of life care	Rehabilitation Engineering	Quality/Innovation.