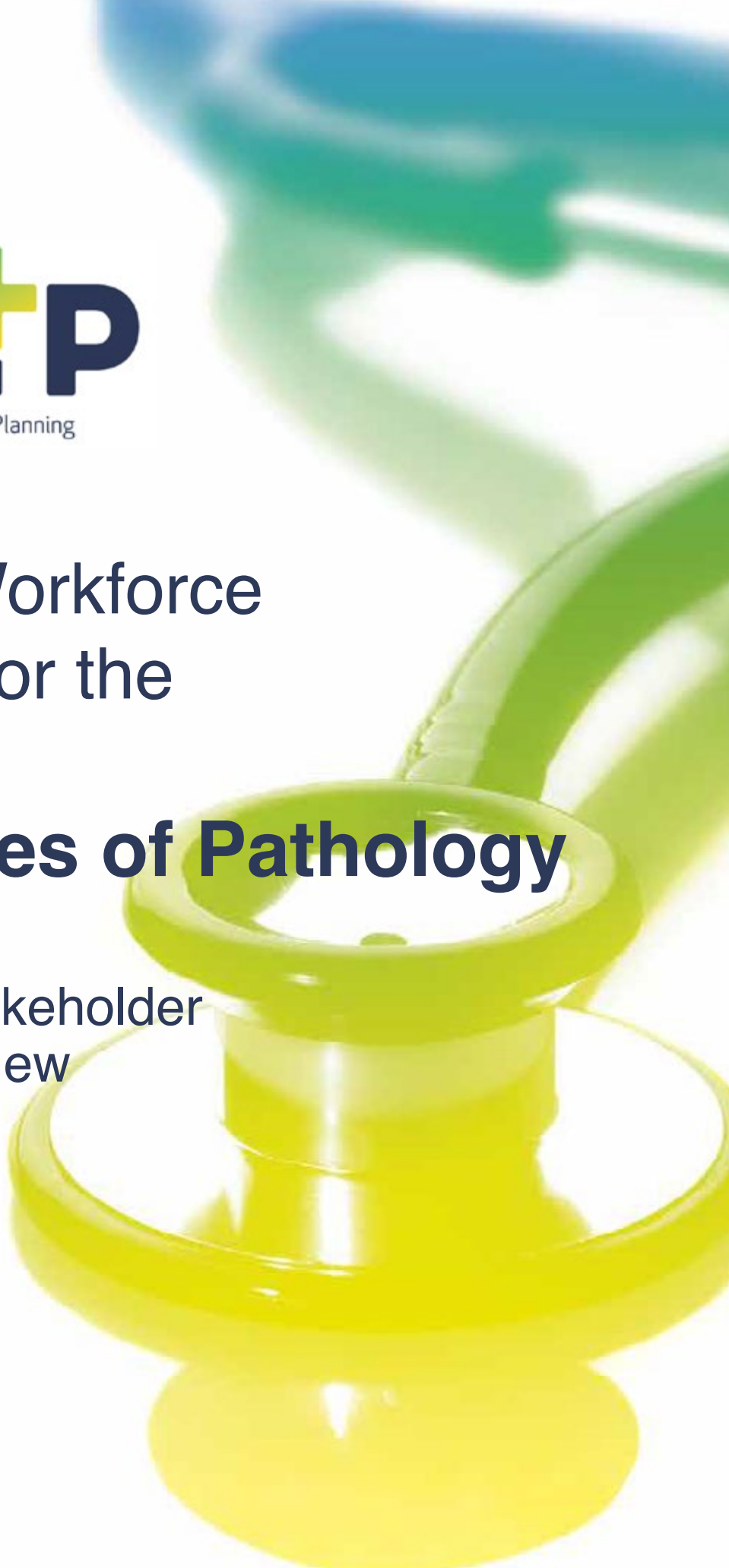
National Doctors Training & Planning

Medical Workforce Planning for the

Specialties of Pathology

An Expert Stakeholder Informed Review

2023



"Investing in the career development of doctors"

Contributors

Chemical Pathology: Dr Rama Srinivasan

Haematology: Dr Liam Smyth, Dr Oonagh Gilligan, Dr Clodagh Keohane, Dr John Quinn, Dr Margaret Murray, Dr Joan Power

Histopatholopgy: Dr Niall Swan, Dr Niamh Nolan

Immunology: Prof Mary Keogan

Microbiology: Dr Maeve Doyle, Prof Brieda Boyle, Dr Deirbhile Keady

Neuropathology: Dr Niamh Bermingham

NDTP: Tom Pierse, Roisin Morris, Eddie Staddon, Leah O'Toole, Prof Brian Kinirons

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EXECUTIVE SUMMARY

• This report is a collaboration between the National Clinical Programme for Pathology, the Faculty of Pathology and HSE National Doctors Training and Planning (NDTP). The key objective of this report is to inform the Higher Specialist Training (HST) and Basic Specialist Training (BST) intakes for the specialties of pathology for 2023 to 2031.

• Pathology underpins every aspect of medicine, from diagnostic testing and monitoring of chronic diseases to blood transfusion services. Increased demand for consultant pathologists is being driven by demographic pressures increasing chronic diseases, and the increasing complexity of many of the tests and treatments being carried out by pathologists.

• Pathologists are the specialists who diagnose all types of cancers and manage infection control for cancer patients, they are involved in diagnosing infectious diseases, play an important role in diagnosing and monitoring diseases such as diabetes and rheumatoid arthritis and play an integral role in blood transfusion services.

• Current shortages in consultant pathologists are resulting in a large number of consultants working onerous on call rotas, with some sites not having optimum consultant cover, and long outpatient waiting lists in some specialties.

• In Ireland, pathology has six specialties, each with a dedicated training programme as follows: chemical pathology, clinical microbiology, haematology, histopathology, immunology and neuropathology.

• Separate supply-demand models were constructed for each speciality. Demand projections include both current unmet demand and projected growth in demand.

• There are currently 292 Whole Time Equivalent (WTE) consultant pathologists working in Ireland (March, 2021, public and private sectors). The report outlines a current unmet demand for an additional 173.6 WTE consultants, a large proportion of these are in microbiology and haematology. Demand for consultants is projected to increase at a rate of 2.7% per year to 2035 requiring an additional 191 WTE.

• The report recommends increasing the intake number of HST trainees from 23 in 2022 to 70 in 2028. With the exception of Haematology there are very limited non-training posts that can be converted into training posts to accommodate the expansion in pathology trainees.

• The HST intake recommendations in the report are set to either meet the projected demand or to the highest feasible level that is anticipated can be trained. The proposed increases in HST intake are projected to increase the number of consultants to 451 by 2035. This does not fully meet the projected demand by 2035, additional time will be required to fully bridge the gap between supply and demand.

• Constraints to increasing the pathology medical workforce, such as the availability of buildings, funding for additional training and consultant posts are not considered in the report. The broader scientific and administrative staffing of the pathology services are also not considered here.

• In addition to annual implementation reviews the projections outlined in this report will need to be revisited in 5 years.

1. INTRODUCTION

Overview of Medical Workforce Planning Within NDTP

The HSE National Doctors Training and Planning (NDTP) Unit operates within the Office of the Chief Clinical Officer and has statutory roles in medical education and training, medical workforce planning, and the consultant post approval process.

Within its Medical Workforce Planning (MWP) remit, NDTP is tasked with proposing the annual intake number of post-graduate trainees required for each medical specialty. In order to do this NDTP works with specialty stakeholders including National Clinical Programmes, Postgraduate Training Bodies and others to estimate the demand for consultants and specialists across the Irish healthcare system, both public and private. In this way, a population health approach is taken to MWP. This information then feeds into the medical education and training role of NDTP via the commissioning of medical training required to meet workforce needs, ensuring that the training content and delivery is responsive to the changing needs of the Irish healthcare system, and supporting the retention of doctors upon completion of their training.

The approach taken to MWP is broadly based on the following principles as per existing Government policies:

- MWP should be aligned with Government policy e.g. Sláintecare (2017), the Health Service Capacity Review (2018), and the Smaller Hospitals Framework (2013).
- More patient care should be consultant-delivered and there should be a reversal in the ratio of Non-Consultant Hospital Doctors (NCHDs) to consultants/ specialists.
- The Irish health service should be self-sufficient in the production of medical graduates, with reduced dependence on International Medical Graduates.
- MWP recommendations should be consistent with the WHO Global Code on the International Recruitment of Healthcare Personnel (World Health Organisation, 2010, 2011).
- MWP recommendations should encompass medical workforce requirements for the entire population to include both the public and private healthcare systems.
- MWP recommendations should incorporate future health needs of the population. MWP recommendations should include the incorporation of projections relating to, for example, demographic changes; alterations in disease incidence and prevalence; models of clinical care; medical and therapeutic innovations; policy initiatives and technological advances.
- Trainee numbers for each specialty should be based on MWP projections for that specialty.
- Training capacity should match the recommended training numbers. Where recommendations are made to increase the intake of trainees into a particular specialty, additional training posts may be required.
- Where appropriate, innovative models of care should be explored, for example new team structures, new medical roles, skills transfer and task sharing.

It is important to note that workforce planning is an inexact science and estimated demand and supply requirements are based on the best available data, expert opinion as well as the policy context.

Objectives and Scope

This report is a collaboration between National Clinical Programme for Pathology and HSE National Doctors Training and Planning (NDTP). The key objective of this report is to inform the Higher Specialist Training (HST) intake for pathology and to provide guidance on the Basic Specialist Training (BST) intake requirements for Histopathology. The report also seeks to demonstrate the demand for consultants in the medium term and pathways to reducing reliance on Non-Training Scheme Doctors (NTSD) in Haematology, the only specialty of pathology with a substantial number of NTSDs.

Constraints to increasing the pathology medical workforce, such as the availability of buildings, funding for additional training and consultant posts, are not considered in the report. The broader scientific and administrative staffing of the pathology services are also beyond the scope of the report.

Identifying the need for post-CSCST training in highly specialised areas within each specialty is beyond the scope of this report. Further work is required to assess the training requirements for highly specialised areas within each specialty. This report does not examine the supply and demand for scientific laboratory workforce; a review of the scientific laboratory workforce is currently being carried out by the National Working Group to Inform the Strategic Direction of Laboratory Medicine.

Overview of Pathology

Pathology is the study of the nature and causes of diseases. It underpins every aspect of medicine, from diagnostic testing and monitoring of chronic diseases to blood transfusion services. The increasing prevalence of chronic diseases among an aging population is a key driver of demand for pathology services. Pathologists are the specialists who diagnose all types of cancers and manage infection control for cancer patients, they are involved in diagnosing infectious diseases, play an important role in diagnosing and monitoring diseases such as diabetes and rheumatoid arthritis and play an integral role in blood transfusion services. Increasingly pathologists use genetics and genomic testing in diagnosing disease [40]. Having an adequately staffed pathology service is a key element in the implementation of Slaintecare with a significant proportion of the laboratory workload sourced directly from community services in some specialties.

In Ireland, pathology has six specialties, each with a dedicated training programme.

- Chemical Pathology
- Clinical Microbiology
- Haematology
- Histopathology
- Neuropathology
- Immunology

Consultant pathologists provide a wide range of services within the health system. Robboy, Gupta [1] provide a taxonomy of services provided by pathologists with three broad categories: "one patient at a time" services, population services and professional responsibilities. This taxonomy is useful for thinking about how demand for the service may increase over time.

One patient at a time services include: direct specimen preparation, analysis and reporting, inpatient and outpatient consultations, laboratory consultations for complex sets of results, genomic pathology and autopsies. A key function of consultant pathologists is the direct interpretation of complex diagnostic tests. In line with the international experience [2, 3], both the volume of laboratory testing and the complexity of interpreting the results have been increasing for all specialties. Demand for pathology services can be driven by initiatives to improve service provision in other parts of the health service, for example cancer care programmes, initiatives in surgical specialties to clear waiting lists and through screening programmes. These initiatives frequently have knock on implications for the demand for pathology services. Additionally, investment in pathology services can create efficiencies in other parts of the health service. For example, in the UK, supporting GP access to calprotectin measurement resulted in a 40% reduction in hospital gastroenterology referrals and a 21% reduction in colonoscopies. Hence strategic investment in pathology can significantly reduce healthcare costs and waiting lists in other areas [4].

Pathologists provide direct patient care in haematology, immunology, microbiology and chemical pathology. Outpatient clinics

are a substantial proportion of a consultant's workload in Haematology and Immunology. Antimicrobial stewardship to optimise individual patient management, as well as infection prevention and control to minimise the risk of healthcare acquired infection are key roles of consultant microbiologists.

Histopathology and neuropathology also provide autopsy services. Most of the autopsies ordered by the coroner are conducted by hospital histopathologists as independent work outside of their HSE contracts [5]. In regional hospitals, the provision of autopsies comprises a large minority of the histopathologist's workload.

Population services include the direction of laboratory services and public health services. The governance of laboratory services is an important component of workload for all specialties of pathology. Pathologists provide public health services both within hospitals and in the community. For example, Infection Prevention and Control (IPC) comprises a large component of the hospital workload for consultant microbiologists. Consultant microbiologists also provide clinical governance for Public Health Food and Water laboratories. A key constraint on the Irish publicly funded health service is the physical infrastructure to provide care. There are increasing demands for input into the upgrading, expansion and building of healthcare facilities – requiring early involvement by consultant pathologists to ensure design is compliant with national/international standards.

Professional responsibilities include teaching, audit and quality improvement, research and professional body related workload. The National Cancer Strategy notes that "The positive impact of research activity, including clinical trials, on the care of patients is evident". Optimal cancer care should be closely integrated with a cancer research programme, including clinical trials. In 2014, c.3% of cancer patients were enrolled in a clinical trial, a modest aim of the cancer strategy was to increase this to 6% [6].

In some disciplines, such as surgery, waiting lists can be used as a metric to gauge the imbalance between the supply and demand for a specialty's services. However for pathology, with the exception of outpatient clinics in some specialties, this is not the case. Proxies can be used to infer unattractive posts and posts with an unsustainable workload, such as unsustainable rotas and posts vacant for extended periods. Other potential indicators of excess demand include turn-around-times, and the duration of service of post retirement locums.

Onerous on call rotas for consultants are noted in a number of sites, specialties and subspecialties. 1 in 1 to 1 in 4 rotas are noted in a number of departments. This can result in consultants working continuous days over an extended period and broken sleep patterns. Onerous on call rotas are particularly the case in departments within microbiology, immunology, neuropathology and haematology. The extent to which on call services are used is likely to vary by site due to variations in the services provided and policies [7]. Onerous on call rotas are likely to have a range of negative impacts on the health system including early retirements, exacerbating staffing issues, increased difficulty in recruiting new trainees, and potentially having a negative impact on patient safety.

More generally, shortages in pathologists are likely to lead to a wide range of negative impacts on the health services such as delayed diagnosis, unnecessary spread of infectious diseases and delayed discharges in hospitals [40].

Pathology teams typically consist of consultants, NCHDs, medical scientists, medical laboratory aides and clerical staff. Many pathology services are provided on a 24/7 basis. The focus of this report is on consultant and NCHDs in pathology as the report is aimed at informing training numbers. For most of the specialities of pathology consultant delivered care is the norm [8]. This means that important clinical decisions can be made faster and at a more senior level. Haematology is the exception with a substantial reliance on non-training scheme doctors.

International Approaches to Workforce Planning in Pathology

A range of approaches have been used internationally to model the supply and demand for doctors [9]. However, there are a limited number of international examples of published workforce planning models for the discipline of pathology and its specialties. One US based study used a range of factors to drive the change in demand incuding: tissue biopsy diagnoses, and complete blood cell counts by age, gender; cancer incidence by age and gender; and changes in accreditation standards [1]. One Austrailian study used the growth in billed services for each specialty as the growth driver (RCPA, 2018). A number of reports view changing population demographics as the key driver of changes in demand for pathology services [10, 11]. A supplementary approach that

has been used in the literature is to compare the relative availability of other doctors. For example – the number of pathologists is compared with the number of radiation oncologist over time as a surrogate for cancer diagnostic burden [2]. In the UK, a tool has been developed to estimate the workload of histopathology, cytopathology and neuropathology departments [12].This tool is based on a points system for specimens of various complexity. However, due to the differences in the functions performed by pathologists between the two juristictions this tool is not applicable to Ireland.

International Comparisons

In determining the appropriate demand for pathology consultants and specialists in Ireland, one approach is to look at how Ireland compares with other countries. There are a range of reasons why it is difficult to make meaningful comparisons across countries. For example: autopsy is not the duty of pathology in all countries; in some countries pathology does not include microbiology or clinical biochemistry; differences in the extent of screening programmes; and differences in service delivery models [13]. There are significant differences between countries in relation to other professional and support staff involved in providing services, advanced scientific practice, IT infrastructure to support effective communication, digital pathology and accreditation requirements. In specialties with a significant clinical component, the development of specialised nursing and advanced nursing practice will also impact significantly. In addition, the extent to which the available data cover both the public and private sectors is not always clear. There is also a global shortage of pathologists in many specialties, and numbers of pathologists in posts fail to take account of vacancies, impacted by global recruitment difficulties.

NDTP has reviewed the workforce composition in a number of countries with available data: UK, New Zealand and Canada. This data, shown in table 1.1, indicates that the overall number of consultant pathologists in Ireland is in line with these countries. The smaller specialties of chemical pathology and immunology are substantially below these comparator countries while the other specialties are in line.

Table 3.1. International Ratio Comparison of Consultant Pathologists

	Ireland		UK		New Zeland		Canada	
	5.1million		67.4 million		4.7 million		38.0 million	
	Number[1,2]	Ratio	Number[1,2]	Ratio	Number[1,2]	Ratio	Number[1,2]	Ratio
Chemical Pathology	14	0.27	412	0.61	18	0.38	96	0.25
Haematology	82	1.60	1132	1.68	70	1.47	659	1.73
Histopathology	134	2.62	1495	2.22	164	3.44	1,401	3.68
Immunology	6	0.12	191	0.28	7	0.15	242	0.64
Microbiology	67	1.31	830	1.23	29	0.61	303	0.80
Neuropathology	6	0.12	55	0.08			49	0.13
Total	309	6.03	4106	6.10	288	6.04	2,750	7.23

Data sources: UK: RCPath survey 2021 [14]; NZ: New Zealand Pathologists Workforce Study 2018 [15]; Canada: Scott's Medical Data Base 2021. Notes: 1 public and private, 2 Headcount.

Workforce shortages in pathology have been reported in a range of countries including the US, UK, Australia and Germany [13, 16-18]. The UK is currently experiencing staffing shortages and recruitment difficulties in pathology [17, 19-21]. There has been significant consolidation of laboratory services in a number of countries including the UK and Germany [22]. In the UK, this has resulted in some reductions in the cost of pathology services [22].

The growth in demand for pathology services in Ireland outlined in this report is mirrored in other countries. In the UK, histopathology requests to laboratories have increased by around 4.5% on average year on year since 2007 [19]. Also in the UK, 20-30% increases in the last decade have been reported for requests for full blood counts, investigation of anaemia, bone marrow aspirates and trephine biopsies. In additon, a doubling of immunophenotyping requests and a significant increase in requests for molecular diagnostic tests have been recorded [20].

2. Methods

Data Used

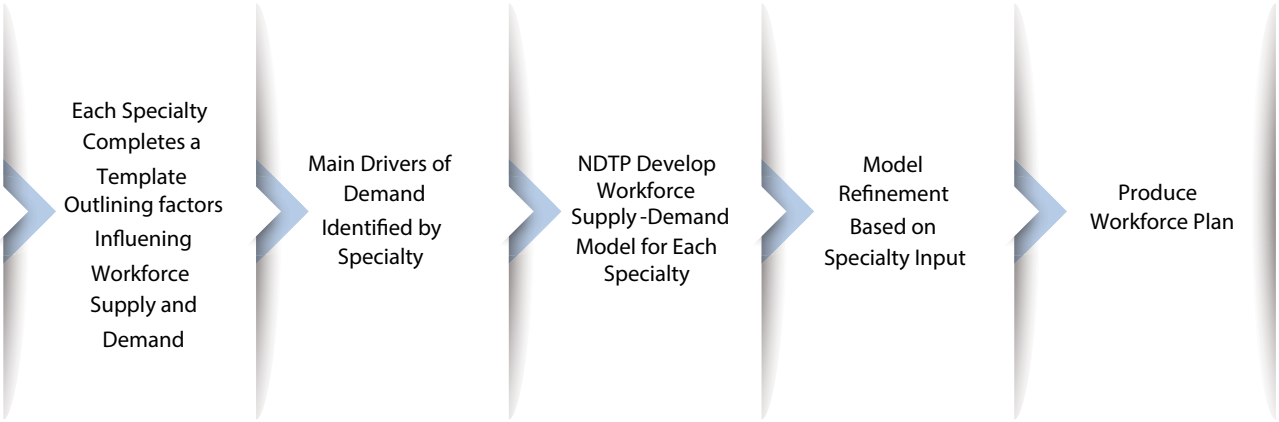
The data utilised in the analysis of the medical workforce in each speciality are drawn from multiple sources. For the purpose of this report, the Doctors Integrated Management E-System (DIME) is the main source of data in establishing the baseline medical workforce statistics in conjunction with data from the training bodies. DIME workforce data was accessed in March 2022. Data on the number of trainees and CSCSTs qualified in 2020 and 2021 were sourced from the Post Graduate Training Body.

Collaborative Approach

Figure 2.1 below outlines the process through which the workforce plans for each specialty were developed. This process involved active engagement between NDTP and the representatives of each specialty of pathology to develop a workforce plan. Specialty representatives, provided contextual information of their specialty, identified demand drivers and current unmet demand and identified the level of trainee intake that was achievable to meet projected demand. NDTP generated supply-demand models for each specialty, provided data and assumptions on the stocks and flows of trainees and consultants, and assisted and coordinated the writing of the report using the information provided by each specialty.

The approach to medical workforce planning for pathology is based on the methodological framework 'NDTP Health Workforce Planning, Ireland: A Simple Stepwise Approach' (HSE NDTP, 2016). Typically, this methodology is applied to a medical specialty to determine the future medical workforce needs of the country's health system.

Figure 2.1. Process of engagement between NDTP and each Specialty

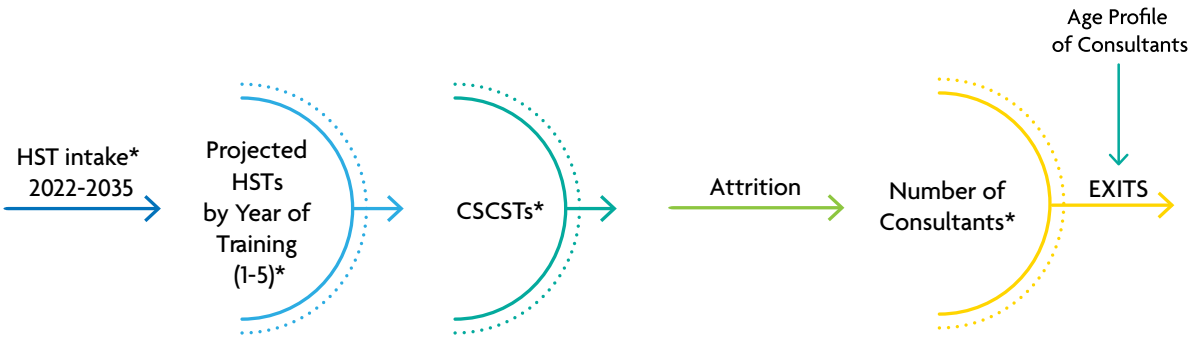


Supply-demand Model

A model was developed for each specialty comprising of supply and demand modules. The workforce was modelled from 2022 to 2035. This time frame was used in line with international best practice [23] and other workforce planning models for Ireland [24]. The chosen time frame is important, particularly in specialties where there is a large gap between current supply and current demand. Due to the long time frame between entering HST and taking up a consultant post, large increases in the HST intake will only impact on consultant numbers in the later years of the model.

As the main focus of the report is on informing the HST intake, a national approach to workforce planning is primarily taken. A stock-flow model with a standardised structure for all specialties, was used to project the number of training-scheme NCHDs and consultants over the time period. An overview of the supply model is shown in Figure 2.2. Most specialties of pathology do not have a specific BST programme. Histopathology and neuropathology are the exception with a common two year programme which is included in the modelling for those specialties.

Figure 2.2. Supply Model Diagram



* All by Gender
Adjust HST intake to align supply and demand by 2035

Model parameters for the supply model were derived from internal NDTP research, current values and expert opinion. Table A1 in the Appendix outlines the key parameter values and sources for the supply module.

Modelling Demand

A two-step process was used to generate demand estimates for the projection period. The first step is to estimate the current un-met demand. This is achieved in different ways for each specialty, for example in haematology it is based on a survey of sites while in microbiology it is based on a hospital bed staffing ratio. Section 6 outlines the approach used to estimate current unmet demand for each specialty.

The second step is to estimate the growth in demand over the projection period. To generate a projection of the required consultant workforce requires identifying a small number of the most important drivers of change in demand over time. These drivers were identified by each specialty. Section 5 outlines the metrics used to project demand for each specialty.

There are no current models of care for the specialties of pathology. However, there are older models of care or more recent broader strategies that relate to the specialties of pathology. A model of care for neuropathology was prepared in 2014 however significant changes in neuropathology have taken place since that time, which are impacting on neuropathology staffing requirements. Similarly a service delivery model for immunology was outlined in a Comhairle na nOspideal report on immunology in 2001, however there have been substantial changes in the speciality since that time.

The projected demand for consultants needs to fit within broader strategy frameworks such as the National Cancer Strategy, NCCP Guidance on the Management of Acute Capacity Challenges in Systemic Anti-Cancer Therapy Ambulatory Day Units, NCCP SACT Model of Care, NCCP AYA Cancer services.

3. The Configuration of Pathology in the Irish Health Service

Overview of Specialties in Ireland

Consultants in the discipline of pathology are required to be registered as a specialist in the Specialist Division of the Register of Medical Practitioners maintained by the Medical Council in Ireland in one of six specialties. Each of these specialties have areas of Special Interest. Areas of Special Interest typically require one or two years of certified postgraduate training.

In addition, in many areas consultants are further specialised, for example by organ or disease. While there are six specialties and a small number of recognised Special Interest areas within each specialty, there are a wide range of areas of further specialisation as outlined below. These areas of further specialisation are not currently considered in the CAAC approval system and are beyond the scope of this report.

Some pathologists in all specialties are also academics and work in university teaching and research roles simultaneously.

Chemical Pathology

Chemical Pathology involves the biochemical investigation of bodily fluids such as blood, urine and cerebrospinal fluid. Chemical Pathologists are medically trained consultants who supervise and manage the provision of clinical biochemistry services. Consultant Chemical Pathologists (CCP) are trained in the clinical management of patients with metabolic disorders such as obesity, dyslipidaemia, diabetes, osteoporosis, fluid, electrolyte and nutritional disturbances and endocrine disorders such as thyroid disease. These services are generally delivered on an outpatient basis either in partnership with other medical consultants or in dedicated specialist metabolic clinics operated by the CCP. Other clinically-related activities undertaken by CCP include participation in both adult and paediatric multidisciplinary team (MDT) meetings, the organisation of National Newborn Screening Programme, involvement in the National Bowel Screening Programme, and coordinating investigative outpatient procedures such as dynamic function testing in endocrinology.

Special interest areas: paediatric chemical pathology .

Further specialisation: metabolic bone disease, inherited metabolic disease, screening programmes (newborn, bowel), porphyria, toxicology, lipidology.

> *The focus of this report is on consultant chemical pathologists and trainees. Consultant chemical pathologists are medically qualified doctors on the specialist register of the Irish Medical Council. Clinical Biochemist are involved in the oversight of a small number of clinical biochemistry labs in Ireland. Biochemists are qualified scientists and have no medical qualifications. A review of the scientific laboratory workforce is currently being carried out by the National Working Group to Inform the Strategic Direction of Laboratory Medicine.*

Haematology

Haematology is the specialty responsible for the diagnosis and management of a wide range of benign and malignant disorders of red and white blood cells, platelets and the coagulation system in adults and children. Haematologists specialise in both haemotopathology (including Transfusion medicine) and the clinical care of patients with blood related disorders.

Special interest areas: paediatric haematology and transfusion medicine

Further specialisation: malignant haematology, benign haematology, haemoglobinopathy, haemostasis and thrombosis services, obstetric haematology, bone marrow transplantation and cellular therapies.

Histopathology

Histopathology involves the examination of tissue specimens which have been removed from a patient in a clinic or during an operation / procedure, to discover if disease is present (diagnosis) and what course of action should be taken. Diagnostic histopathology involves making diagnoses based on the microscopic examination of tissues removed during various operative interventions and procedures such as endoscopy, biopsy or resections. Cytopathology involves examining cells from bodily tissues or fluids to determine a diagnosis. A common application of cytopathology is the "smear test" (gynaecological cytopathology), used to detect precancerous cervical lesions and prevent cervical cancer. Autopsy, determining how someone has died, is another component of a histopathologists' role.

Special interest areas: paediatric pathology, cytology, ocular pathology, oral pathology, perinatal pathology.

Further specialisation: non gynaecological cytology, gynaecological cytology (currently outsourced to the US with a very small amount being performed in National Cervical Screening Laboratory), head and neck pathology, breast pathology, gastrointestinal pathology, genitourinary pathology, gynaecological pathology, dermatopathology, renal pathology, liver pathology, cardiothoracic pathology, haematopathology, soft tissue and bone pathology, forensic pathology, autopsy pathology.

Immunology

Immunology is a combined clinical and laboratory discipline. In adult services, clinical immunologists are trained to both direct a laboratory, including direct analysis of specimens, and to manage patients with immunological disorders. Core clinical services are primarily for patients with allergic disorders, and patients with primary, and increasingly, cases of secondary immune deficiency. Patients with severe, complex or difficult to treat autoimmune diseases are also seen on a tertiary care basis. In addition to these core large patient cohorts, individual immunology services may be the lead provider of specialist care for patients with vasculitis, other complex autoimmune diseases, or neuro immunology.

Special Interest areas: transplant immunology

Further specialisation: immunodeficiency, allergy, autoimmunity.

Microbiology

Clinical microbiology is a broad specialty encompassing laboratory, clinical and research aspects of infection, from 'diagnosis through to bedside'. It encompasses three main areas of expertise: clinical laboratory management, Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS). Clinical microbiology workload includes patient result authorisation, clinical liaison, attendance at MDTs and ward rounds and direct patient review as well as involvement with testing algorithms and laboratory accreditation. IPC may be considered as "reactive" – dealing with outbreaks and prioritising scarce resources (e.g. isolation facilities) to minimise patient risk and "proactive" which involves clinical surveillance and feedback; Quality Improvement (QI) projects; managing risk of infection from environmental factors including water quality, healthcare ventilation and hospital infrastructure and design; attendance at various hospital committees. Antimicrobial Stewardship (AMS) is essential for both individual patient management as well as minimising antimicrobial selection pressure at institutional level, while trying to maintain cost efficiencies.

Microbiologists continually react and pivot in response to the ever evolving events from increasingly antimicrobial resistant bacteria, including tuberculosis (TB), emerging viruses, e.g. COVID-19, Monkeypox and other pathogens e.g. Candida auris. Molecular diagnostics have revolutionised laboratory practice in recent years and advances in Whole Genome Sequencing (WGS) are clarifying potential routes of transmission with real time impact on prevention of Health Care Associated Infections (HCAI).

Special Interest areas: Virology

Neuropathology

Neuropathology is a cellular pathology discipline centred around the diagnosis of diseases of the nervous system – brain, spine, skeletal muscle and nerves. Ophthalmic biopsies are also reported in many departments of Neuropathology. Diagnostic neuropathology is a recognized distinct specialty; in the past, it was a subspecialty of histopathology but is now recognized as a separate discipline in most countries, requiring dedicated practitioners and training.

In addition to reporting neurosurgical specimens, neuropathologists also undertake post-mortem examinations in the form of whole-body autopsies and specialist examination of post-mortem brains, spinal cords, nerve and muscle. While the majority of neurosurgical biopsies are performed for tumours of the Central Nervous System (CNS), biopsies are also undertaken for neurologists and infectious diseases specialists as a part of the investigation of non-neoplastic CNS disease. Because of the small number of practitioners in Ireland, each Neuropathologist has to report a wide range of specimens and sub-specialisation is limited.

Neuropathology is becoming increasingly dependent on molecular information for tumour diagnostic classification. The specialty will require the newer appointees to have expertise in this area to ensure that the service continues to provide appropriate, accurate and meaningful information to the treating clinicians so that patient outcomes are optimized.

Special interest areas: none

Further specialisation: adult neuro-oncology, paediatric neuro-oncology, neuromuscular pathology (adult and paediatric), perinatal neuropathology, adult and paediatric non-neoplastic surgical pathology and autopsy pathology (including forensic neuropathology and investigation of neurodegenerative disease).

Training to be a Pathologist in Ireland

Basic Specialist Training (BST) is the first step towards specialisation in medicine. It is a hospital-based training programme completed in Senior House Officer (SHO) posts. BST usually takes two years. For chemical pathology, haematology, immunology and Microbiology BST is typically completed in general internal medicine. Rotations into pathology for general medicine BSTs is an important mechanism for introducing the discipline to trainees. In 2020-2021, 28% of BSTs in general medicine did a rotation in haematology and 1.2% in immunology. Historically, c.3% of trainees on BST general medicine did a Clinical Microbiology rotation. In 2021 there were 272 doctors who commenced their BST in General Medicine, for the same year the intake into HSTs in chemical pathology, haematology, immunology and microbiology was 21. Thus, the intake into Higher Specialist Training (HST) in pathology from general medicine represents a small proportion of the trainees from that programme. Histopathology and neuropathology differs in that a BST in histopathology is required for entry into HST.

HST in pathology involves four or five years of training. The Royal College of Physicians in Ireland conduct HST programmes for all the specialities in pathology. In addition to supervised training in the hospital the attendance of courses and study days are mandatory in order to acquire the non-clinical skills and general medical professional knowledge necessary. HST neuropathology trainees typically train for 1 to 2 years in histopathology followed by three years in neuropathology. Alternatively, histopathology trainees can specialise in neuropathology though post-CSCST training. Historically, microbiology and histopathology are amongst the highest users of Flexible Training places; a consideration for the duration between starting HST and completing CSCST [25].

Following satisfactory completion of training, the Certificate of Satisfactory Completion of Specialist Training (CSCST) is awarded. Once a CSCST is received, which allows for entry into the Specialist Division of the Medical Council Register, the successful trainee can apply for a consultant post.

There are currently 4 post-CSCST fellowships funded annually in pathology, with the 2022 intake in the areas of haematology, histopathology and microbiology. The benefits of these post-CSCST fellowships is that trainees get the opportunity to train in areas of special interest where there are skills shortages. In addition to the benefit to trainees, these posts are of critical importance to the health system, providing an agile system to train future consultants in areas of need.

Laboratory Configuration

Accreditation Status of Laboratories

The number of laboratories is an important consideration as accrediting each laboratory will require consultant pathologist oversight and governance. Table 3.1 and 3.2 below list the Irish National Accreditation Board (INAB) accreditation status of Irish pathology labs in the public, voluntary and private sectors.

Table 3.1. Laboratory Accreditation Status (Public and Voluntary Sector)

Clinical Site	Chemical Pathology	Haematology	Blood Transfusion	Histopathology	Immunology	Microbiology	Neuropathology
Model 4							
Beaumount Hospital	Yes	Yes	Yes	Yes	Yes	Yes	Yes
St James Hospital	Yes	Yes	Yes	Yes	Yes	Yes	
St Vincents University Hospital	Yes	Yes	Yes	Yes	Yes	Yes	
Tallaght University Hospital	Yes	Yes	Yes	Yes		Yes	
University Hospital Galway	Yes	Yes	Yes	Yes	Yes	Yes	
Cork University Hospital	Yes	Yes	Yes	Yes		Yes	Yes
Mater Misericordiae University Hospital	Yes	Yes	Yes	Yes	Yes	Yes	
University Hospital Limerick		Yes	Yes	No		Yes	
University Hospital Waterford	Yes	Yes	Yes	No		Yes	
Model 3							
Connolly Hospital		No	Yes	Yes		Yes	
Letterkenny General Hospital	Yes	Yes	Yes	Yes		Yes	
Mercy University Hospital	Yes	Yes	Yes			Yes	
Midlands Regional Hospital, Tullamore	Yes	Yes	Yes	Yes		Yes	
Our Lady of Lourdes Hospital, Drogheda		Yes	Yes	Yes		Yes	
Sligo University Hospital	No	No	Yes	No		Yes	
Cavan General Hospital	Yes	Yes	Yes	Yes		Yes	
Mayo University Hospital	No-planned		Yes	No		No-planned	
Portiuncula Hospital, Ballinasloe	No-planned		Yes	Yes		No-planned	
Naas General Hospital	Yes	Yes	Yes			Yes	
University Hospital Kerry	Yes	Yes	Yes			No	
Wexford General Hospital			Yes				
Our Lady's Hospital Navan	Yes	Yes	Yes			Yes	
Regional Hospital Mullingar	Yes	Yes	Yes			Yes	
Midland Regional Hospital Portlaoise		Yes	Yes				
Tipperary University Hospital (TippUH)			Yes				
Model 2 & Specialist							
Roscommon University Hospital	No	Yes	Yes				
Children's Health Ireland at Temple St- Specialist Paediatric Hospitals	Yes	Yes	Yes			Yes	
Children's Health Ireland at Crumlin	Yes	Yes	Yes	Yes		Yes	
Rotunda Hospital - Specialist Maternity	Yes	Yes	Yes	Yes		Yes	
The National Maternity Hospital- Specialist Maternity	Yes	Yes	Yes	Yes		Yes	

St Luke's, Rathgar - Specialist Oncology/Radiotherapy	Yes	Yes	Yes				
Irish Blood Transfusion Service - Dublin		Yes*	Yes*			Yes	
Irish Blood Transfusion Service - Cork		Yes*	Yes*				
Public Health Laboratory						Yes	
Bantry General Hospital			Yes				
National Orthopaedic Hospital	Yes	Yes	Yes			Yes	
Mallow General Hospital			Yes				
National Viral Reference Laboratory						Yes	
Portiuncula Hospital			Yes				
St Michael's Hospital	No	No					
St Columcille's Hospital	No	No					
Ennis General Hospital	No	No					
Nenagh General Hospital	No	No					

Notes: YES denotes INAB accreditation in place; No-Planned, denotes INAB accreditation not in place, but with planned inspection to achieve accreditation in the future; No denotes Accreditation not in place, with no planned inspection to achieve accreditation in the future. Yes* denotes accredited as Blood Establishments by the HPRA, the principal regulatory authority. In addition IBTS has begun additional accreditation to ISO 15189 (INAB). The immunehaematology laboratory at Dublin recently achieved INAB accredited.

Table 3.2. Laboratory INAB ISO 15189 Accreditation Status (Private Sector)

Principle Clinical Site	Chemical Pathology	Haematology	Blood Transfusion	Histo pathology	Immunology	Micro biology
Beacon Hospital	Yes	Yes	Yes	Yes		Yes
Blackrock Clinic	Yes	Yes	Yes	Yes		Yes
Bon Secours Hospital Cork	Yes	Yes	Yes			Yes
Bon Secours Hospital Dublin	Yes	Yes	Yes	Yes		Yes
Bon Secours Hospital Galway			Yes			
Bon Secours Hospital Tralee			Yes	Yes		Yes
GoSafe48						Yes
LetsGetChecked Labs	Yes					Yes
Galway Clinic			Yes			
Enfer Medical Ltd						Yes
Complete Laboratory Solutions						Yes
Eurofins Biomnis	Yes	Yes		Yes		Yes
Mater Private	Yes	Yes	Yes	Yes	Yes	Yes
Hermitage Medical Clinic		Yes	Yes			

Chemical Pathology

There are currently 25 public and 7 private chemical pathology laboratories. Some hospitals have a minor sessional commitment while others are covered on a remote basis. There is one private consultant covering public labs in UH Waterford, UH Kerry, Portiuncula UH, Mayo UH.

Haematology

There are currently 35 public and 10 private laboratories providing blood transfusion and/or haematology services around the country. The main Tissue Establishments Laboratories are in St James, University Hospital Galway, CHI Crumlin and St Vincent's University Hospital; with another services planned in Cork University Hospital. There is a HPRA licensed Tissue Establishment in Beaumont (Transplant Immunology).

ISO 15189 is mandated by statutory instrument for hospital transfusion laboratories (whereas it is an agreed but optional standard for other laboratories). To support this, there is a mandatory requirement for consultant haematologists to act as directors for transfusion laboratories and investigate haemovigilance incidents.

Histopathology

There are currently 22 public and 6 private laboratories providing histopathology services around the country with 14 of the public labs accredited by the Faculty of Pathology as training sites. Gynaecological cytology is currently outsourced to the US with a very small amount being performed in the Coombe. There is a plan to repatriate this work gradually over the coming years to the National Cervical Screening Laboratory based in the Coombe.

Immunology

Currently, there are 3 consultant directed Immunology units, providing clinical and laboratory services. These sites are Beaumont Hospital, St James Hospital and Galway University Hospital. Each site currently has 2 consultants. In addition, Beaumont Hospital provides laboratory and tertiary clinical advice in the area of solid organ transplant Immunology, through the National Histocompatibility and Immunogenetics Service for Solid Organ Transplantation (NHISSOT). NHISSOT also provides a Tissue Establishment, licensed by the HPRA, to provide banked vessels to support Living Donor Renal Transplantation. Immunology tests are provided by a number of other public hospital laboratories, some of which have sessional cover provided by a post retirement consultant, and some of which lack appropriate clinical governance, because of the current shortage of appropriately trained consultants.

Immunology tests are also provided by private laboratories, such as Biomnis and MedLab. In many cases the immunology tests are within scope of accreditation, and therefore some arrangements must be in place for clinical governance. A number of public hospitals which do not have immunology tests available on site outsource testing to these private laboratories. Clinical queries from laboratory users are often directed to the public consultant directed units.

Allergy services are provided by a number of private providers, however, none of these providers are directed by consultants with specialist registration in Immunology.

Microbiology

There are currently 31 public and 11 private labs providing microbiology services around the country.

Neuropathology

There are two neuropathology laboratories in Ireland located in Cork University Hospital and Beaumont Hospital Dublin. Both laboratories are accredited to ISO 15189 by the Irish National Accreditation Body (INAB). Clinical Neurosciences incorporate neurosurgery (adult and paediatric), neurology (adult and paediatric), neuropathology, neuroradiology and neurophysiology. A number of hospitals throughout Ireland have some of these disciplines onsite. However, Beaumont Hospital and Cork University serve as the neuropathology centres for the entire country; Beaumont provides neuropathology for approximately 2/3 of the country, while CUH provides neuropathology for 1/3. In many cases, this reflects the pattern of neurosurgery referrals, with the patients being referred to Cork University and Beaumont for their surgical procedures; however, it also means that the Neuropathology departments receive many specimens from outside hospitals.

At present, the majority of paediatric neuro-oncology is performed in Dublin and 2 Beaumont Neuropathologists have sessional commitments to CHI (one of whom is a recent appointment and is not yet in post). Since paediatric-type tumours may continue to present into young adulthood, all neuropathologists in Ireland will report these tumours.

4. Medical Workforce

Consultant Workforce

Characteristics of Consultant Workforce

Table 4.1 shows descriptive statistics for the current public consultant workforce (March 2022) as recorded on DIME (headcounts differ from table 1.1 as public sector only).

Specialty	HC	WTE	WTE Rate	Female	Over 55 Years	Fulltime	Permanent	Temporary	Locum	Agency	General Register
Chemical Pathology	12	11.5	0.96	41%	42%	91%	83%	17%	0%	0%	0%
Haematology	80	75.7	0.95	53%	40%	90%	93%	6%	0%	0%	1%
Histopathology	122	115.8	0.92	54%	38%	90%	91%	6%	2%	1%	1%
Immunology	6	6.0	1.0	50%	50%	83%	100%	0%	0%	0%	0%
Microbiology	63	58.3	0.93	71%	33%	89%	90%	5%	5%	0%	0%
Neuropathology	6	6.0	1.0	50%	33%	83%	100%	0%	0%	0%	0%

The Number of Specialists Working Exclusively in the Private Sector

Table 4.2 shows the number of consultants identified as working only in the private sector on the medical council register. Consultants who work partially in the public and private sectors are included in the DIME data above. This data has not been validated by NDTP, the data may include consultants who are not currently practicing in Ireland.

Table 4.2. Private only Consultants (Irish Medical Council)

Specialty	Private Only
Chemical Pathology	2
Haematology	3
Histopathology	12
Immunology	0
Microbiology	4
Neuropathology	1*
Total	21

Vacant Posts

There were 49 vacant pathology posts on DIME in March 2022, 28 of these posts had been vacant for less than 12 months with the remaining 21 had been vacant for over a year. The latter highlights the difficulty in recruiting suitably qualified consultants in some specialties and sites.

Table 4.3. Vacant Posts

Specialty	Post Vacant <12 Months	Post Vacant >12 Months	Total
Chemical Pathology (inc. Biochemistry)	0	1	1
Haematology	9	1	10
Histopathology	8	8	16
Immunology	1	3	4
Microbiology	10	7	17
Neuropathology	0	1	1
Total	28	21	49

A vacant post is a post that has been approved by the CAAC committee but is currently unfilled. The vacancy figures shown include a combination of vacant posts that have previously been filled and have now become vacant, and posts that have never been filled. Recruitment may be underway or an appointment may have been made to a number of these vacancies with a prospective start date. There is often a significant period of time between approval of a consultant post through the CAAC process to the commencement of the recruitment process and ultimately the recruitment of a Consultant to a post.

NCHD Workforce

The Number of NCHDs Working in Publicly Funded Services

The distribution of Histopathology BST and Pathology HST trainees for the 2021/2022 training year are presented in Table 4.4. The figures incorporate a small number of trainees who are repeating a year of training for various reasons e.g. remediation/ completing examination requirements. Overall there are only a small number of non-training scheme doctors (NTSD) employed in most specialties of pathology, also shown in table 4.4. Haematology is the exception.

While most NCHDs will contribute to the clinical service on Saturday (+/- Sunday mornings), the training scheme for NCHDs in Ireland does not provide for a 24/7 out of hours (OOH) commitment in most sites and most specialties, hence all of this workload is delivered by consultants. Haematology is the exception, with a 24/7 service which includes trainees.

Table 4.4. Pathology NCHDs by Specialty and Training Stage and Year (PGTB, Headcount)

Headcounts	BST			HST							NTSD	Total
Speciality	Year 1	Year 2	Sub-total BST	Year 1	Year 2	Year 3	Year 4	Year 5	Post CSCST	Sub-total HST + PC		
Chemical Pathology	-	-		1		2				3	1	4
Haematology	-	-		8	9	6	5	6	2	36	36	72
Histopathology	11	7	18	5	10	9	8	7	1	40	9	67
Immunology	2*	-	2	3	2		2	1		8	1	11
Microbiology	-	-		10	6	6	6	8	1	37	8	45
Neuropathology							1	1		2	0	2
Total	13	7	20	27	27	23	22	23	4	126	55	201

*BSTs in Medicine and GP

Characteristics of the NCHD Workforce

Table 4.5 shows that trainees in pathology are predominantly female with a mean age of 34. The gender and age profile of pathology trainees highlights the importance of including maternity leave in the assessment of time from starting to completion of HST training programmes, as well as incorporating the impact of initiatives to promote Less-Than-Full-time Working (LTFT).

Table 4.5. Training Scheme NCHDs Descriptive Statistics (DIME)

Specialty	% Female	Mean Age
Chemical Pathology	100%	*
Haematology	64%	33.7
Histopathology	67%	34.9
Immunology	100%	34.3
Microbiology	80%	33.6
Neuropathology	100%	*
Total	74%	34.3

*Not shown due to the small number of trainees in these specialties.

Clinical Sites of Consultants and NCHDs

The tables below outline the medical staffing by site for each of the specialties. For each specialty staffing also includes medical scientists, medical laboratory aides and clerical staff.

Chemical Pathology

Table 4.6 shows the clinical sites of consultants and HSTs for chemical pathology. The chemical pathology medical team consists of one or more consultant chemical pathologists and an SpR in some cases. Given that there are currently 3 trainees and 1 non-training NCHD, a number of laboratories have a single-handed consultant chemical pathologist, with no trainee.

Table 4.6. Chemical Pathology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	RHA	Consultant (WTE)[4]	HST	NTSD
Beaumont Hospital	Area A	1.5	1	
Connolly	Area A	0.5		
Drogheda	Area A	1.0		
St James's Hospital	Area B	1.0	1	1
Tallaght University Hospital[1]	Area B	1.5	1	
St Vincent's University Hospital	Area C	1.1		
Cork University Hospital	Area D	1.0		
UH Limerick[2]	Area E	1.0		
University Hospital Galway[3]	Area F	1.0		
Temple St	National	0.6		
Rotunda	Nationa	0.2		
Crumlin	National	0.2		
Academic	Other	0.9		
Total		11.5	3	1

1. Also covering Peamount and Naas
2. Also covering Ennis, Nenagh, Croom, St. John's and the maternity hospital
3. Advisory services for Sligo and Roscommon
4.Consultants WTE relates to potentially multiple consultants whose time is partially allocated to various sites

Haematology

Table 4.7 shows the clinical sites in the public and voluntary sectors of consultants, HSTs and NTSDs for haematology. The haematology team also includes BSTs in general medicine, typically on 4-6 month rotations. In contrast to the other specialties of pathology, the haematology service is reliant on NTSDs with 38 employed in the service, in line with the number of HSTs. Many services are very heavily reliant on NTSDs to deliver clinical care on the ground including procedures, outpatient care, day care and in-patient services.

Table 4.7. Haematology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	RHA	Consultants (WTE)[3]	HST (TB)[1]	NTSD (DIME)	BST[1,2]
Beaumont Hospital	Area A	5.3	2	4	5
Cappagh National Orthopaedic Hospital	Area A	0.2	0	0	
Cavan General Hospital	Area A	0.3	0	0	
Connolly Hospital, Blanchardstown	Area A	1.4	0	2	
Mater Misericordiae University Hospital	Area A	4.8	3	5	1
Our Lady's Hospital, Navan	Area A	0.2	0	0	
Our Lady of Lourdes Hospital, Drogheda	Area A	1.5	1	1	
Rotunda Hospital	Area A	0.5	0	1	
Coombe Women & Infants University Hospital	Area B	0.5	0	0	
Midlands Regional Hospital, Mullingar	Area B	0.4	0	0	
Midlands Regional Hospital, Tullamore	Area B	1.5	1	0	

Naas General Hospital	Area B	0.6	0	0	
St James's Hospital	Area B	11.5	7	3	4
St Luke's, Rathgar	Area B	0.2	0	0	
Tallaght University Hospital	Area B	2.2	2		3
National Maternity Hospital	Area C	0.7	0	0	
St Columcille's Hospital	Area C	0.1	0	0	
St Michael's Hospital, Dun Laoghaire	Area C	0.2	0	0	
St Vincent's University Hospital	Area C	4.1	1	4	2
University Hospital Waterford	Area C	4.0	1	3	1
Bantry General Hospital	Area D	0.1	0	0	
Cork University Hospital	Area D	4.8	2	4	1
Mallow General Hospital	Area D	0.1	0	0	
Mercy University Hospital	Area D	2.0	1		1
University Hospital Kerry	Area D	1.0	0	0	
St John's Hospital, Limerick	Area E	0.2	0	0	
University Hospital Limerick	Area E	4.8	1	3	
Letterkenny University Hospital	Area F	2.0		2	
Mayo University Hospital	Area F	0.3	0	0	
Portiuncula Hospital, Ballinasloe	Area F	0.2	0	0	
Sligo University Hospital	Area F	2.0		2	1
University Hospital Galway	Area F	5.8	4	3	4
CHI at Crumlin	National	6.1	4.5	1	3
CHI at Temple St	National	0.8	0	0	
IBTS, Cork	National	1.0	1	0	
IBTS, Dublin	National	3.5	1.5	0	
Abroad			1		
Other (NUIG,TCD,RCSI)		0.8	2.5		

1. Sum of the annual rotations, ie. A 6 month rotation is 0.5
2. BST in GIM or Paediatrics
3. Consultants WTE relates to potentially multiple consultants whose time is partially allocated to various sites

Histopathology

Table 4.8 shows the principal clinical sites in the public and voluntary sectors of consultants, HSTs, BSTs and NTSDs for histopathology. Included in the figures below, there are 2 paediatric histopathologists and 7.5 WTE with commitments to perinatal histopathology.

Table 4.8. Histopathology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	RHA	Consultants WTE[1]	HST	BST	NTSD
Beaumont Hospital	Area A	9.5	5.5	2	0
Cappagh National Orthopaedic Hospital	Area A	0.1	0	0	0
Cavan General Hospital	Area A	2.4	0	0	0
Connolly Hospital, Blanchardstown	Area A	2.6	1	1	0
Mater Misericordiae University Hospital	Area A	5.8	2.5	1.5	1
Our Lady's Hospital, Navan	Area A	0.4	0	0	0
Our Lady of Lourdes Hospital, Drogheda	Area A	2.8	0	0	0
Rotunda Hospital	Area A	1.4	1	0	0
Coombe Women & Infants University Hospital	Area B	2.4	1	0	0

As of march 2022, an additional paediatric Histopathologist has since been hired.

Midlands Regional Hospital, Mullingar	Area B	0.4	0	0	0
Midlands Regional Hospital, Portlaoise	Area B	0.7	0	0	0
Midlands Regional Hospital, Tullamore	Area B	2.4	0	0	0
Naas General Hospital	Area B	0.3	0	0	0
St James's Hospital	Area B	10.9	5	3.5	0
St Luke's, Rathgar	Area B	0.6	0	0	0
Tallaght University Hospital	Area B	3.0	3	0.5	0
National Maternity Hospital	Area C	2.0	1	0	0
Royal Victoria Eye & Ear Hospital	Area C	0.4	0	0	0
St Columcille's Hospital	Area C	0.2	0	0	0
St Vincent's University Hospital	Area C	8.5	4	4	2
University Hospital Waterford	Area C	7.0	1	1	2
Cork University Hospital	Area D	14.9	6	1	3
St John's Hospital, Limerick	Area E	1.0	0	0	0
University Hospital Limerick	Area E	4.0	0	0	0
Letterkenny University Hospital	Area F	4.0	0	0	0
Mayo University Hospital	Area F	2.0	0	0	0
Portiuncula Hospital, Ballinasloe	Area F	1.7	0	0	0
Sligo University Hospital	Area F	3.0	0	0	0
University Hospital Galway	Area F	14.9	5	3	1
Breastcheck - Eccles Unit	National	0.3	0	0	0
Breastcheck - Southern Unit	National	0.5	0	0	0
Breastcheck - Western Unit	National	0.5	0	0	0
CHI at Crumlin	National	1.7	0.75	0.5	0
Dublin Dental Hospital	National	0.5	0	0	0
NUIG	Other	1.0	0	0	0
RCSI	Other	0.9	0	0	0
Trinity College Dublin	Other	0.8	0	0	0
UCC	Other	0.5	0	0	0
Other (TCD, University of Galway)		3.1	3		

1. Consultants WTE relates to potentially multiple consultants whose time is partially allocated to various sites

Immunology

Table 4.9 shows the principal clinical sites in the public and voluntary sectors of consultants, HSTs, and NTSDs for immunology. The immunology team will normally be led by 2 or more consultant immunologists. This allows cross cover facilitating continuation of training and supervision when one of the immunologists is on leave. There are benefits in having larger teams, allowing consultants to develop subspecialty interests, in immunodeficiency, autoimmunity, drug or food allergy, respiratory allergy or laboratory practice, in addition to the more readily identified subspecialty of transplant immunology.

Some BST posts rotate through immunology units. One of these posts is on a general medicine scheme, and the second on a GP scheme. As trainees rotate every 3 months, they make a minor contribution to service delivery, however, these early career experiences are important in exposing potentially future trainees to immunology as a possible career choice. There is a single a standalone registrar post, which allows people to test the specialty for fit, before embarking on Higher Specialist training.

Higher Specialist Trainees (SpR) contribute significantly to clinical service delivery in the course of their training. This exposure is essential to build competence and confidence, as in other clinical specialties. The usual maximum ratio is one SpR per consultant trainer. However, due to the extraordinary pressures and inability of immunology to grow at this ratio, a temporary increase, subject to satisfactory inspection was agreed in 2017, allowing Immunology trainers to train 1-2 trainees.

Table 4.9. Immunology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	RHA	Consultants (WTE)	HST (TB)	BST (TB)	NTSD (DIME)
St James's Hospital	Area B	2.0	3	2	0
Beaumont Hospital	Area A	2.0	3	0	1
University Hospital Galway	Area F	2.0	2	0	0
Total		6.0	6	2	1

Note: Consultant workforce shown by principle clinical site. WTEs include commitments to spoke sites and academic commitments.

Microbiology

Table 4.10 shows the clinical sites in the public and voluntary sectors of consultants, HSTs and NTSDs for microbiology. The consultant microbiologist leads the multi-disciplinary IPC and AMS team. The team is usually comprised of the consultant microbiologist(s); IPC nurses of varying grades, surveillance scientist(s); antimicrobial pharmacist(s); and clerical or admin support. There are currently 67 consultant microbiologists employed in publicly funded hospitals. These consultants are based across 27 sites as shown in table 4.10. However additional acute and community sites are covered. There are currently 8 non-training scheme doctors employed in microbiology. The data is as of March 2022, these number fluctuate with entries and exits. Due to the lack of availability of locums one consultant going on leave or retiring can result in severe strains on local services.

Table 4.10. Microbiology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	RHA	Consultants WTE	HST	NTSD
Beaumont Hospital	Area A	4.1	4	0
Cappagh National Orthopaedic Hospital	Area A	0.4	0	0
Cavan General Hospital	Area A	2.0	0	0
Connolly Hospital, Blanchardstown	Area A	1.5	0	0
Louth County Hospital, Dundalk	Area A	0.2	0	0
Mater Misericordiae University Hospital	Area A	3.6	3	1
Our Lady of Lourdes Hospital, Drogheda	Area A	2.0	1	1
Rotunda Hospital	Area A	1.3	0	0
Coombe Women & Infants University Hospital	Area B	0.3	0	0
Midlands Regional Hospital, Mullingar	Area B	0.2	0	0
Midlands Regional Hospital, Tullamore	Area B	0.6	0	0
Naas General Hospital	Area B	0.5	0	0
St James's Hospital	Area B	4.1	4	0
St Luke's, Rathgar	Area B	0.2	0	0
Tallaght University Hospital	Area B	2.4	2	0
National Maternity Hospital	Area C	0.6	0	0
Royal Victoria Eye & Ear Hospital	Area C	0.3	0	0
St Columcille's Hospital	Area C	0.2	0	0
St Luke's General Hospital, Carlow/Kilkenny	Area C	0.1	0	0
St Vincent's University Hospital	Area C	3.3	3	2
University Hospital Waterford	Area C	3.9	4	0
Bantry General Hospital	Area D	0.3	0	0
CHO 4	Area D	0.2	0	0

Cork University Hospital	Area D	2.3	3	2
Cork University Maternity Hospital	Area D	0.7	0	0
Mallow General Hospital	Area D	0.2	0	0
Mercy University Hospital	Area D	0.7	1	0
South Infirmary Victoria University Hospital	Area D	0.3	0	0
University Hospital Kerry	Area D	0.6	0	0
St John's Hospital, Limerick	Area E	0.1	0	0
University Hospital Limerick	Area E	2.9	3	1
Letterkenny University Hospital	Area F	1.0	0	0
Mayo University Hospital	Area F	1.0	0	1
Roscommon University Hospital	Area F	0.2	0	0
Portiuncula Hospital, Ballinasloe	Area F	0.5	0	0
Sligo University Hospital	Area F	2.0	0	0
University Hospital Galway	Area F	3.5	2	0
CHI at Crumlin	National	0.7	0	0
CHI at Temple St	National	2.1	1	0
Childrens Hospital Group	National	0.2	0	0
Health Protection Surveillance	National	1.0	0	0
IBTS, Dublin	National	0.6	0	0
National Rehabilitation Hospital	National	0.4	0	0
National Virus Reference Laboratory	National	0.5	1	0
Public Health Laboratory	National	1.0	0	0
NUIG	Other	0.6	0	0
RCSI	Other	1.7	0	0
Trinity College Dublin	Other	0.5	0	0
UCC	Other	0.5	0	0
UCD	Other	0.5	0	0
Other[1]			4	
Total		58.3	34	8

1. Consultants WTE relates to potentially multiple consultants whose time is partially allocated to various sites
2. Includes Manchester Royal Infirmary UK, PWC Fellowship and Out of Clinical Programme Experience

Neuropathology

Neuropathology services and training are delivered though Beaumont Hospital and Cork University Hospital. The neuropathology team comprises consultant neuropathologists, specialist medical scientists, neuropathology SpRs (these posts are not always occupied) and dedicated clerical staff.

Table 4.11. Neuropathology Medical Workforce by Clinical Site (Public Sector, March 2022)

Clinical Site	Consultants (WTE)	HST
Beaumont Hospital	3.5	1
Cork University Hospital 2	.0 1	
Total	5.5	2

Workforce Supply Assumptions

Table 4.12 below summarises the assumptions of the supply module of the model. A full listing of parameter values by specialty is shown in Appendix A1.

Table 4.12. Supply Model Parameter Values and Sources

Parameter	Value (range)	Description/source
Retirement age	62-65	For simplicity, the model assumes that people retire at a certain age depending on the specialty. For most specialties a retirement age of 62 is used (Source: NDTP internal analysis).
CSCST Attrition Rate	10-21%	This is the proportion of CSCST that are retained in the Irish Health System. This is based on the average for pathology (Source: NDTP internal analysis).
Years abroad between CSCST and Consultants post	1-2	Many Consultants go abroad post CSCST for a fellowship (Source: Clinical Programme).
Additional Years pre CSCST	1-2	This adjusts for the increased time between HST entry and qualification due to time out of the programme eg. maternity leave or research (Source: Clinical Programme).
Gender breakdown of HST intake	64-100%	This is based on the current intake.
BST Attrition Rate	10%	A rate of 10% is used for attrition between BST and HST in Histopathology. (Source: Clinical Programme).
Exit rates private sector	2.6%	No age data is available for the private sector only consultants, an average exit rate is used (Source: NDTP internal analysis).
Additional exits (male/female)	0.5-0.8%	Exits from workforce of consultants under 55 years (Source: NDTP internal analysis).

5. Drivers of Change in Demand

In this section we outline the demographic aging that is impacting all specialties and the specific factors that are likely to drive demand for each specialty of pathology in the medium term.

Demographic Changes

Demographic change is a key driver for demand of pathology services as the incidence of many chronic diseases increases with age. Demographic aging has been shown to be associated both with increased volumes of testing in diagnostic pathology and increased case complexity [26].

Under the Central Statistics Office (CSO) M2F2 scenario for projecting population growth [27], it is estimated that by 2035 the population of Ireland will have increased by over 500,000, from 5 million in 2021 to 5.5 million in 2035 (table 5.1). By 2035 there will an estimated 1.2 million people in between the ages of 61 and 85 and a further 140,072 people over the age of 85 years. This represents an increase in the 61-85 age group of approximately 40% (2.5% p.a.) and an increase of 105% (5.3% p.a.) in the over 85 year age group.

Older age groups exert the greatest pressures on the health service due to increasing chronic disease presentation and the complexity of care requirements. Health care utilisation has been shown to rise substantially in the period prior to death [28]. The number of deaths is projected to increase at a rate of 2% p.a. over the period.

In tandem with the ageing of the population the under 15 year age group is expected to decrease by around 15% (1.1% p.a) with the number of births declining marginally over the period. According to the National Clinical Programme for Paediatrics and Neonatology, despite a decreasing paediatric population, workload in related specialties will continue to be maintained due to the impact of increasing premature births and resulting increasing complex needs for children.

Table 5.1. Projected population changes 2021-2036

Age Group	2021	2035	Average Annual Growth Rate
0-15	1,071,137	917,662	-1.1%
16-30	927,978	1,096,232	1.2%
31-45	1,087,225	1,038,412	-0.3%
46-60	956,858	1,106,673	1.0%
61-85	880,779	1,237,451	2.5%
Over 85	68,187	140,072	5.3%
Total	4,992,164	5,536,502	0.7%
Births	59,583	57,384	-0.3%
Deaths	32,272	42,035	1.9%

Chemical Pathology

Epidemiological Changes

Consultant chemical pathologists are trained in the clinical management of patients with metabolic disorders such as obesity, dyslipidaemia, diabetes, osteoporosis, fluid and electrolyte and nutritional disturbances and endocrine disorders such as thyroid disease. The prevalence of many of these diseases are strongly related to the aging pressures, outlined above. The projected growth of metabolic disorders such as obesity [29] and type 2 diabetes [30] will have substantial ramifications for the workload of chemical pathologists.

Test, Treatments and Technology

Near-patient testing (NPT) aims to improve patient outcomes through provision of a laboratory medicine service by healthcare professionals using small analytical devices provided near to the patient rather than from a clinical laboratory. There is a rapidly increasing role of NPT services in primary and secondary healthcare for which consultant supervision is essential. In addition, within chemical pathology services there is an increasing requirement for complex technology, including Liquid Chromatography – Mass Spectrometry, Next Generation Sequencing, Multiplex Ligation Dependent Probe Amplification and Real-time PCR, amongst others. With regard to specialist chemical pathology clinics e.g. lipidology, porphyria, bone metabolism, novel medical therapeutics are increasingly becoming available and requiring consultant-led patient oversight to optimise clinically effective outcomes.

Health Service Reform/ Service Reconfiguration Policy implications

Reconfiguration of services within the HSE signals the need to develop both core and outreach consultant services to facilitate appropriate consultant level input and clinical risk management. Maintenance of laboratory quality management systems in accordance with ISO15189 (as assessed by INAB) requires that each clinical diagnostic laboratory has discipline-specific consultant level governance. INAB also require deputy consultant cover, which further highlights the need to increase consultant chemical pathologist numbers.

Adequate consultant paediatric chemical pathologist levels need to be provided for the new National Children's Hospital and the associated satellite centres in addition to continuing to support current paediatric service delivery requirements.

Choice of Growth Driver(s)

The historic growth rate (4.4% p.a.) in the number of specimens in one large hospital (St James's) between 2016 and 2022 was chosen as a growth driver for chemical pathology. This incorporates the impact of a range of the factors outlined above, including demographic aging and epidemiological changes. While the growth metric does not account for an increase in near-patient testing there is currently no data available to represent this. A substantially higher growth rate (9.3% p.a.) in specimen numbers has been observed for Beaumont laboratory for the same period. This was not used in the analysis, however it highlights the uncertainty in the projected future demand growth.

Table 5.2. Growth drivers for Chemical Pathology

Specialty	Sub-Category	Demand Driver(s)	Source
Chemical Pathology	None	Growth in Test Numbers	Clinical Programme

Haematology

Epidemiological Changes

The prevalence of people with blood cancers is a key driver of demand for haematology services. Malignant haematology involves the care of paediatric and adult patients with haematological malignancies including acute and chronic leukaemia; plasma cell disorders; high grade and low grade lymphoma. Many adult blood cancers are strongly associated with aging.

Haematologists are involved in a wide aspect of direct patient care in maternity services. Some of the maternal complications that require clinical and laboratory haematology input including post-partum haemorrhage and obstetric blood transfusions [31].

Inward migration and changing ethnicity are key driver of the growth demand for haemoglobinopathy services. These services are provided to paediatric and adult patients with genetic conditions such as sickle cell disease (SCD) and thalassaemia. Unlike population aging, rates of immigration are volatile and difficult to predict being highly correlated with domestic economic growth and international developments [32].

Test, Treatments and Technology

Specialist and general laboratory services have expanded and are predicted to expand further with the expansion of other services and with novel diagnostic techniques. Nearly every patient attending a hospital will have a full blood count done, as a result the expansion of any other service impacts on haematology laboratory services. Molecular testing has become a critical aspect of care for haematological malignancies and many haematologists will be involved in the management of laboratory molecular diagnostics as well as the clinical implications.

Increased therapeutic options, the complexity of treatment programmes, managing co-morbidities in association with primary haematological diagnoses, transfer of lymphoma services to haematology and earlier diagnosis are resulting in increased patients under surveillance management. As a result of improved treatment and management, median survival times have increased to between 5 and 20 years.

Acute haematological malignancies require complex treatment and are resource intensive. Bone marrow transplantation activity continues to rise year on year. CAR-T cell therapy has started in Ireland – St James Hospital has opened and, Galway University Hospital has been announced as a 2nd site. Planned facilities to perform this treatment are expected to open in CHI Crumlin. Previously patients in Ireland requiring CAR-T cell therapy travel abroad to receive this treatment. The area of benign haematology is becoming increasingly complex with the advancement of therapies available.

Health Service Reform/ Service Reconfiguration Policy implications

The development of trauma centres, the expansion of other medical and surgical specialties with the subsequent reliance on laboratory testing will result in increased demand for haematological services.

Haematology is the only specialty of pathology with a large number of non-training scheme doctors (NTSDs). Currently the provision of a safe and efficacious clinical haematology service around the country is only made possible by a large number of NTSD supporting the service. Reducing the reliance on NTSD will require an increase in SpR numbers. To free up time for appropriate laboratory experience and other training activities, such a transformation would require the support of some additional advanced nurse practitioners to deliver routine haematological clinical care.

The development of survivorship clinics, in line with the National Cancer Strategy, will also have a significant impact on workload.

Development of Model 3 Hospital services to deliver appropriate care, close to patients' homes in line with Slaintecare, will reduce dependency on overcrowded Haematology/Oncology Day Ward settings in model 4 hospitals. An appropriate shared care model will improve efficiency and time to treatment, and reduce reliance on inpatient beds for commencement of therapy as Day Ward treatment slots are unavailable.

Other Drivers of Workload Change

Haematologists are regularly involved in local and national service development and strategic planning. This involves a significant proportion of time for meetings, report & recommendation writing for development of services. Services include both Haematology specialist services and non-haematology services. Much of this time is conducted outside of normal service times. There is a need to redress this to ensure all patients and services, for example laboratory service, are represented in national and local policy development.

As per the National Cancer Strategy "The positive impact of research activity, including clinical trials, on the care of patients is evident". Optimal cancer care should be closely integrated with a cancer research programme, including clinical trials. In 2014 c.3% of cancer patients were enrolled in a clinical trial, a modest aim of the cancer strategy was to increase this to 6%. It is anticipated that the number of haematology patients involved in clinical trials programme is significantly less. To address this, it is necessary to provide a dedicated time to clinical trials at each designated cancer centre and treating centre. The opportu-

nity for clinical trials for non-malignant haematology is sparse, with most concentrated on haemostasis and thrombosis, and paediatric haematology.

Choice of Growth Driver

Table 5.3 outlines the workforce drivers for haematology. The workload for haematology was broken down into ten areas with each area having a separate workforce driver. These workload areas are an artificial division of the haematology workload rather than a division of specialist areas. In practice most haematologists work across numbers of these areas. The historic growth in specimen numbers was chosen as the growth driver for the laboratory workforce. The projection does not take into account the growing complexity of haematological tests which require increased consultant input.

The growth in the workload associated with the adult malignant caseload is calculated from the historic growth rate in the prevalence of adult blood cancers. This accounts for the increasing survival durations of people with blood cancers resulting in an ongoing workload.

The prevalence of Haemoglobinopathy in Ireland has increased rapidly in recent decades as Ireland has attracted more migrants from a wide range of ethnicities. The future number of people with new and ongoing requirements for haemoglobinopathy services is likely to be driven by the ethnic mix in Ireland which will be a function of both historic and future migration patterns. The growth in demand for adult and paediatric haemoglobinopathy are both modelled based on the historic growth rate in black/asian/mixed ethnicities in Ireland between the 2011 census and the 2016 census.

The change in the demand for malignant and benign paediatric care are assumed to change in line with the size of the paediatric population. Similarly, adult benign obstetrics is assumed to change in line with projected births.

Demand for thrombosis services (including the National Coagulation Centre) are assumed to be driven by population aging, with the age profile of service utilisation assumed to be driven by the incidence of Venous Thromboembolism (VTE). Other activities, such as teaching and research and palliative care, are assumed to constitute of a constant proportion of the consultant workload.

Table 5.3. Growth drivers for Haematology

Specialty	Sub-Category	Demand Diriver(s)	Source
Haematology	Lab Work	Growth in test numbers	The growth in test numbers is based on data from Cork University Hospital which is expected to be nationally representative. The allocation of workload across each of the areas of activity is based on expert judgement.
	Adult Malignant	Growth in blood cancer prevalence	National Cancer Registry
	Adult Benign: Haemoglobinopathy	Historic growth rate in black/asian/mixed ethnicities	Central Statistics Office
	Adult Benign: Thrombosis services (inc National Coagulation Centre)	Incidence of venous thromboembolism (VTE) * Projected Population	Kevane et al. 2019 Central Statistics Office
	Adult Benign Obstetrics	Projected Births	Central Statistics Office
	Adult Benign Other	Population growth	Central Statistics Office
	Paediatric Malignant	Projected growth in Paediatric Population	Central Statistics Office
	Paediatric Haemoglobinopathy	Historic growth rate in black/asian/mixed ethnicities	Central Statistics Office

	Paediatric Benign	Projected growth in Paediatric Population	Central Statistics Office
	Other Activities (Teaching and Research, Palliative Care)	Proportion of total workload	Expert Judgement

Histopathology

Epidemiological Changes

Histopathology is the diagnosis and study of diseases of the tissues. The risk of cancer in the population and the prevalence of known cancers (NCRI, 2020) are key epidemiological drivers of demand for histopathology services. Evidence from the National Histopathology Quality Improvement Programme (NQI) show that the number of cases grew at an average rate of 2.7% p.a. between 2015 and 2019; cases refer to a patient's pathological material, which may comprise a single sample or multiple samples (specimens) from the same patient. The Increasing numbers of cases is partially driven by an aging population, but also by improved screening programmes resulting in earlier detection (see below). The complexity of cases is also increasing, this is evidenced by the rapid growth in the use of Immunohistochemistry (IHC) tests. IHC tests can provide useful information about tumours, including the subtype of the tumour and what types of treatment it might respond to. The number of cases requiring this test has increased by 9.4% p.a. in the 2015 to 2019 period.

Usually when a death occurs in Ireland, the treating doctor or family doctor signs the death certificate. For several reasons, including where the cause of death is unnatural or undetermined, or where death has occurred in suspicious or criminal circumstances, the coroner in the area where the death has occurred will be contacted and may to order a post-mortem. Most of the post-mortems ordered by the coroner are conducted by histopathologists as independent work outside of their HSE contracts for a set fee [5]. The number of post-mortems has been growing at an average rate of 4.1% p.a. from 2018 to 2021.

Test, Treatments and Technology

Screening initiatives, for example BreastCheck and BowelScreen, place substantial demands on Histopathology services. BreastCheck extended the upper age limit for screening from 65 to 69 years in 2015 which has resulted in a significant increase in pathology workload. BowelScreen are also likely to extend their age limits in the coming years with a resultant increase in pathology demand. While the impact of the HPV vaccination programme is likely to reduce but not eliminate the requirement for gynaecology cytopathology in the longer term, this is likely to take some time to materialise; for the next 15-20 years there will be a need for fully qualified histopathology consultants with a special interest in cytopathology to manage the service in the National Cervical Screening Laboratory, based in the Coombe.

Significant advances in molecular pathology and cancer treatments are underway with many cancers now having specific targeted treatments available. This often requires molecular testing of the patient's tumour and thus significant input from histopathology, requiring consultant and medical scientist expertise, equipment and space. Activity levels are often measured as the number of specimens examined by a laboratory which is dependent on surgical activity within a given hospital, peripheral hospitals and GPs it serves. However, this often does not accurately reflect workload as the complexity of specimens being handled is not reflected. Tertiary referral centres, for example, will handle more complex specimens than smaller peripheral hospitals and non-cancer centres.

Advances are being made in the fields of digital pathology and artificial intelligence to help with both diagnostic work and with education and teaching [33]. Due to significant lack in IT infrastructure and dedicate time allocated to the development of digital pathology, the Irish health service is perceived to be falling behind comparable countries. Many Histopathology departments worldwide are embracing digital pathology either for diagnostic work or educational work or both. It has the potential to assist in niche areas within histopathology where only a small number of pathologists are available to report on a specific area. It can help with seeking expert opinions in difficult cases. It can allow for histopathologists to be more flexible with their working practices and facilitate remote interpretation of tests.

Increasing research, developments and approval of new treatments particularly in cancer care have increased the need for molecular services within Histopathology which have not been sufficiently met.

Health Service Reform/ Service Reconfiguration Policy implications

Demand for histopathology services are increased when new surgeons and clinicians are appointed, when bodies such as NCCP create guidelines for cancer care, when new treatments become available, when new hospitals open and when bed numbers are increased. In addition, waiting list initiatives and National Treatment Purchase Fund (NTPF) initiatives are frequently being set up with surgeons / endoscopists etc performing lists at weekends. This increases activity however histopathology (from a consultant, medical scientist and clerical perspective) is often not considered when these initiatives are being planned. Subspecialisation within histopathology is beneficial, so that for example, a small group of Histopathologists would report all liver specimens rather than every histopathologist reporting these cases. Thus, centralising departments with larger numbers of histopathologists present, allowing subspecialisation would be more beneficial to patients rather than having small separate departments within each hospital. It is not clear how Slaintecare reforms relating to private versus public work will impact Histopathology. A move to completely separate public and private services may result in smaller labs which would not be beneficial to patients.

Cervical cytology was outsourced to the US by the HSE in 2008/2009 and thus this service has not been provided by histopathologists in Ireland since then. The return of cervical cytology (Cervical Check) which is being planned will significantly impact Histopathology as specialised fellowship training in cytopathology is required for consultants in this area and there is currently no expertise in Ireland to provide this training

Choice of Growth Driver

Histopathology was sub categorised into three groups: adult, paediatric and perinatal. The historic growth rate in the number of cases was chosen as a growth driver for histopathology. As the number of patients presenting for suspected cancer will grow over the coming decades there will be a significant increase in the number of pathology cases / specimens that will both diagnose cancer and also be required to rule out cancer. With more sophisticated treatment options becoming available, mainly in the field of genomics, the complexity of the interpretation required by histopathologists to inform treatment decisions and provide prognostic information to each individual patient will increase. In addition to the projected growth in the number of cases, an index was included in the model to adjust for the increasing number complex specimens. While the number of IHC tests is viewed as a proxy for the increasing complexity of testing, expert judgement was used to set the level of the complexity index used to project the growth in demand; further evidence is required in this area.

There are currently 7 WTE perinatal histopathologists. There is currently a requirement for an additional 3.5 additional WTE in perinatal histopathology; based on a stable projected paediatric population size, additional perinatal histopathologists are not anticipated to be required in the medium term.

There are currently (March 2022) two paediatric histopathologists. There is currently a requirement for two additional paediatric histopathologists; based on a stable projected paediatric population size, additional paediatric histopathologists are not anticipated to be required in the medium term.

Table 5.4. Growth drivers for Histopathology

Specialty	Sub-Category	Demand Driver(s)	Source
Histopathology	Adult Histopathology (inc. cytology and autopsy)	Case Numbers & Complexity Index	National Histopathology Quality Improvement Programme & Expert Judgement
	Paediatric Histopathology	Paediatric Population Growth Rate	Central Statistics Office
	Perinatal Histopathology	Paediatric Population Growth Rate	Central Statistics Office

Immunology

Epidemiological Changes

Core clinical services in immunology are primarily for patients with allergic disorders, and patients with primary, and increasingly, secondary immune deficiency. Patients with severe, complex or difficult to treat autoimmune diseases are also seen on a tertiary care basis. The clinical workload in immunology has changed significantly over the last decade. From being a niche specialty, seeing a small number of patients with rare diseases, immunology has evolved to have large referral demand from primary care and a range of specialties.

The exponential rise in the prevalence of allergic diseases has led to a large demand for allergy services, with many patients having complex investigational needs. The rapid increase in childhood allergy, particularly food allergy, is now impacting on adult services as children transition to adult services. International evidence indicates that the prevalence of food allergies and rates of hospitalisation as a result of allergies have increased rapidly [34, 35].

Immunology services are frequently the lead provider of specialist care for patients with less common conditions such as vasculitis, other complex autoimmune disease, or neuro immunology. Increased survivorship following cancer therapy and transplantation also increases the population of immunologically vulnerable people, many of whom require specialist care.

There have also been direct impacts of Covid-19 related issues on immunology services. Despite a proactive approach to providing information, concerns about possible allergy to excipients in COVID-19 vaccines led to hundreds of requests for advice. Approximately 10% of these people require specialist advice. Additionally, requests for advice on management of patients with Covid-19 and underlying immunological conditions, altering immunosuppressive protocols to reduce Covid-19 risk, and assessment of vaccine effectiveness stress the importance of improving immunology capacity. The requirement for immunological input is likely to be on-going and increasing for booster vaccine campaigns.

Test, Treatments and Technology

Multiple new immunological therapies are becoming available for a variety of conditions. While many of these are incorporated in management plans by organ based specialists, immunology expertise may be sought for monitoring, assessment of adverse effects, or choice of approach in complex patients. This has led to an increase in MDTs to provide immunology input both at protocol level, and for complex patients where full involvement in management may not be required.

Health Service Reform/ Service Reconfiguration Policy implications

Slaintecare is likely to increase demand for a hub and spoke mode of delivery of clinical services. Immunology services are currently based in large academic teaching hospitals. However once staffing permits, outreach clinics in a hub and spoke model is important to optimise patients access to immunology care. A pilot project has been proposed to evaluate Advanced Nurse Practitioner (ANP) led allergy care, across the community and hospital setting. This model would allow simple allergy care be delivered in the community, while patients requiring challenging and complex immunological investigation would access these services in a hospital setting, managed by the same ANP. This continuity of care is valued by patients, and is likely to offer considerable efficiencies rather than having multiple healthcare professionals assess the patient for the same condition.

There is a recognised need for a national reference laboratory for investigation of immunodeficiency, to support development of complex cellular immunology assays. The paucity of immunologists results in a large volume of testing being performed in non-immunology labs, or outsourced to the private sector. An increased number of immunologists will be required to cover all immunology testing.

Other Drivers of Workload Change

Patient expectation is also a major driver of change. Many patients are referred to immunology services at their own request, or because friends or relatives have attended with good outcomes. Patients are often convinced by on-line information, or alternative practitioners that non allergic symptoms are due to allergy. Diagnosing these patients, reintroducing foods or supporting them as they reintroduce medications, often complicated with severe anxiety, greatly increases workload.

The In Vitro Diagnostic Regulations (IVDR) came into force in May 2022, and place a considerable regulatory burden on laboratories. The impact of the IVDR will increase the regulatory burden on laboratory directors going forward, and will impact dispro-

portionately on laboratories which assess patients for rare disease, and use cellular assays, such as immunology laboratories.

Many doctors currently in practice received little or no immunology training at medical school. The pace of change in immunology has been remarkable, making it a challenge to keep up with advances. Immunologists need to have time to provide on-going immunology training to other medical colleagues, as well as those in other relevant Healthcare professionals.

Choice of Growth Driver

There is currently a very large gap between the current and required number of immunologists. Given the scale of the gap, a crude population metric [36] was used to identify the required number of consultants in 2035.

Table 5.5. Growth drivers for Immunology

Specialty	Sub-Category	Demand Driver(s)	Source
Immunology	None	Population Ratio	RCP [36]

Microbiology

Epidemiological Changes

The three core areas of clinical microbiology (Clinical Laboratory Management, Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS)) are all under increasing demand for service.

Clinical microbiology workload includes patient result authorisation, clinical liaison, attendance at MDTs and ward rounds and direct patient review as well as involvement with testing algorithms and laboratory accreditation. While the COVID-19 pandemic workload had an enormous impact on clinical microbiology laboratories and IPC services, the reality is that the workload had been increasing rapidly, for example between 2015 and 2018 the annual growth rate in specimens was 8% in Galway University Hospital.

Microbiologists continually react and pivot in response to the ever evolving events from increasingly antimicrobial resistant bacteria, including TB, to emerging viruses such as COVID-19 and monkey pox and other pathogens such as Candida auris. Reactive IPC is where most of the current workload lies – i.e. dealing with outbreaks of infection; prioritising isolation facilities; reviewing data for the mandatory hospital KPIs (i.e. Health Care Associated Infection (HCAI) Clostridium difficile toxin (CDT) or Staphylococcus aureus blood stream infection, hospital-acquired COVID) writing outbreak reports; feedback on audits of hand hygiene compliance or environmental or equipment hygiene and attendance at various hospital committees e.g. Quality & Risk; Decontamination; Environmental Monitoring. The infrastructure (e.g. isolation rooms, toilets, bed and trolley spacing, ventilation) in many Irish hospitals is far from ideal, leading to a constant risk assessment to manage patients in as safe a manner as possible. Suboptimal infrastructure, limited acute bed capacity, limited critical care capacity, an ageing population, increasing demand for clinical services and increasing complexity of clinical care create a perfect storm, whereby a patient population at increased risk of infection requires care in a busier acute system with already limited access to single occupancy rooms. The demand for the limited stock of single rooms has been further strained by the increasing incidence in highly antimicrobial resistant organisms (e.g. CPE) and the emergence of SARS-CoV-2. Immigrant health is another area where increased resources are required to isolate and manage risks such as multiply drug resistant organisms (MDRO) and TB. "Proactive" IPC involves clinical surveillance and feedback e.g. surgical site infection surveillance; Quality Improvement (QI) projects; managing risk of infection from environmental factors including water quality, healthcare ventilation and hospital infrastructure and design. Resources are needed to bring these benefits to patients and the public.

Antimicrobial Stewardship (AMS) is essential for both individual patient management as well as minimising antimicrobial selection pressure at institutional level, while trying to maintain cost efficiencies. Antimicrobial resistance adds to the complexity of both laboratory testing and reporting of patient results. Regular patient review rounds, restricted antimicrobial agent authorisation and analysis of laboratory antimicrobial susceptibility data with regular updates of treatment guidelines are integral to

the role. Participation in annual Point Prevalence Studies (PPS) is usually coordinated by microbiologists working with AMS pharmacist and colleagues.

Microbiologists work closely with colleagues in various disciplines which can act as a demand driver, for example Oncology, Public Health, Occupational Health and ICU Physicians. Approx. 10% of positive micro lab results relate to patients with cancer, therefore demand for clinical microbiology or IPC input needs to be incorporated into future cancer strategies. The public health response to infectious disease epidemics and pandemics such as COVID 19 create significant additional workload with requirements for quick turnaround times. There are also seasonal fluctuations with epidemics with no additional capacity to manage this increased demand. While the COVID workload has subsided in most hospitals, there is still significant workload associated with TB and other occupational pathogens which is time consuming between attending meetings, report writing. The increase in medical specialist numbers in disciplines relevant to Microbiology (Infectious Diseases/Respiratory/ICU Physicians) results in increasing rates of referrals to Microbiologists for testing, advice and MDT attendance.

Test, Treatments and Technology

The microbiology laboratory workload has been revolutionised in the past decade. Technologies such as MALDI-ToF identification; rapid diagnostics including near patient testing; molecular diagnostics and resistance determinants continue to evolve at a rapid pace which require consultant microbiologist expertise in interpretation, liaison or IPC advice in real time to impact positively on patient care. Advances in whole genome sequencing are clarifying potential routes of transmission with real time impact on prevention of HCAI. Increased demand for Out Patient Antibiotic Therapy services will also impact demand.

Following the increasing recognition of the importance of rapid identification and management of sepsis, INAB accreditation for blood cultures now entails a service with results in real time on a 24/7 basis. This has led to an intensity and complexity of the on-call service has increased dramatically with previous manpower estimates (e.g. Hanly report) not now reflective of the current work patterns or workload of clinical microbiologists.

Health Service Reform/ Service Reconfiguration Policy implications

While most NCHDs will contribute to the clinical service on Saturday (+/- Sunday mornings), the training scheme for NCHDs in Ireland does not provide for a 24/7 out of hours (OOH) commitment in most sites, hence all of this workload is delivered by consultant microbiologists.

Increased mandatory reporting requirements in line with risk management reporting, data collection requirements or HIQA standards and Key Performance Indicators (KPIs) (e.g. Staphylococcus aureus bloodstream infection and Clostridium difficile infection) will impact on workload both in and outside of normal working hours.

Clinical programmes have evolved which impact on laboratory workload but without consideration of this e.g. Hepatitis B/C viral load requests and Cancer patient management.

Oversight, development and implementation of the planned national Medical Laboratory Information System (MedLIS) project and IT software for IPC teams across acute and community services will impact on workload.

Increasing demands for greater linkages to community services will also increase demand on microbiology teams. Some Clinical Microbiology teams have been requested to provide 24/7 cover to community sites. A number of posts (2 per hospital group) with 50% commitment to acute and 50% to community services have recently been approved to provide this service. However the additional posts are not yet sufficient to provide the level of community cover required.

Other Drivers of Workload Change

Increasing demands for input into the upgrading, expansion and building of healthcare facilities – requiring key early involvement to ensure design is compliant with National/International standards e.g. building Health Technical Memorandum (HTM) guidance. In addition to the clinical microbiologist will also need to carry out a risk assessment of all patient populations, at or attending the hospital site and provide oversight of measures to mitigate risk (e.g. air sampling in clinical areas during building work, or recommendation of antifungal prophylaxis etc).

Choice of Growth Driver

Microbiology was split into three sub categories for the purpose of projecting workload: hospital microbiologists, virologists and community microbiologists. There are currently 0.47 consultant microbiologists in Ireland per 100 beds. A recent review of Hospital Infection Services in the UK found a range of 0.4 to 0.7 consultant microbiologists (including virology excluding infectious disease only) per 100 acute beds across the UK regions [21].

A 2016 survey by the European Society of Clinical Microbiology and Infectious Diseases (ESCMID), found that the average number of 0.83 senior physicians per 100 hospital beds [37]. This survey included infectious disease physicians, in Ireland these have a substantial commitment to general internal medicine. As the survey was carried out pre-Covid 2019 it also reflects the supply at that time. CPE was declared a national public health emergency by the minister for health in October 2017. The burden of CPE and other MDROs in Ireland has further increased the volume and complexity of the microbiologists workload. The ESCMID ratio was used, unadjusted for infectious disease consultants, Covid-19 or CPE, as a guide to demand in future years.

The Health Service Capacity Review 2018 outlines alternative scenarios for the growth rates of hospital beds. Without reforms the number of hospital beds required is estimated to grow at a rate of 2.9% per annum, with reforms the growth rate is reduced to 1.2% per annum.

The ESCMID recommended level of microbiologists per hospital bed was used in conjunction with current numbers of hospital beds in each site (Open Beds Report, March 2021), adjusted for the current number of hospital trollies and the average projected growth rate in bed numbers from Health Service Capacity Review.

In addition, to the above it is recommended that there should be a lead virologist per 500,000 population in keeping with the Trust model in the UK; a Community Microbiologists of at least 0.5 WTE per Regional Health Area are required, and 1 WTE Microbiologists for the Irish Blood Transfusion Service (IBTS) service.

Table 5.6. Growth drivers for Microbiology

Specialty	Sub-Category	Demand Driver(s)	Source
Microbiology	Hospital Microbiologists	Bed-Ratio	ESCMID survey [37], Open Beds Report March 2021 and Health Service Capacity Review.
	Virologists	Population Ratio	Trust Model
	Community Microbiologists	Geographic Coverage	

Neuropathology

Epidemiological Changes

Neuropathology is a cellular pathology discipline centred around the diagnosis of diseases of the nervous system with the brain, spine, skeletal muscle and nerves. Ophthalmic biopsies are also reported in many departments of neuropathology. While the majority of neurosurgical biopsies are performed for tumours of the central nervous system (CNS), biopsies are also examined for neurologists, rheumatologists, consultants in medicine of the elderly, and infectious diseases specialists as a part of the investigation of non-neoplastic CNS and neuromuscular disease. CNS tumors have an increasing incidence with age. This includes both primary tumours of the CNS and secondary tumours (as the CNS is a relatively frequent site of metastasis for systemic cancers). As the management of cancers arising outside of the central nervous system (systemic malignancies) has improved with newer chemotherapy and immunotherapy options, there is an increasing demand for neurosurgical resection of metastatic tumours; this can significantly improve outcome for patients in whom their primary tumour is stable on treatment.

Test, Treatments and Technology

Neuropathology referrals are increasing. This reflects a number of developments in medicine, surgery and neuro-oncology. The central nervous system is affected by primary CNS tumours and is also a frequent site of metastasis from tumours elsewhere in the body. Neurosurgical techniques and neuroimaging are constantly advancing, which impacts on the number of patients on whom biopsies are performed.

The molecular classification of primary CNS tumours has radically changed diagnoses. This increases the complexity of reporting of all CNS tumours. It also has practical implications for management, with expanding recognition of diagnostic, prognostic and predictive biomarkers, thus moving towards personalised treatment planning. The specific implications for neuropathology are two-fold. Firstly, more tumours identified on neuroimaging will come to biopsy; in the past, it was acceptable to monitor some brain tumours on imaging over time, or to treat without a specific tissue diagnosis, depending on the imaging characteristics and clinical scenario. In the new histo-molecular-driven assessment, this is less justifiable since the information from the tissue can have significant therapeutic impact. Secondly, access to molecular platforms has to be timely. Moreover, access to molecular platforms is required for more and more tumour categories. This will need an expansion of the molecular neuro-oncology service, with provision for capital investment as well as increased specialist medical scientist staffing.

Many neurosurgical biopsies require intraoperative neuropathology examination, which involves a neuropathologist and a medical scientist (to prepare a frozen section). Intraoperative examinations are frequent in Neuropathology relative to Histopathology. This is because of the complexity of many neurosurgical procedures, particularly in targeting parts of the brain or spine that are difficult to access.

Tissue handling in cases of primary CNS tumours following formalin fixation and paraffin processing is increasingly complex; this reflects refinements in tumour classification with direct therapeutic implications as well as the expanded molecular characterization of primary CNS tumours which has radically changed diagnosis, consequently impacting on patient management. CNS tumour reporting has increasingly evolved to become a multi-step process which additionally incorporates molecular information with standard histology and an expanded and dynamic panel of immunohistochemistry assays.

Molecular neuro-oncology, with its impact on diagnostic and therapeutic decision making is a significant current and future area of need/ expansion for neuropathology in terms of capital investment in molecular platforms, augmentation of medical and scientific staffing and investment in training.

Advances in radiation and medical oncology mean that an increasing number of patients who are treated for systemic malignancies are surviving longer and a proportion of these patients will develop metastases to the CNS. Neurosurgeons are called on to operate to remove these metastases, particularly when the malignancy is otherwise well controlled. This has led to increasing numbers of secondary CNS tumour resections being received in neuropathology which might require further extensive testing in some cases.

Digital pathology is on the verge of becoming a mainstream option for routine diagnostics in tissue pathology. Anticipated advantages include real-time sharing of cases allowing for greater reproducibility in morphologic assessment as well as greater accuracy in spatial correlation across slides and stains from immunohistochemistry or other cytomorphologic assay.

Future advances in the medical treatment of neurodegenerative diseases (in particular Alzheimer's disease) may impact the requirement for specific clinical diagnosis. If medical treatments targeted to specific abnormal proteins in the brain become available, additional neuropathology examinations (both to confirm diagnosis and post-mortem to examine effects of treatment) would be expected.

Health Service Reform/ Service Reconfiguration Policy implications

Surveillance of prior disease is part of the neuropathology remit. Autopsies and brain examination of suspected cases are performed at Beaumont Hospital. This specialist service is provided on a national basis and will require maintenance and refinement, especially as novel techniques for assessment come on stream. In addition, cerebrospinal fluid testing for prior disease is currently performed in Edinburgh. This service will no longer be sustained in 2022. Preparation is underway in Beaumont Hospital to take over this work, with the techniques involved being set up by a specialist scientist.

Other Drivers of Workload Change

Perinatal post-mortem brain examination can provide important information to direct genetic testing. As the perinatal pathology service has expanded nationally, additional neuropathology expertise in this area is necessary.

Neuropathologists form part of neurosciences clinical groups, and work closely within these groups with neurologists (adult and paediatric), neurosurgeons, neuroradiologists, neurophysiologists and neuropsychiatrists. Interpretation of biopsies referred to neuropathology frequently requires considerable clinic-pathological correlation; while some of this can take place in neuro-oncology multidisciplinary team meetings (MDTs), more frequent interdisciplinary consultations and interpretation is necessary for optimal neuropathology reporting. It is difficult, particularly when neuropathology works as a tertiary referral service with specimens coming from a number of outside hospitals, to find time to discuss all complex cases in a situation where staffing is limited.

Neuropathologists are expected to provide input into the training of neuropathology and histopathology trainees. In addition, they also are involved in the training of neurology, neurosurgery and ophthalmology. The expansion of these disciplines will impact on the training workload of neuropathologists. Neuropathologists in Ireland input into research performed by basic scientists, medical scientists and medical graduates undertaking research work or clinical case studies.

Choice of Growth Driver

Due to gaps in the available Irish data on brain tumours, Cancer Research UK 2016-2018 incidence rates of brain tumours were used.

Table 5.7. Growth drivers for Neuropathology

Specialty	Sub-Category	Demand Driver(s)	Source
Neuropathology	None	Incidence of brain tumours & Complexity Index	Cancer Research UK and Expert Judgement

6. Current Unmet Demand and Demand Growth

Current Unmet Demand

In addition to identifying the drivers of growth in demand, the current service gaps also need to be identified. Different approaches were taken to estimating the current unmet demand for each of the specialties, as shown in table 6.1. In some cases, both current service gaps and demand growth are identified from a staffing metric. This is the case in microbiology where current service gaps and growth are driven by ratios of beds to consultant microbiologists. For the other specialties, current service gaps were identified by the Clinical programme on a site by site basis.

Table 6.1. Method for Estimating Current Unmet Demand

Specialty	Method for Estimating Current Unmet Demand
Chemical Pathology	Hospital group survey
Haematology	Hospital group survey
Histopathology	Vacant posts (adult), survey (paediatric and perinatal)
Immunology	Hospital group survey
Microbiology	International staffing standard, minimum cover level
Neuropathology	Hospital group survey

Table 6.2 shows the current estimated service gaps by Regional Health Authority and specialty. The table shows that the 70% of the unmet demand was identified in the specialties of microbiology and haematology.

Table 6.2. Current unmet demand by Regional Health Area and Specialty

WTE	RHA A (NE)	RHA B (Mid-Lands)	RHA C (SE)	RHA D (SSW)	RHA E (Mid-West)	RHA F (WNW)	CHI	National Services*	Total	% of total unmet demand
Chemical Pathology	2.7	1.5				1.6	1		6.8	4%
Haematology	2	9.5	4.4	5.3	0.3	3.9	10.5	3.8	39.7	23%
Histopathology	5	3	0	1	2	3	2	9.5	25.5	15%
Immunology	3	2.5	4	4	2	2	0.5	0	18	10%
Microbiology	15.7	15.6	12.9	14	8.9	10.6	3.3	0.7	81.6	47%
Neuropathology	0.5	0	0	1	0	0	0.5	0	2	1%
Total	28.9	32.1	21.3	25.3	13.2	21.1	17.8	14	173.6	

*Includes IBTS, Cytology and perinatal histopathology

Current unmet demand for microbiology is outlined by hospital model in table 6.3. Model 3 hospitals comprise the largest portion of unmet demand. This is driven by a minimum recommended consultant staffing level of 1.5 WTE per hospital, for larger Model 3 hospitals the recommended number is determined by the staffing standard. Minimum consultant staffing level of 2.0 WTE for maternity hospitals contributes 8.4 addition WTE required, shown below as part of the specialist model of hospital. One of the parameters determining the estimated unmet demand is the 0.83 consultants per 100 beds staffing ratio. A sensitivity analysis of this parameter shows that reducing it to 0.6 consultants per 100 beds reduces the unmet demand from 81.6 to 52.5 WTE.

Table 6.3 Current unmet demand for microbiology consultants by hospital model

Hospital Model	Unmet Demand (WTE)
Model 4	17.2
Model 3	29.5
Model 2	7.6
Specialist	14.8
Community	3.0
Virologist	9.5
Total	81.6

Demand Growth

The increased requirement for consultants is split into two parts: the current unmet demand outlined above and the additional requirements to meet increased demand out to 2035. Table 6.4 below shows the estimated annualised growth rate in demand for each specialty from 2022 to 2035 excluding unmet demand requirements.

Table 6.4. Annual growth rate in demand for each specialty

Speciality (WTE)	Demand Growth Rate
Chemical Pathology	4.4%
Haematology	3.2%
Histopathology	2.5%
Immunology	2.1%
Microbiology	1.6%
Neuropathology	2.3%
Total	2.7%

7. Analysis of the Gap between the Current and Future Supply and Demand

Table 7.1 shows the current actual workforce and the current target workforce as identified by each specialty. The table shows that the discipline believes that it requires an additional 173.6 WTE consultants currently. Table 7.1 also shows the additional 190.8 WTE required out to 2035 to cater for projected growth in demand.

Table 7.1. Current Actual Workforce and Current Target Workforce (Public and Private)

WTE	Current Actual Workforce	Current Unmet Demand	Current Recommended Workforce	Demand growth to 2035	Recommended Workforce 2035
Chemical Pathology	13.5	6.8	20.3	16.8	37.1
Haematology	77.6	39.7	117.3	58.7	176.0
Histopathology	127.2	25.5	152.7	71.3	224.0
Immunology	6.0	18.0	24.0	7.7	31.7
Microbiology	61.8	81.6	143.5	33.5	177.0
Neuropathology	6.0	2.0	8.0	2.8	10.8
Total	292.2	173.6	465.8	190.8	656.6

Table 7.2 shows the HST intake in July 2022 and the level of intake recommended out to 2031. The July 2022 intake of 23 HSTs was well below the current approved intake of 34 HST trainees. An important constraint on the expansion of the training programmes is the capacity of consultant pathologists to allocate time to training. While there may be a clear need to increase the number of HST trainees immediately, in some cases it may not be achievable or desirable to increase the number of HST trainees straight away. There are a number of reasons for this including the need for sufficient BST trainees to feed the HST training programmes, sufficient training capacity within the system and availability of funding for HST training posts. For these reasons, a staged approach to increasing the intake of HST trainees is taken where increases are required. In some cases there is currently training capacity available, for example due to new consultant hires. While the table below represents an ambitious target level of expansion in the training intake, this will not be sufficient to meet the projected demand outlined previously by 2035.

Table 7.2. Current (July 2022) and Proposed HST Intake 2023-2031.

	HST Intake July-2022	Proposed HST Intake July -2023	Proposed HST Intake July -2024	Proposed HST Intake July -2025	Proposed HST Intake July -2026	Proposed HST Intake July -2027	Proposed HST Intake July -2028	Proposed HST Intake July -2029	Proposed HST July - Intake 2030	Proposed HST Intake July -2031
Chemical Pathology	0	3	3	3	5	5	5	5	5	5
Ratio of HST to Consultants	*0.2*	*0.2*	*0.4*	*0.7*	*0.8*	*1.2*	*1.4*	*1.7*	*1.8*	*2.0*
Haematology	6	8	12	15	18	20	20	20	20	20
Ratio of HST to Consultants	*0.4*	*0.4*	*0.4*	*0.5*	*0.6*	*0.7*	*0.8*	*0.8*	*0.8*	*0.4*
Histopathology*	6	10	9	11	14	18	18	18	23	23
Ratio of HST to Consultants	*0.3*	*0.3*	*0.3*	*0.4*	*0.4*	*0.5*	*0.6*	*0.6*	*0.7*	*0.7*
Immunology	1	4	4	4	4	4	4	4	4	4
Ratio of HST to Consultants	*1.3*	*1.0*	*1.5*	*2.1*	*1.9*	*2.4*	*2.1*	*2.6*	*2.6*	*2.3*
Microbiology	10	10	14	14	18	18	20	20	18	14
Ratio of HST to Consultants	*0.5*	*0.5*	*0.7*	*0.8*	*0.9*	*1.1*	*1.2*	*1.3*	*1.4*	*1.4*
Neuropathology**	0	2	2	2	2	1	1	1	1	1
Ratio of HST to Consultants	*0.0*	*0.0*	*0.0*	*0.3*	*0.7*	*0.7*	*1.3*	*1.5*	*1.3*	*1.3*
Total	23	37	44	49	61	66	68	68	71	67

*Does not include year 1 histopathology who go on to neuropathology. ** Intake initially into histopathology.

HSTs in histopathology and neuropathology are typically sourced from the BST programme in histopathology. Table 7.3 shows the required intake to feed the HST programme.

Table 7.3. Current and Proposed BST Intake Allocation 2022-2031

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Histopathology	10.0	12.0	15.0	20.0	20.0	20.0	25.0	25.0	25.0	25.0
Neuropathology	1.1	2.1	2.1	2.1	2.1	1.1	1.1	1.1	1.1	0.0

Table 7.4 shows the number of new consultant posts that need to be created and filled to achieve these workforce projections. The table does not include any pathologists who are trained abroad. The table shows the long lag between the new intake of trainees and available Irish trained specialists that can be appointed to consultant posts.

Table 7.4. Projected New Hires

Headcount	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total
Chemical Pathology	0.8	0.0	0.0	0.0	0.0	1.6	0.0	0.8	0.0	2.4	2.4	2.4	4.0	4.0	18.2
Haematology	2.4	1.6	4.7	3.2	0.0	6.3	6.3	6.3	4.7	6.3	9.5	11.9	14.2	15.8	93.2
Histopathology	7.7	0.9	7.7	8.5	8.5	3.4	5.1	8.4	7.7	9.2	11.5	15.3	15.3	15.3	124.3
Immunology	0.8	0.0	1.6	0.8	0.0	2.4	0.8	1.0	1.4	3.2	3.2	3.2	3.2	3.2	24.5
Microbiology	0.0	1.6	1.6	6.3	4.7	0.0	4.7	4.7	7.9	7.9	11.1	11.1	14.2	14.2	90.1
Neuropathology	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	0.8	7.1
Total	11.7	4.1	15.6	18.8	13.2	13.7	16.9	21.2	21.7	30.6	39.3	45.5	52.5	53.3	357.4

Table 7.5 outlines the projected supply of consultants from 2022 to 2035 and the projected gap between supply and demand in 2035.

Table 7.5. Projected Supply

WTE	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Outstanding Gap 2035
Chemical Pathology	13.5	12.9	11.7	11.6	11.5	12.8	12.6	13.2	13.1	15.1	15.1	17	19.4	21.9	15.2
Haematology	77.6	72.6	73.7	73.4	71.9	76.4	79.1	81.6	82.7	84.3	92.6	98.5	110.3	120.7	56.3
Histopathology	127.2	121.3	127.4	132.3	136.2	132.3	134	135	135.4	139	142.8	152	157.5	168.6	55.3
Immunology	6	6.7	8.2	8	7.9	10.2	9.9	9.8	11.2	14.2	17.3	20.3	23.3	26.3	5.4
Microbiology	61.8	57.3	57.3	62.4	63.2	60.8	64.5	65.4	70.9	74.6	81.9	87.4	96.5	102.9	75.5
Neuropathology	6	5.9	5.9	5.8	5.8	4.8	4.7	4.7	4.7	6.2	7.8	9.3	9.8	10.5	0.2
Total	292.2	276.7	284.2	293.5	296.5	297.3	304.8	309.7	318	333.4	357.5	384.5	416.8	450.9	207.9

Table 7.6 compares the current number of consultants per 100,000 with the projected number for 2035. The table shows the substantial increases in the ratios in some of the specialties, however these crude population ratios are not adjusted for demographic aging.

Table 7.6. Current Actual Workforce and Projected Workforce 2035 per 100,000

Headcount	Current Actual per 100,000	Projected Workforce per 100,000
Chemical Pathology	0.27	0.42
Haematology	1.60	2.28
Histopathology	2.62	3.49
Immunology	0.12	0.45
Microbiology	1.31	2.13
Neuropathology	0.12	0.19
Total	6.03	8.95

8. Discussion

The report outlines substantial shortages of consultants in the current pathology service across many specialties. A number of common factors are driving increased demand for consultant pathologists. These include demographic pressures increasing chronic diseases, and the increasing complexity of many of the tests being carried out by pathologists.

There are currently 292 consultant pathologists (WTE) working in the Irish health system. There are 49 vacant post, 21 of which have been vacant for more than one year. The clinical programmes have identified 174 additional currently required consultants (includes vacant posts). Substantial gaps in the current service have been identified in all specialties but particularly in microbiology which comprises 47% of the identified unmet demand.

A wide range of factors have been used in the report to project growth in demand over the period to 2035. The demand for consultant pathologists (excluding current unmet demand) is projected to grow at a rate of 2.7% per year. On aggregate, to meet current unmet demand and future increases in demand an average growth rate of 6.4% will be required.

However, increases in the workforce cannot be achieved quickly. At a minimum it takes 5 years to complete a HST training programme. After accounting for leave years (eg maternity leave) and post CSCST fellowships, the average time between entering HST and taking up a consultant post is likely to be substantially longer.

A key restriction in achieving increased HST training numbers is attracting a sufficient number of suitable candidates. This situation is not restricted to Ireland with difficulties in recruiting a sufficient number of new trainee being noted in a range of countries [38]. A range of studies have shown that a lack of exposure to, and understanding of pathology, is a significant hindrance to recruitment (ibid). This highlights the importance of pathology in BST general medicine rotations. Other mechanisms may also be required to increase the visibility of some of the less popular specialties of pathology.

Onerous on call rotas are experienced widely in a number of specialties and sites. These onerous on call rotas are likely to reduce the attractiveness of specialties to new trainees; new consultant posts in sites with onerous on call rotas are likely to reduce the attractiveness of these posts resulting in posts being vacant for extended periods. Onerous on call rotas may also result in the earlier retirement of consultants. In the UK, a review of on call commitments for all older clinicians has been called for, allowing a degree of flexibility and including options such as day-time on-call only (Academy of Medical Royal Colleges, 2018). With the exception of clinical management of in-patients in haematology, the on-call service required is largely complex and needs to be consultant delivered. It is possible that senior trainees in some specialties could provide supervised sessional on call (evenings and weekends), which would have a modest impact on onerous consultant on-call. However such exposure to on-call scenarios has significant training value.

Pathology is integral to the functioning of the health service. The services provided by the specialties of pathology need to be explicitly linked to the clinical service plans of other specialties. For example, initiatives to clear waiting lists or develop cancer services need to explicitly incorporate pathology in the planning process.

Chemical Pathology

Consultant chemical pathologists are medically trained consultants involved in the provision of clinical biochemistry services including the clinical management of patients with metabolic disorders. In addition to laboratory governance and sample interpretation, consultant chemical pathologists provide direct care through outpatient clinics, participation in multidisciplinary team meetings and to inpatients.

Most chemical pathologists do an onerous 1 in 1 on call rota and are often covering more than 1 site. An additional 6.8 WTE consultant chemical pathologists are required to meet the current unmet demand. These additional consultants will extend consultant cover to sites without cover, sites that are covered though a small number of sessions currently, and public sites that are covered remotely by a private sector consultant.

A further 16.8 addition WTEs are required to cater for the projected increased demand – this equates to an annual growth rate in demand of 4.4%. Projected increases in conditions such as obesity, dyslipidaemia, diabetes and osteoporosis will drive the

demand for consultant chemical pathologists. Initiatives to deal with these conditions will lead to large increases in demand for pathology services. For example there have been large increases in recent years in HbA1c and NT-proBNP testing as a result of the chronic disease management programme. Routine biochemistry (renal/liver profiles etc) will also be required for the majority of these patients. The requirement for clinical advisory services will increase in line with the test numbers.

The proposed increases in the number of consultant chemical pathologists will allow for capacity to meet the projected increased demand both within the laboratory and associated clinical out-patient services. The proposed increases will also allow for an expansion of near patient testing services in primary and secondary healthcare for which consultant supervision is essential.

Haematology

Haematology is the specialty responsible for the diagnosis and management of a wide range of benign and malignant disorders of the red and white blood cells, platelets and the coagulation system in adults and children. Haematologists specialise in both haematopathology (including transfusion medicine) and the clinical care of patients with blood related disorders.

A survey of haematology sites identified substantial workforce gaps across a range of service areas and sites. Of the 39.7 additional WTE consultant haematologists identified, 11.3 were related to adult malignant care and a further 10.5 were in the CHI. These additional post will allow for: the implementation of the national cancer strategy; increased inpatient and ambulatory day care capacity; management of acute capacity challenges in ambulatory day units and inpatient units; the centralisation of leukaemia services which has resulting in increased clinical and laboratory workload; the provision of the survivorship programme; providing MDTs for all haematological malignancies in line with national cancer strategy, which requires dedicated time for preparation and attendance; the development of children, adolescent and young adult services.

A further 58.7 addition WTE are required to cater for the projected increased demand out to 2035 – this equates to an annual growth rate in demand of 3.2%. The key drivers in the growth in demand for consultant haematologists is the adult malignant and laboratory workloads. The projected growth in demand for these services is modelled by the historic (pre-Covid) growth rate in the prevalence of blood cancers, and laboratory tests respectively. In the short term this may understate the demand for haematology as demand re-bounds post-Covid. However, over the period of the model with substantial uncertainty, these represent the best estimate of future demand growth.

Reducing reliance on non-training scheme doctors is a key goal of NDTP workforce planning projections. Currently the provision of a safe and efficacious clinical haematology service around the country is only made possible by a large number of NTSDs supporting the service. NTSDs can only be phased out with an increase in SpR numbers. Based on the proposed increase in HSTs being met by converting NTST posts, the number of NTSDs could be reduced to a minimal level over a seven year time frame. Such a transformation will require additional advanced nurse practitioners to free up time for laboratory experience, and other training activities, while ensuring that the needs to provide routine care is met.

The Enhanced Community Care and the Chronic Disease Management programmes bring laboratory tests closer to home and so increased laboratory activity is and will be seen in Model 3 Hospitals. This will result in a corresponding increase in the need for easily available clinical advice. Medical Assessment Units and acute inpatient care and the Model of Care in the Cancer strategy, with enhanced ambulatory care closer to the patient's home, are all challenges to the haematology consultant staffing of Model 3 Hospitals. Some Model 3 sites operate a hub and spoke model with consultant haematologists based in the group Model 4 hospital providing the service. This works best where the spoke site is in close proximity to the hub. This model has the benefit of a broader roster, in that all consultants in all sites participate in the roster but because of need for level 4 inpatient cover they are not available on call to attend these hospitals if the need were to arise. This is unsatisfactory if ICUs and maternity units are on these sites. In Model 3 Hospitals that are more peripheral to the hub site, consultants may be based on site. The rotas on these posts can be onerous with poor work life balance. An advantage of this model is on site laboratory Governance. Increased rotations of trainees through Model 3 hospitals as part of training would be beneficial to these services.

While the focus of the report is on estimating the required HST intake number for each year, there is an imminent transfusion consultant crisis with unfilled transfusion specialists posts and impending retirements with no succession planning.

Histopathology

Histopathology involves the examination of tissue or cells which have been removed from a patient in a clinic or during an operation, to discover if disease is present and what course of action should be taken. Autopsy is another component of a histopathologists' role and determines how someone has died.

The number of vacant posts was used to identify the current unmet demand for consultant histopthologists with additional requirements for cytology, perinatal and paediatric services. A total current unmet demand of 25.5 WTE was identified. A further 71.3 addition WTE are required to cater for the projected increased demand out to 2035 – this equates to an annual growth rate in demand of 2.5%. This projected growth in demand is driven by continued growth in the number of cases in line with recent years. The complexity of specimens has been increasing rapidly in recent years. While an adjustment has been included in the model for further increases in the complexity of cases there is a high degree of uncertainty in the projected change in the complexity of specimens.

The number of autopsies requested by coroners has grown rapidly in recent years. This workload forms a substantial part of histopathologist workload in regional centres. This is a valuable training resource under appropriate consultant supervision. It is hoped that additional consultant posts which acknowledge and address this workload will be created in the near future with the support of the Coroners and the Department of Justice.

Immunology

Clinical immunologist's workload includes the direct analysis of specimens and laboratory governance, and the management of patients with immunological disorders with large outpatient commitments. The demand for immunology has been growing rapidly in recent years primarily due to the rise in the prevalence of allergic diseases.

There are currently 6 consultant immunologists in post, with 4 funded vacant posts for which recruitment has been unsuccessful. The clinical programme has identified a current additional requirement for 18 posts (which includes the 4 vacancies). The total target workforce for 2035 is 32 consultants. This would bring the Irish workforce in line with the UK.

There is scope to improve allergy services by recruitment of Advanced Nurse Practitioners (ANPs), to provide much needed specialist care for children transitioning into adult care. ANPs work as part of the multi-professional team, and require training by consultant immunologists, as well as on-going supervision and support. Hence support of allergy services with ANPs will provide much needed improvement in access and capacity of allergy services, but will not negate the need for the proposed number of consultant immunologists outlined in this report.

Microbiology

The role of the consultant clinical microbiologist is wide ranging and includes laboratory diagnosis, clinical consultation, laboratory management, antibiotic stewardship and infection prevention and control. Consultant clinical microbiologists provide a 24/7 service, advising on diagnosis, antimicrobial therapeutics and overall infection management for all patient groups in both acute and community setting.

A high level of unmet demand was identified by the specialty. Current unmet demand was estimated at 81.6 WTE. This is driven by a combination of a requirement for an increased level of staffing per bed in larger hospitals, minimum staffing levels in smaller hospitals, a dedicated virology service and community microbiology services.

At a local level, hospitals need to be appropriately staffed based on their bed numbers, laboratory specimen numbers, and the complexity and specialist services e.g. regional services, specialist departments e.g. paediatrics, maternity. For the purpose of this report, the current recommended workforce for the model 4 hospitals is based on a consultant per bed ratio. For the Model 3, Paediatric and Maternity hospitals a minimum consultant level is an important factor driving the increased requirement for consultants. All level 3 hospitals are recommended to have a minimum of 2 consultant microbiologists (1.5 WTE), one consultant to lead the IPC Programme and one consultant to lead the AMS Programme. This will also ensure that service delivery may be maintained when one consultant is on leave.

Onerous rostering is currently the norm in clinical microbiology, with most consultants on 1:1 to 1:4 on-call rotas. On call rotas substantially below 1:5 are recognised as being onerous [39]. While most calls to the on call consultant are made before 11pm it

is not uncommon to receive calls between 11pm and 7am [7]. The intensity and complexity of the on-call service has increased dramatically in recent decades with previous manpower estimates (e.g. the Hanly report) not now reflective of the current work patterns or workload of clinical microbiologists.

Microbiology NCHDs do not participate in out-of-hours service provision in most hospitals. Due to staff shortages, most IPC and AMS services are now completely reactive – i.e. only have capacity to deal with problems rather than a preferable proactive service where surveillance, stewardship, enhanced user involvement with education, audit, feedback and patient involvement lead to improvements at both patient and institutional level.

The proposed increases in training and consultant numbers outlined in this report would allow for sustainable on call rotas of 1:8; cover for leave in Model 3 and specialist hospitals; and additional proactive services. The large proposed increase in consultant staffing will bring Ireland into line with European norms of consultant numbers per hospital beds.

The modelling in this report relies on a crude WTE per bed metric for Model 4 hospitals. There is significant uncertainty in the potential growth rate of the number of hospital beds. There are also uncertainties around the epidemiological context such as the development of communicable diseases such as Covid-19, multidrug-resistant organisms, and cancer care.

Neuropathology

Neuropathology is a cellular pathology discipline centred on the diagnosis of diseases of the nervous system – brain, spine, skeletal muscles and nerves. Ophthalmic biopsies are also reported in many departments of neuropathology. In addition to reporting neurosurgical specimens, neuropathologists also undertake post-mortem examinations in the form of whole-body autopsies and specialist examination of post-mortem brains, spinal cords, nerve and muscles.

There is a requirement for 2 additional neuropathologists – one in Cork University Hospital and one in Beaumont with sessional commitments to CHI. The business plans and applications for these posts are currently underway. These additional post will allow for integration of expanded molecular reporting of CNS tumours, increasing requirement for post-mortem perinatal CNS examinations, reporting of prion disease investigations and appropriate delivery of clinical advice based on neuropathology investigations.
An additional 2.5 WTE consultants is projected to be required by 2035. This projected increase in demand is based on population aging, with an increasing incidence of brain tumours in older age groups. The growth in demand is also based on the complexity of specimen preparation and reporting, which has increased substantially.

References

1. Robboy, S.J., et al., The pathologist workforce in the United States: II. An interactive modeling tool for analyzing future qualitative and quantitative staffing demands for services. Archives of Pathology & Laboratory Medicine, 2015. 139(11): p. 1413-1430.

2. Maung, R.T., et al., Pathology workload and human resources in Canada-Trends in the past 40 years and comparison to other medical disciplines. Canadian Journal of Pathology, 2020. 12(1).

3. Cheung, C.C., et al., Modeling complexity in pathologist workload measurement: the automatable activity-based approach to complexity unit scoring (AABACUS). Modern Pathology, 2015. 28(3): p. 324-339.

4. AHSN. 2017 11/10/2022]; Available from: https://www.ahsnnetwork.com/case-study/faecal-calprotectin-pathway.

5. RCPI, Review of the Office of the State Pathologist 2019.

6. National Cancer Strategy 2017-2026. 2017, Dept. of Health,: Dublin.

7. Humphreys, H., Out-of-hours calls in clinical microbiology: the when, the why and from whom. European Journal of Clinical Microbiology & Infectious Diseases, 2020. 39(2): p. 287-291.

8. Hanly, D., Report of the National Task Force on Medical Staffing. -79, 2003.

9. Roberfroid, D., C. Leonard, and S. Stordeur, Physician supply forecast: better than peering in a crystal ball? Human resources for health, 2009. 7(1): p. 1-13.

10. Legg, M., The Australian pathology workforce crisis. 2008.

11. Bennett, A., et al., Building a laboratory workforce to meet the future: ASCP Task Force on the Laboratory Professionals Workforce. American journal of clinical pathology, 2014. 141(2): p. 154-167.

12. Carr, R., T. Helliwell, and S. Sanders, Guidelines on staffing and workload for histopathology and cytopathology departments September 2015. 2015.

13. Märkl, B., et al., Number of pathologists in Germany: comparison with European countries, USA, and Canada. Virchows Archiv, 2021. 478(2): p. 335-341.

14. RcPath. 2021; Available from: https://www.rcpath.org/profession/workforce-data.html.

15. RCPA, New Zealand Pathologist Workforce Study 2018.

16. Metter, D.M., et al., Trends in the US and Canadian pathologist workforces from 2007 to 2017. JAMA network open, 2019. 2(5): p. e194337-e194337.

17. Martin, J., Meeting pathology demand: Histopathology workforce census. London: Royal College of Pathologists, 2018.

18. RCPA, Australian Pathologist Workforce Study 2018, The Royal College of Pathologists of Australasia, Editor. 2018.

19. RcPath. 2022; Available from: https://www.rcpath.org/discover-pathology/public-affairs/the-pathology-workforce.html.

20. RcPath, The haematology laboratory workforce: challenges and solutions. 2020.

21. Lawrence, S., et al., The State of Infection Services in the UK: British Infection Association Workforce Survey 2021. Clinical Infection in Practice, 2022: p. 100151.

22. Satta, G. and J. Edmonstone, Consolidation of pathology services in England: have savings been achieved? BMC health services research, 2018. 18(1): p. 1-7.

23. Van Greuningen, M., R.S. Batenburg, and L.F. Van der Velden, Ten years of health workforce planning in the Netherlands: a tentative evaluation of GP planning as an example. Human Resources for Health, 2012. 10(1): p. 1-15.

24. Keegan, C., et al., Projections of expenditure for public hospitals in Ireland, 2018–2035, based on the Hippocrates Model. ESRI Research Series 117 December 2020. 2020.

25. NDTP, NDTP Annual Report. 2019.

26. Warth, A., et al., Individualized medicine and demographic change as determining workload factors in pathology: quo vadis? Virchows Archiv, 2016. 468(1): p. 101-108.

27. CSO. 2019; Available from: https://www.cso.ie/en/releasesandpublications/ep/p-plfp/populationandlabourforceprojections2017-2051/populationprojectionsresults/.

28. Howdon, D. and N. Rice, Health care expenditures, age, proximity to death and morbidity: Implications for an ageing population. Journal of health economics, 2018. 57: p. 60-74.

29. Ipsos, M., Healthy Ireland survey 2015: summary of findings. 2016: Department of Health (DoH).

30. Pierse, T., et al., A simulation study of the economic and health impact of a diabetes prevention programme in Ireland. Diabetic Medicine, 2021. 38(6): p. e14540.

31. McMahon, L., et al., Irish Maternity Indicator System National Report. 2019. 2020.

32. Arranz, A.O., When gravity hits: projecting Ireland's migration. 2019.

33. Lewis, T., M. Wood, and M. Myers, Pathology GIRFT Programme National Specialty Report. 2021.

34. Kattan, J., The prevalence and natural history of food allergy. Current allergy and asthma reports, 2016. 16(7): p. 1-7.

35. Rudders, S.A., S.A. Arias, and C.A. Camargo, Trends in hospitalizations for food-induced anaphylaxis in US children, 2000-2009. Journal of Allergy and Clinical Immunology, 2014. 134(4): p. 960-962. e3.

36. RCP, Consultant Physicians Working With Patients. 2013, Royal College of Physicians. : London.

37. Dickstein, Y., et al., Staffing for infectious diseases, clinical microbiology and infection control in hospitals in 2015: results of an ESCMID member survey. Clinical Microbiology and Infection, 2016. 22(9): p. 812. e9-812. e17.

38. Fielder, T., et al., Why Choose a Pathology Career? A Survey of Australian Medical Students, Junior Doctors, and Pathologists. Archives of Pathology & Laboratory Medicine, 2022. 146(7): p. 903-910.

39. HSE. Proposals for provision of compensatory rest for Consultants on 1:3 and 1:4 rotas. 2013 14/10/22]; Available from: https://www.hse.ie/eng/staff/resources/terms-conditions-of-employment/ccontract/comprestconsultants.pdf.

40. Graves, D., The impact of the pathology workforce crisis on acute health care. Australian Health Review, 2007. 31(5): p. 28-30.

Appendix

Detailed Workforce Supply and Demand Assumptions

Table A1. Supply Model Parameter Values

Parameter	Chemical Pathology	Haematology	Histopathology	Immunology	Microbiology	Neuropathology
Retirement age	65	62	62	62	62	62
WTE Rate	0.86	0.92	0.92	1.0	0.91	1.0
CSCST Attrition Rate	21%	21%	15%	21%	21%	21%
Years abroad between CSCST and Consultants post	1	2	2	1	2	1
Additional Years pre CSCST (eg. Maternity Leave)	1	1	1	2	1	1
Gender breakdown of HST intake	100%	50%	71%	75%	83%	71%
BST-HST Attrition Rate			5%			
Exit rates private sector	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Additional exits female (under 55)	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%
Additional exits male (under 55)	0.54%	0.54%	0.54%	0.54%	0.54%	0.54%

Table A2. Demand Model Parameter Values for Chemical Pathology

Demand Assumptions	Value	Source	Description
Growth rate in specimen/test numbers	4.4%	Clinical Programme	Average growth Rate in specimen numbers (St James) from 2016 to 2022 projected.

Table A3. Demand Model Parameter Values for Haematology

Demand Assumptions	Value	Source	Description
IBTS	2.0%	TBC	Growth in Over 50 year old population
Laboratory work	4.9%	Based on CUH	Historic growth in lab tests extrapolated
Adult Malignant	3.9%	Cancer Registry	Historic cancer prevalence growth rates (2009 to 2019) C81-C96
Adult Benign: Haemoglobinopothy	5.0%	CSO	Historic growth rate in black/Asian/mixed ethnicities
Adult Benign: Thrombosis services (inc National Coagulation Centre)	2.0%	Kevane et al. 2019	VTE incidence rates*Population Projection
Adult Benign Obstetrics	0.0%	CSO	Projected Births (M2F2)
Adult Benign Other	0.7%	CSO	Projected growth in Population
Paediatric Malignant	-1.0%	CSO	Projected growth in Paediatric Population
Paediatric Haemoglobinopothy	5.0%	CSO	Historic growth rate in black/Asian/mixed ethnicities
Paediatric Benign	-1.0%	CSO	Projected growth in Paediatric Population
Other Activities (Teaching and Research, Palliative Care)	5.0%	Based on current estimate	Proportion of Workforce

Table A4. Demand Model Parameter Values for Histopathology

Demand Assumptions	Value	Source	Description
Growth rate in cases	2.7%	National Quality Improvement Programme	Average annual growth rate in the number of cases.
Annual Growth in Complexity	0.5%	Clinical Programme	Based on expert judgement
Growth in Paediatric Demand	0.0%	CSO	Paediatric population growth rate
Growth in Perinatal Demand	0.0%	CSO	Paediatric population growth rate

Table A5. Demand Model Parameter Values for Immunology

Demand Assumptions	Value	Source	Description
Target population Ratio per 100,000	0.58	Current UK	

Table A6. Demand Model Parameter Values for Microbiology

Demand Assumptions	Value	Source	Description
Growth Rate in Hospital Beds	2.1%	Health Service Capacity Review	Average across with and without reform scenarios
WTE per 100 Beds	0.83	ESCMID	
Minimum Number of consultants in Model 3 Hospitals (WTE)	1.5	Clinical Programme.	Minimum required to ensure service delivery is maintained when one consultant is on leave.
Minimum Number of consultants in Maternity and Children's Hospitals (WTE)	2.0	Clinical Programme.	
WTE per RHA	0.5	Clinical Programme.	
Lead virologists per 500,000 population	1.0	UK Trust Model.	

Table A7. Demand Model Parameter Values for Neuropathology

Demand Assumptions	Value	Source	Description
Growth rate in Cases	1.8%	Cancer Research UK and CSO population Projections	Incidence rates by age and gender of Brain, Other CNS and Intracranial Tumours (C70-C72, C75.1-C75.3, D32-D33, D35.2-D35.4, D42-D43, D44.3-D44.5): 2016-2018
Annual Growth in Complexity	0.5%	Expert Judgement	

Notes

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