NCP IR NATIONAL CLINICAL PROGRAMME FOR INTERVENTIONAL RADIOLOGY

# Model of Care for Interventional Radiology

## Incorporating Body Interventional Radiology and Neurointerventional Radiology (Adults and Paediatrics)

**FEBRUARY 2026**


RCSI UNIVERSITY OF MEDICINE AND HEALTH SCIENCES

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# GLOSSARY AND INTERPRETATION GUIDE

**Body IR** – Body IR procedures are performed throughout the body usually excluding the head and neck.

**Neuro IR** – Neuro IR procedures are performed in the head, neck and spine with some overlap with Body IR where Neuro IR is not available.

**Paediatric IR** – Paediatric IR procedures are performed on children under the age of 16 but with mostly similar procedures to adult Body IR and Neuro IR.

**Interventional Radiologist** - Consultant radiologist who has completed at least 2 years of certified fellowship training in IR and clinical practice.

**IR Suite** – Refers specifically to the fluoroscopic procedure room itself (similar to operating room suite), where image-guided interventions are performed. It is the clinical environment that houses the imaging system and interventional table.

**IR Unit** – Refers to the entire organisational entity that provides IR services, including all physical spaces, staff, and resources required to deliver IR procedures and patient care.

**Radiology Department** – Refers to the overall entity responsible for all imaging and image-guided services within a hospital. It covers both diagnostic and interventional services.

**Level 1 IR Procedures** – Non-complex IR procedures that should be within the proficiency of all trainee radiologists exiting the Irish radiology training programme (5 years). Examples of common Level 1 IR procedures are biopsies and drainage.

**Level 2 IR Procedures** – Advanced or complex IR procedures that require more extensive and dedicated IR training (2 years minimum); and a higher level of technical skill, and clinical expertise. Examples of Level 2 IR procedures are embolisation and angiographic procedures.

**IR Session** – An IR session is a half-day period (usually 3.5–4 hours) during which an IR consultant carries out a defined area of clinical activity.

## HSE HEALTH REGIONS AND HOSPITALS

| HEALTH REGION | MODEL 4 HOSPITALS | MODEL 3 HOSPITALS |
|---|---|---|
| HSE Dublin and North East | Beaumont Hospital<br>Mater Misericordiae University Hospital | Cavan General Hospital<br>Connolly Hospital<br>Our Lady of Lourdes Hospital, Drogheda<br>Our Lady's Hospital, Navan |
| HSE Dublin and Midlands | St James's Hospital<br>Tallaght University Hospital | Regional Hospital Mullingar<br>Midland Regional Hospital Portlaoise<br>Midland Regional Hospital Tullamore<br>Naas General Hospital |
| HSE Dublin and South East | St Vincent's University Hospital<br>University Hospital Waterford | St Luke's General Hospital, Kilkenny<br>Tipperary University Hospital<br>Wexford General Hospital |
| HSE South West | Cork University Hospital | Mercy University Hospital<br>University Hospital Kerry |
| HSE Mid West | University Hospital Limerick | |
| HSE West and North West | University Hospital Galway | Letterkenny University Hospital<br>Mayo University Hospital<br>Portiuncula University Hospital<br>Sligo University Hospital |

Body IR is performed in all nine Model 4 hospitals and 10/17 Model 3 hospitals

Neuro IR is performed in the two national neuroscience centres at Beaumont Hospital and Cork University Hospital.

Paediatric IR is predominantly performed in Children's Health Ireland in Crumlin and Children's Health Ireland in Temple Street, under the governance of HSE Dublin and Midlands.

***A note on terminology used in this document.***

When describing interventional *procedures or conditions* treated by IR, a distinction is made between Body IR and Neuro IR. Within those categories, there are references to adults and children as appropriate.

When describing the *organisation and delivery of IR services*, a further distinction is made to separate Paediatric IR. This is because the delivery model for Paediatric IR differs significantly from adult services.

# ABBREVIATIONS

| | |
|---|---|
| AI | Artificial Intelligence |
| ANP | Advanced Nurse Practitioner |
| AVM | Arteriovenous Malformation |
| CHI | Children's Health Ireland |
| CNM | Clinical Nurse Manager |
| CNS | Clinical Nurse Specialist |
| CPD | Continuing Professional Development |
| cSDH | Chronic Subdural Hematoma |
| CSO | Central Statistics Office |
| CSR | Clinical Specialist Radiographer |
| CT | Computed Tomography |
| DR | Diagnostic Radiology |
| DVT | Deep Venous Thrombosis |
| ENT | Ear Nose and Throat |
| EVT | Endovascular Thrombectomy |
| GI | Gastrointestinal |
| GP | General Practitioner |
| HCA | Healthcare Assistant |
| HIPE | Hospital In-Patient Enquiry |
| HSE | Health Service Executive |
| IR | Interventional Radiology |
| KPI | Key Performance Indicator |
| MDT | Multidisciplinary Team |
| MMA | Middle Meningeal Artery |
| MOC | Model of Care |
| MRI | Magnetic Resonance Imaging |
| NCH | National Children's Hospital |
| NCP | National Clinical Programme |
| NCP IR | National Clinical Programme for Interventional Radiology |
| NDTP | National Doctors Training and Planning |
| NIMIS | National Integrated Medical Imaging System |
| NRQI | National Radiology Quality Improvement |
| OPD | Outpatient Department |
| PACS | Picture Archive Communication System |
| PBRA | Population-Based Resource Allocation |
| PE | Pulmonary Embolism |
| PICC | Peripherally Inserted Central Catheter |
| PPH | Postpartum Haemorrhage |
| RCR | Royal College of Radiologists |
| RIS | Radiology Imaging System |
| SI | Special Interest |
| SLA | Service Level Agreement |
| UAE | Uterine Artery Embolisation |
| US | Ultrasound |
| WHO | World Health Organization |
| WTE | Whole Time Equivalent |
| YE | Year Ending |

# Foreword

The National Clinical Programme for Interventional Radiology (NCP IR) was established in October 2023 and is pleased to publish the first HSE-approved Model of Care for Interventional Radiology. The aim of this Model of Care is to provide a national framework for the delivery of 24/7, networked acute and elective interventional radiology (IR) services for Irish patients over the next 10 years. This model for future delivery of IR services is based on an increasing clinical practice model to fully serve patients.

The model aligns with the implementation of Sláintecare, the new health regions, and models of care and strategy documents from other clinical services. We set out to make an inclusive Model of Care to act as a roadmap for the future provision of services in Body IR, Neuro IR and Paediatric IR in both Model 3 and Model 4 hospitals.

This document would not have been possible without significant input from our own IR colleagues across the country and the valuable input and insight gained from consultation with many other national programmes, nursing, radiography and the wider healthcare community. We also want to thank our patients for giving permission for the NCP IR to publish their experiences of IR treatments in their own words in highlighted patient stories throughout the text.

The clinical range of conditions treated by IR is expanding every year, and the requirement for IR services is also increasing on a year-to-year basis. This Model of Care provides a roadmap for the delivery of patient-centred care and improved access to IR consultation and services, improving patient outcomes and returning patients to their lives as soon as possible.

Delivering IR care requires a team of professionals in the IR suite and to support patients before and after IR care. This Model of Care reflects not only the general requirements of emergent and acute inpatient IR service delivery, but also the need to develop training for healthcare professionals, outpatient treatment pathways and improve the availability and patients' acceptance of new and emerging IR treatments. Implementation of this Model of Care will require time and appropriate funding but will ensure that Irish patients have safe, equitable and timely access to important IR services.

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# Executive Summary

The aim of this Model of Care for Interventional Radiology (IR) is to assess the current situation of Body IR, Neuro IR and Paediatric IR services in Ireland and to propose an expert-informed plan for robust future IR services in line with the Sláintecare objectives of delivering a patient-centred service across community and hospital services and as close to patients' homes as possible. It encompasses both elective (scheduled) IR care and emergency (unscheduled) IR care.

The population health principles of equity in health, sustainability, and integration of care underpin the Model of Care and associated recommendations. It is intended that this Model of Care will enable high-quality, standardised care and equity of access for patients requiring IR.

This Model of Care enables the implementation of many national strategies and policies, including the National Trauma Strategy, the National Stroke Strategy, the Emergency Medicine Programme Model of Care 2025, the Model of Care for Acute Surgery, the Vascular Surgery Model of Care, the National Women and Infants Health Programme, and the National Acute Medicine Programme, as well as many others.

This Model of Care also outlines future demand for IR consultants in Ireland and makes recommendations on the higher specialist programme intake on an annual basis to meet this demand until 2038 and to deliver equitable access to IR care in both in- and out-of-hours scenarios.

Since the early 2000s, IR has become a primarily *therapeutic* discipline, compared with *diagnostic* radiology. As IR procedures are image-guided, an expert knowledge of imaging physics, radiation safety, pathophysiology, anatomy, tissue characteristics, and medical device characteristics, as well as real-time image interpretation skills and procedural skills and knowledge, is required. Interventional radiologists also need to understand clinical issues such as patient selection, indications and contraindications, procedure characteristics, anticipated results, complications, postoperative care, and longitudinal care. Given the increasing number and complexity of IR procedures, involvement in clinical practice is a logical next step and necessary for safe patient care.

IR services are delivered by teams of IR consultants, nurses, radiographers and healthcare assistants (HCAs), who work closely together and with clinical teams across the healthcare spectrum, including general surgery, emergency medicine, trauma and orthopaedics, obstetrics and gynaecology, paediatric surgery and medicine, and anaesthesiology, among others. Neurointerventional radiologists similarly adopt a multidisciplinary approach to patient care, working closely with colleagues in neurosurgery; stroke; neurology; ear, nose and throat surgery; and plastic surgery, among others.

## Current Interventional Radiology Services

Data to inform the Model of Care for IR were gathered through the following means:

- The National Clinical Programme for Interventional Radiology undertook a comprehensive 'as is' assessment of IR services in all Model 3 and Model 4 hospitals in late 2023 and early 2024. Data were obtained via structured surveys, engagements with IR consultants, and local and national IR systems.
- IR procedure numbers were obtained for all of the Model 3 and Model 4 hospitals that use the National Integrated Medical Imaging System (NIMIS) (85%) courtesy of the NIMIS office, and data from non-NIMIS hospitals were obtained by direct communication with the hospitals in question.
- IR consultant numbers were identified through engagement with each Model 3 and Model 4 hospital and also sourced from the National Doctors Training and Planning (NDTP) Doctors Integrated Management E-System (DIME).

Significant service deficits, geographic variations in availability, and inequality of IR services are present; most notably, there are inconsistent out-of-hours emergency IR services within and across health regions, a lack of formal transfer arrangements, and deficits in workforce resources. Moreover, IR suffers from key structural and governance challenges, including a lack of independent specialty status, training gaps, current and future workforce shortages, limited time for clinical practice, and poor visibility within the healthcare system.

Currently, all 9 Model 4 hospitals and 10 of the 17 Model 3 hospitals in Ireland provide an IR service within core working hours. Only three of the nine Model 4 hospitals provide an out-of-hours service (two in the same health region), resulting in four of the six health regions having no out-of-hours IR service.

Paediatric IR is currently an unfunded service with limited resources and no out-of-hours service. Neurointerventional procedures are performed by neurointerventionalists in the neurosurgical centres at Beaumont Hospital and Cork University Hospital.

There were 50,488 Body IR procedures performed in public hospitals in 2023. The number of Body IR procedures performed annually increased by 12% between 2017 and 2023, an average of 2% per year. The number of Level 2 (more complex) IR procedures performed annually increased by 18% between 2017 and 2023, an average of 3% per year. The number of out-of-hours IR procedures performed annually increased by 11% between 2019 and 2023.

The number of Paediatric IR procedures performed annually doubled in the period from 2019 to 2023.

The overall number of Neuro IR procedures performed annually increased by 27% between 2019 and 2023, an increase driven by a 47% increase in stroke thrombectomy procedures during the same period. The number of out-of-hours Neuro IR procedures increased by 43% between 2019 and 2023, mainly due to a 62% increase in stroke thrombectomies.

## Future Vision for Interventional Radiology in Ireland

The future vision for Body IR services for the adult population involves 24/7 emergency IR services (i.e. formal on-call rotas for IR consultants, radiographers and IR nurses) organised in a hub-and-spoke model for the new health regions, with agreed pathways for the transfer of patients with and between regions. Elective care will include IR outpatient clinics with direct access from general practitioner (GP) and community care services, increased ambulatory care provision enabled by direct IR day care facilities, and inpatient admission for selected patients.

The full range of Paediatric IR services (in and out of hours, and including trauma services) should be provided in the new National Children's Hospital (NCH). Service-level agreements (SLAs) should be organised with adjacent Neuro IR centres for children requiring Neuro IR services. Transfer arrangements with the health regions should also be formalised.

Highly specialised Neuro IR services, offering the full spectrum of Neuro IR procedures, will continue to operate from the two national neuroscience centres at Beaumont Hospital and Cork University Hospital.

Implementing the recommendations of the Model of Care for IR will require appropriate numbers of radiographers, nurses and HCAs and robust equipment planning to deliver an optimal service. Opportunities to refurbish or replace IR infrastructure should be pursued through the National Equipment Replacement Programme. In addition, implementation of this Model of Care will require an uplift in the number of consultant interventional radiologists and trainee numbers, and local agreement on staffing of other diagnostic services. Hub hospitals should aim for an out-of-hours on-call rota with a minimum frequency of 1:6. Some on-call rotas will require more consultants depending on the acuity and frequency of call-outs.

## Workforce Planning

Future IR service needs were informed by a review of historic IR demand, changes in the scope of IR procedures, demographics of the Irish IR patient population, population size and age statistics for Ireland, models of population growth and ageing in Ireland, and available international IR benchmarks.

Interventional radiologists in Ireland make up a smaller proportion of the radiology workforce compared with the United Kingdom (9% versus 17%). There are no OECD figures for interventional radiologist per capita. However, there are currently an estimated 6.5 Clinical Radiologists (public and private, WTE) per 100,000 in Ireland, the median number of radiologists per 100,000 across Europe is 11.5.

In order to meet the demand for consultant interventional radiologists, Body IR training structures need to recruit between six and seven trainees every year from 2026 to 2030. Paediatric IR and Neuro IR training structures need to recruit and train on average one trainee per year from the Faculty of Radiologists and Radiation Oncologists training programme.

Analysis undertaken in collaboration with the NDTP and the Faculty of Radiologists and Radiation Oncologists in 2024 indicates that three to six new consultant hires per year are required in Body IR from 2024 to 2040. This is projected to increase the IR workforce to 50 whole-time equivalents by 2033. The proposed expansion in Neuro IR indicates new hires of 12 neurointerventional radiologists in the end of 2030, as suitable candidates become available. The proposed expansion of Paediatric IR indicates new hires of 6 paediatric interventional radiologists through a combination of hiring paediatric interventional radiologists and backfilling current paediatric radiology commitments, as suitable candidates become available.

Detailed workforce plans for IR nursing and radiography should be developed collectively at national and health region level in order to ensure that IR units have the right IR nursing and radiography capacity, capability and skill mix to enable the implementation of this Model of Care, both in hours and via a sustainable on-call service.

## Clinical Governance, Audit and Quality Improvement, Patient Safety, and Education and Training

Effective clinical governance of IR will require an appropriate framework for leadership and management to support the delivery of an equitable service throughout the country, as well as supporting safe practice, quality improvement and innovation. Within the overarching governance framework of the new health regions, a number of specific IR governance roles are needed, including a national radiology office with a national IR consultant clinical lead to deal with IR matters and a designated IR lead in each health region and in each hospital. A national registry for IR – with an agreed standardised dataset, key performance indicators and structured reporting mechanisms – should be established in order to enable national and international benchmarking and drive quality improvement.

## Implementation

Implementation of the recommendations of this Model of Care will not be achieved without the buy-in of the Department of Health, the Health Service Executive, and regional executive officers in each region, and sufficient funding to achieve the goals of the Model of Care. While some of the changes proposed will take time to implement, other high-impact actions can be taken immediately with committed funding, and will contribute to the long-term vision for IR. The National Clinical Programme for Interventional Radiology or proposed National Radiology Office is the most appropriate body to provide leadership advice and management of the implementation strategy at a national level.

# Key Recommendations of the Model of Care for Interventional Radiology

# ADULT BODY INTERVENTIONAL RADIOLOGY

1. A nationwide 24/7 emergency body interventional radiology (IR) service must be based in hub Model 4 hospitals in each health region, with on-call rotas for IR consultants (minimum of six), IR nurses and radiographers. Ideally, out-of-hours emergency IR services should be available in all Model 4 hospitals; at a minimum, at least one Model 4 hospital in each health region must act as a regional out-of-hours IR hub. In health regions where there are two Model 4 hospitals, a joint or shared rota could be organised, depending on resources.

2. Model 3 hospitals should provide in-hours IR services within the skill mix that the radiologists staffing the unit can provide based on their areas of competence and training. Joint appointments between Model 4 and Model 3 hospitals could help maintain IR services in Model 3 hospitals and contribute to a robust IR on-call rota in Model 4 hospitals that are designated as out-of-hours IR hubs.

3. Emergency IR services in Model 3 hospitals must align with patient care pathways in surgery, trauma, obstetrics and gynaecology, and other clinical services in their health region. Formal arrangements are required for network access from spoke hospitals and maternity hospitals to Body IR services in Model 4 hospitals that are designated as out-of-hours IR hubs. NB implementation of the proposed model for emergency out of hours IR will not compromise existing patient referral pathways e.g. the national Trauma network.

4. Ambulance services must be configured to support all components of the emergency IR care network, including any necessary transfer arrangements protocols.

5. Appropriate equipment, trained radiographers, nursing staff and anaesthesiology teams must be available to staff expanded IR services.

6. Expanding IR services to provide 24/7 on-call services, projected increases in elective IR service activity, increased provision of IR procedures in Model 3 hospitals designated as trauma units, and clinical integration will require an increase in the number of consultant interventional radiologists and increased IR training. Service needs require the training and appointment of consultant interventional radiologists in line with the NDTP workforce plan. All new IR consultant job plans should have an 80% IR component that is adequately resourced. Existing IR consultants should move to at least a 50% IR job plan.

**7.** A robust, curriculum-based IR training programme with competency assessment must be established to deliver the required number of consultants set out in the Workforce Planning section of this Model of Care.

**8.** Clinical integration of IR requires the development of a consultant led IR inpatient consultation service, multidisciplinary team (MDT) meeting attendance, IR same-day admission, and the development of outpatient radiology clinics. In hospitals providing complex (Level 2) IR services, IR clinical time should be recognised in consultant work plans and adequately resourced.

**9.** There must be investment in moving inpatient procedures to same-day IR admissions. All IR services in Model 4 hospitals should have governance over and scheduled access to radiology day care beds, preferably close to the IR work area. IR should be included in the new National Elective Hospital Programme for day case IR procedures.

**10.** Hospital clinical services, community services and GPs must be able to access patient consultation and treatment through IR clinics.

**11.** A detailed workforce plan should be developed collectively at national and health region level to ensure that IR units have the right IR nursing and radiography capacity, capability and skill mix to enable the implementation of this Model of Care, both in hours and via a sustainable on-call service.

**12.** An educational and training needs assessment for IR nursing (including HCAs) and radiography should be undertaken in collaboration with relevant stakeholders to inform the development of an educational and training pathway that incorporates foundation and postgraduate education provision.

**13.** A national radiology office should be established with a national IR consultant clinical lead to deal with IR matters. The IR lead, together with other stakeholders and the National Radiology Quality Improvement Programme, should devise a relevant plan for quality assurance and audit in IR.

# PAEDIATRIC BODY INTERVENTIONAL RADIOLOGY

**14.** Because there is no current out-of-hours Paediatric IR service, there is an urgent need to organise a Paediatric IR implementation committee liaising with the new National Children's Hospital (NCH) management to provide a sustainable 24/7 rota to manage the critical risk associated with trauma and sepsis in children. The NCH should be designated a major trauma centre for paediatric patients, as indicated in the National Trauma Strategy, and paediatric trauma care should be guided by the National Trauma Office and publications by relevant National Clinical Programmes.

**15.** The NCH requires a new 08:00–18:00 Paediatric IR service 5 days per week for elective and emergency in-hours procedures with a dedicated anaesthesia service.

**16.** Spoke hospitals (Model 3 hospitals) and paediatric services in Model 4 hospitals should continue to provide IR services to children within their competence and training.

**17.** Multidisciplinary team attendance by paediatric interventional radiologists, Paediatric IR outpatient department clinics and clinical integration must be included 1 day per week in the work plans of new paediatric interventional radiologists.

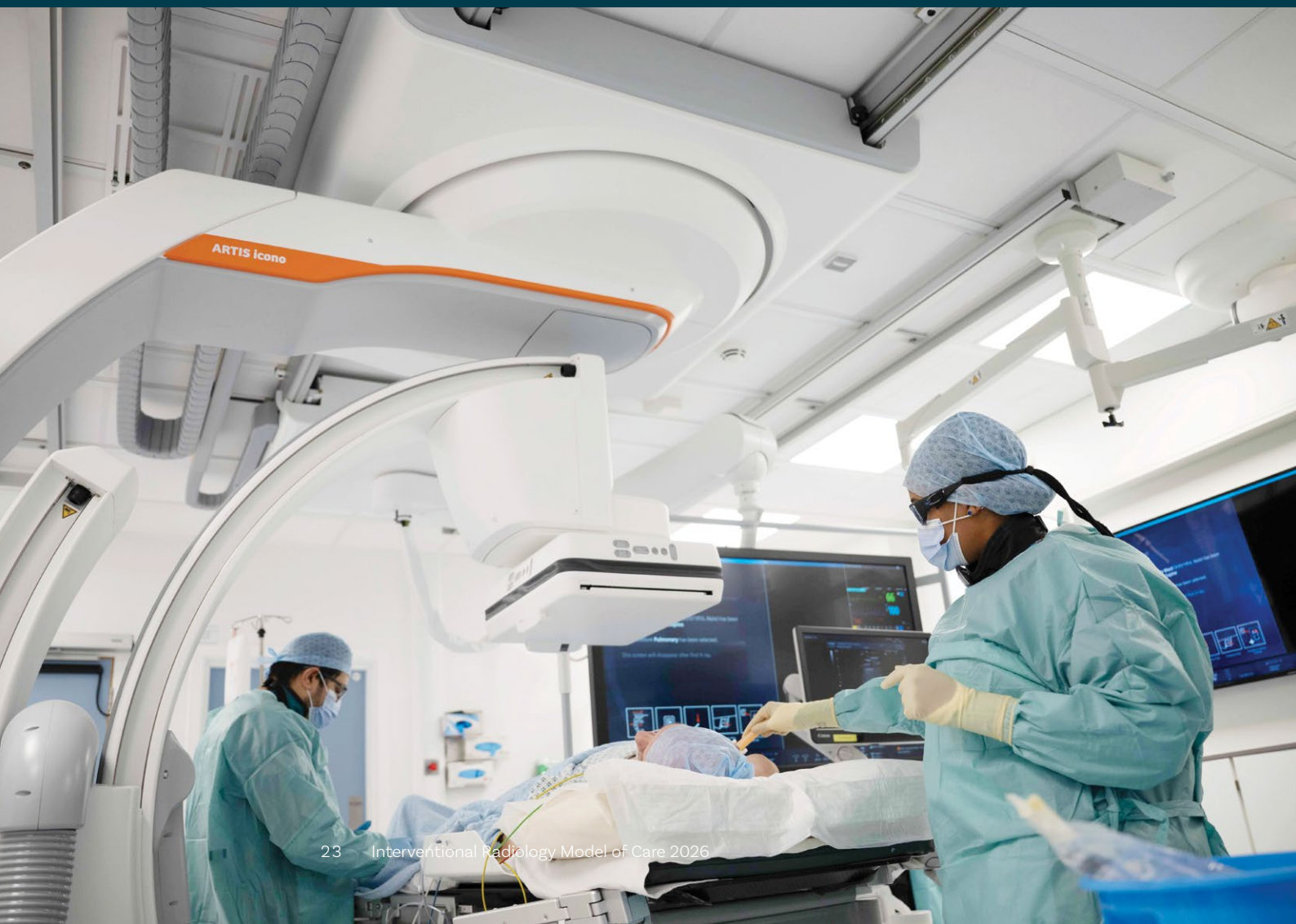
**18.** Service Level Agreements (SLAs) and/or co-appointments of adult interventional radiologists and neurointerventional radiologists should ideally be progressed before the opening of the NCH to support complex body embolisation and neurointerventional procedures. The requirement for these outside services may alter in the future with recruitment of body and possibly trained paediatric interventional radiologists in NCH.

# NEURO INTERVENTIONAL RADIOLOGY

**19.** Beaumont Hospital and Cork University Hospital must continue to deliver adult Neuro IR services including those for trauma (embolisation and covered stent placement), subarachnoid haemorrhage (endovascular coiling of cerebral aneurysm) and stroke (thrombectomy). Beaumont Hospital and Cork University Hospital must continue to offer 24/7 emergency Neuro IR services with formal on-call rotas for IR consultants, IR nurses and radiographers and appropriate resources.

**20.** Appropriate equipment, trained neurointerventional radiologists, radiographers, nursing staff and anaesthesiology teams must be available to provide sustainable emergency Neuro IR services without affecting elective services.

# PART 1
# The Current Interventional Radiology Landscape



# 1. Introduction

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## 1.1 Overview of the Specialty of Interventional Radiology

Interventional radiology (IR) is a clinical specialty that encompasses the diagnosis, clinical management and image-guided treatment of a wide range of diseases, both acquired and congenital.

### 1.1.1 Background and Evolution

The practice of IR began when a Swedish radiologist, Sven Seldinger, devised a simple method to safely puncture the femoral artery to perform diagnostic angiography. The period from 1954 to 1964 was the era of invasive diagnostic procedures. The transformation of this specialty to image-guided intervention occurred when Charles T Dotter (an American radiologist) performed the first percutaneous angioplasty in 1964. IR can be categorised into three divisions:

1. **Body IR** – Body IR procedures are performed throughout the body, usually excluding the head and neck.
2. **Neuro IR** – Neuro IR procedures are performed in the head, neck and spine, with some overlap with Body IR where Neuro IR is not available.
3. **Paediatric IR** – Paediatric IR procedures are performed on children aged under 16 years, but they are largely similar to adult Body IR and Neuro IR procedures.

In 1964, the Norwegian radiologist Per Amundsen was the first to perform complete brain angiography with a transfemoral approach. Between the end of the 1980s and the beginning of the 1990s, Neuro IR was revolutionised due to the work of two Italian physicians: Cesare Gianturco and Guido Guglielmi. Gianturco invented Gianturco coils, which he used to make the first attempts to embolise arteries and aneurysms. Gianturco also patented the first endovascular stent. Coil embolisation was revolutionised by the work of Guido Guglielmi, who realised that electricity could function as a controlled release mechanism for coils; in 1991, he published two works dealing with the embolisation of brain aneurysms by means of detachable platinum coils.

From these beginnings, advancements in the field of radiological imaging and innovations in instrumentation have led to a rapid development in practice. Body IR and Neuro IR have evolved into unique and distinct fields of expertise with their own clinical and technical skill sets and knowledge bases.

Interventional radiologists have specific medical knowledge relevant to their scope of practice (see *Appendix 1*). Best practice inpatient care demands a comprehensive system of longitudinal care, including patient assessment in clinics for potential IR management, patient selection, and consent. IR care is delivered mostly as elective procedures on a day-case basis and less commonly through hospital admission. Clinical follow-up and management is delivered through outpatient assessment.

IR services are now delivered by teams of IR consultants, IR nurses, radiographers and healthcare assistants, who work closely together and with clinical teams across the healthcare spectrum, including general surgery, emergency medicine, trauma and orthopaedics, obstetrics and gynaecology, paediatric surgery and medicine, and

anaesthesiology, among others. Neurointerventional radiologists similarly adopt a multidisciplinary approach to patient care, working closely with colleagues in neurosurgery; stroke; neurology; ear, nose and throat surgery; and plastic surgery, among others. Interventional radiologists also participate in multidisciplinary team meetings for optimal and agreed decision-making with other specialties.

IR procedures have become an integral part of medical care with the potential to provide life-saving emergency care, so much so that currently, any regional hospital with an emergency department and intensive care facility cannot operate effectively without having access to a local or networked IR service. Many other specialties – including surgery, emergency medicine, obstetrics and urology – now acknowledge the availability of IR as essential to the safe delivery of their service.

### 1.1.2 Development of Interventional and Diagnostic Radiology

Wilhelm Röntgen discovered X-rays on 8 November 1895, and received the first Nobel Prize in Physics for his discovery in 1901. Diagnostic radiology (DR) developed as X-rays were applied to human health. Administering contrast to the arteries, veins and cavities while using low-dose X-rays (fluoroscopy) allowed the arterial, venous and other spaces to be imaged and characterised by radiologists. IR developed from this DR specialty. As invasive DR procedures were replaced by technological advances in non-invasive imaging, such as computed tomography and magnetic resonance imaging, the need for invasive diagnostic imaging reduced. At the same time, minimally invasive therapies developed and were combined with the ability to deliver treatments to specific locations in the body using image guidance. IR is now primarily a *therapeutic* discipline, whereas DR is primarily a *diagnostic* specialty, as the names imply. IR uses image guidance to perform minimally invasive procedures to *treat* patients with many medical conditions, including cancer.

### 1.1.3 Interventional Radiology: A Specialist Skill Set

As IR procedures are image-guided, an expert knowledge of imaging physics, radiation safety, pathophysiology, anatomy, tissue characteristics, and medical devices, as well as image interpretation skills and procedural skills and knowledge, is required. Image interpretation forms a strong common bond between IR and DR and makes IR quite different from all other medical and surgical specialties. DR and IR also share a commonality in that all trainees undergoing radiology training in Ireland learn biopsy and drainage procedures in years 1-5.

However, there are also significant differences in the training required for IR and DR. IR specialty training is required to become competent in vascular/venous IR, embolisation and interventional oncology. While the common trunk of DR training focuses primarily on how to detect disease safely and accurately and characterise imaging findings, interventional radiologists need to understand clinical issues such as patient selection, indications and contraindications, procedure characteristics, anticipated results, complications, postoperative care, and longitudinal care. In addition, the interventional radiologist must be competent in the use of a vast array of equipment specific and unique to IR, including needles, guide-wires, catheters, balloons, embolic agents, drugs and novel equipment.

Practitioners specialising in Body IR, Neuro IR and Paediatric IR require advanced (fellowship-level) training surpassing the core diagnostic and procedural radiology skills acquired by radiologists during their DR training.

### 1.1.4 Interventional Radiology: Procedures and Indications

The broad range of conditions and organs that can be treated by IR is continuously expanding and includes diseases of the vascular, gastrointestinal (GI), hepatobiliary and genitourinary systems. IR procedures are used in the treatment of obstructed kidneys, the emergency management of active haemorrhage, the treatment and palliation of cancer (both primary and metastatic disease), and stroke therapy. Diseases of the brain, sensory organs, meninges, cerebrospinal fluid, head and neck, spinal cord, and vertebral column in both adults and children are diagnosed, managed and treated by neurointerventional radiologists.

The scope of IR includes both elective and emergency inpatient and outpatient services.

**Emergency IR procedures include:**

- embolisation to treat GI haemorrhage, variceal bleeding, iatrogenic haemorrhage, haemoptysis and postpartum haemorrhage;
- embolisation for major trauma, including:
  - treating patients with liver, kidney and splenic injury to control bleeding and preserve organ function;
  - treating severe pelvic injury in young patients and in 'silver trauma' patients by controlling arterial bleeding; and
  - treating vascular injuries by stent graft placement, such as in traumatic injuries to the aortic arch from high-speed motor vehicle collisions (Thoracic Endovascular Aortic Repair (TEVAR)).
- drainage procedures for patients with sepsis (nephrostomy for obstructed kidneys, abscess drainage, and drainage of obstructed biliary systems in jaundiced patients with sepsis);
- thrombolysis and thrombectomy for acute limb ischaemia, intermediate- and high-risk pulmonary embolism, acute iliofemoral venous occlusion, and dialysis arteriovenous fistula occlusion; and
- thrombectomy for stroke patients.

Access to the above IR services can be life-saving.

**Elective IR procedures include:**

- fibroid embolisation for women with fibroids;
- embolisation of pelvic veins for women with pelvic congestion syndrome/pelvic venous disorder;
- embolisation for men with symptomatic testicular varicocoeles;
- the placement of tunnelled catheters or ports in the chest for delivering chemotherapy or dialysis;
- liver, kidney, chest and bone biopsies;
- treatment of selected liver, kidney and lung cancers;
- treatment of aneurysms in the brain and elsewhere in the body;
- treatment of vascular anomalies; and
- the placement of feeding tubes and gastrostomy for adults, babies and children.

Many of the above elective IR procedures are eminently suitable for ambulatory care as they do not require general anaesthesia (except for in younger children).

The main IR procedure categories are further expanded in Appendix 1.

### 1.1.5 Benefits of Interventional Radiology

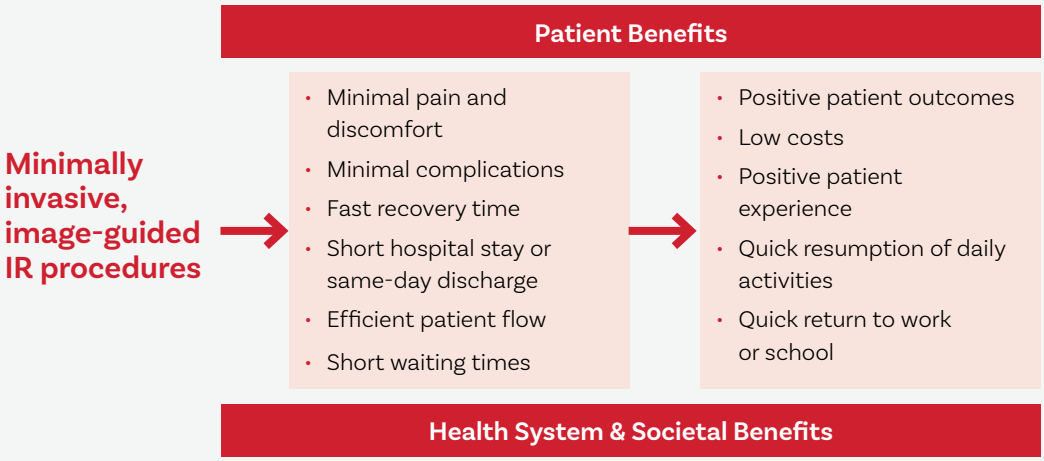
The practice of specialist IR delivers high-quality, patient-centred care that can be advantageous to patients, the healthcare system and society at large, at low treatment costs.

IR procedures offer numerous benefits to individual patients (see *Figure 1* and the patient story at the end of Section 1.1.5). Minimally invasive techniques typically result in shorter hospital stays compared with open surgery. They also carry a lower risk of complications and infections, leading to better patient outcomes. Patients experience less pain and discomfort, faster recovery times and earlier resumption of daily activities. Effective treatment of acute conditions can significantly improve quality of life and reduce long-term disability. Some IR procedures have become the standard of care; for example, transjugular intrahepatic portosystemic shunt (TIPS) for gastric variceal haemorrhage and, when local endoscopic treatments fail, in oesophageal variceal haemorrhage; and embolisation for lower GI haemorrhage and where endoscopy fails to control upper GI haemorrhage. In the absence of IR services, patient outcomes are associated with significant morbidity or mortality.

IR is also beneficial for the health service. Over 90% of IR procedures are undertaken through two- to three-millimetre incisions, and most procedures are performed under local anaesthesia and/or mild sedation, often allowing same-day discharge from hospital. As IR procedures are performed in IR suites rather than operating theatres, the efficiency of turnaround times between procedures is improved. IR suites can treat 10–15 patients per day with short, intense procedures.

The ability to perform procedures quickly and efficiently allows for better management of patient flow and reduces waiting times. Faster recovery leads to greater patient satisfaction and trust in the healthcare system. Minimally invasive approaches often result in lower overall healthcare costs due to a short hospital stay and fewer complications. Cost analysis has shown that hospital costs to place a chest port in the IR suite are half the cost of placement using an operating theatre.[1,2] Similarly, locoregional IR therapies for hepatocellular cancer and colorectal hepatic metastases were found to be more cost-effective than surgical equivalents.[3]

*Figure 1* DIAGRAM ILLUSTRATING THE EFFECT OF INTERVENTIONAL RADIOLOGY TREATMENTS ON PATIENT CARE



## My Interventional Radiology Story

It started with a routine scan for kidney stones. In it, the medical folk found an aneurysm in my left kidney. Symptomless, and at this stage no real problem, its size nonetheless suggested it was storing up trouble further down the line; something needed to be done. Thus, I found myself in front of Ireland's leading kidney transplant surgeon. The normal procedure, she explained, would be for her to cut me open (a very large incision), remove the imperfect organ, fix it outside my body, and then replace it and sew me back up. It is a major, complicated and extremely invasive procedure. If successful, it's followed by a long recovery period, both in the hospital and at home. Not a pleasant prospect.

Luckily for me, the kidney transplant surgeon felt I was, for whatever reason, an unsuitable candidate for the traditional operation. But she felt, she had an alternative that might well work. So I was passed on to the previously-unknown-to-me world of Interventional Radiology.

What followed was astonishing. A few days later, the IR doctor and his gang were nicking a hole in my groin and doing a complex, delicate operation inside my kidney and its adjacent tubes through a series of pipes and God knows what other gadgets. All the time, they gauged their progress on a series of television screens. The whole thing took a couple of hours, and here's the amazing thing: because of the need to occasionally ask the patient to hold their breath (to enhance the images), I was wide awake throughout the entire event. Slightly sedated, but very much conscious.

The time I spent in the recovery area afterwards was occasionally stressful, occasionally painful. Lying perfectly still on your back for several hours is not a pleasant experience. But compared to the poor fellow who lay opposite me, I was in a very good place. He had undergone the more traditional operation; ahead of him lay weeks in the hospital, followed by a lengthy recuperation elsewhere. I, by comparison, would be out of the hospital that day, and, sore and careful, back home by the evening. Another miracle gifted by Interventional Radiology.

The skill of the surgeons (and their teams) and the science-fiction-level technology are remarkable enough, but the really amazing thing about Interventional Radiology is the effect it has on the patient. My operation has been a complete success, and all achieved without extremely bloody, invasive, and (physically and mentally) scarring surgery. And the speed and relative ease of my recovery was fantastic, as well as a considerable saving on the valuable resources of the HSE.

Words like 'miraculous' and 'unbelievable' are easy to bandy about, but in relation to Interventional Radiology they are entirely accurate. Since my operation, I have discovered the myriad ways in which Interventional Radiology might, where available, help people faced with otherwise more difficult, or less appropriate, options. It is evident that every hospital in Ireland should have an Interventional Radiology team continuously available. The arguments for such an arrangement are medical, human, financial and, as one who has been a huge beneficiary of the process, deeply emotional. Widely available IR is a great leap forward, a better future we should strive to hasten.

**Danny Kelly, Co Kilkenny**

## 1.2 The Rationale for a Model of Care for Interventional Radiology

### 1.2.1 Rationale

Since the 1960s, IR services have developed within the specialty of radiology in response to enormous advances in imaging technology, advances in medical devices, and IR's minimally invasive nature and increasing applications to multiple disease entities. Heretofore, IR services have not been planned on a regional or national basis. The development of IR staffing and capital investment was based on the available resources in each hospital and on clinical need. Radiology departments replaced consultant radiologists and recruited new radiology consultants with a subspecialty interest in IR who trained outside of Ireland.

The fundamental changes in IR since the early 1990s, supported by advancements in technology, in medical education and in specialist continuing professional development, and research on defined skills, have changed IR from a subspecialty to a standalone specialty. Work practices have changed IR from a part-time interest to a full-time occupation. As a result of this evolution, the quality of intervention by IR specialists has improved, leading to improved outcomes for patients in general.

IR procedures have become the standard of care for many conditions, and are life-saving or organ-preserving in emergency care.

The National Clinical Programme for Interventional Radiology (NCP IR) undertook a comprehensive survey of IR services in all Model 3 and Model 4 hospitals in Ireland in late 2023 and early 2024. This survey revealed significant service deficits, geographic variation in availability, and inequality of services based on patient age; most notably, there are inconsistent out-of-hours emergency IR services within and across health regions, a lack of formal transfer arrangements, and deficits in workforce resources. This review is consistent with data regarding IR services in Ireland obtained in 2015 and 2020 for a service model developed by the Irish Society of Interventional Radiology and the Faculty of Radiologists and Radiation Oncologists, which revealed similar geographic variations in services available to patients.[4]

### 1.2.2 Key Challenges Facing Interventional Radiology

Engagement within radiology and allied health professional bodies has identified that IR faces a number of key structural and governance challenges:

- Recruitment and training crisis:
  - IR is recognised in an increasing number of countries as a specialty or a subspecialty, but is not recognised as a medical specialty by the Irish Medical Council.
  - Currently, IR trainees are sought from the general pool of DR trainees, with variable recruitment success. This arrangement will not be tenable in the future.
  - The postgraduate radiology training programme offered by the Faculty of Radiologists and Radiation Oncologists does not have the structure and funding to deliver 2 years of IR training.
  - There is currently no certification of IR training by examination.
  - To be trained in IR, trainees must undertake IR fellowship training abroad.
  - There is no predictable workforce supply of IR consultants.
  - IR specialty-specific continuing medical education (CME) is not compulsory.
- Clinical practice deficits:
  - Clinical roles in IR are not recognised in consultant job plans.
  - Interventional radiologists have limited time to devote to clinical practice (e.g. the consent process, patient communication and building trust).

- Organisational issues:
  - IR services vary across Model 4 hospitals, where many key procedures are not available out of hours. This impedes the delivery of national health strategies.
  - There is a lack of out-of-hours emergency IR care in four of the six health regions.
  - There is a shortage of consultant diagnostic radiologists which impacts on the capacity of interventional radiologists to function and deliver IR care because of additional time required for DR roles.
  - There is variable general practitioner access to IR services.
  - There are capacity deficits in elective care.
  - There is no structured quality improvement programme in IR.
  - The delivery of post-procedure clinical follow-up and complication management by non-IR staff can delay discharge and can lead to inappropriate treatment.
  - There is a lack of inpatient bed access.
  - There is a lack of day care bed access.
  - There is no specific resourcing of IR.
  - Many patients do not have direct access to IR.
  - Patients are not receiving information regarding alternative treatments in order to provide fully informed consent.
- Poor visibility:
  - There is poor visibility of IR by health authorities, healthcare professionals, patients and the public.
  - Activity in IR is not coded by the Hospital In-Patient Enquiry (HIPE) system at time of writing. However, the NCP is actively engaging with the HSE HIPE team to address this issue.

It is intended that this Model of Care will enable high-quality, standardised care for patients requiring IR by facilitating:

- access to 24/7 emergency IR services for wide-ranging indications with potentially life-saving impact;
- improved/equitable access to minimally invasive IR, with the associated benefits of quicker recovery time and reduced hospital length of stay;
- improved quality of care by providing a standardised best practice framework; and
- greater awareness of IR as a clinical and cost-effective specialty across the health and political spectrums and with the general public.

### 1.2.3 Scope of the Model of Care

This Model of Care covers Body IR, Paediatric IR and Neuro IR. It encompasses both elective (scheduled) IR care and emergency (unscheduled) IR care.

### 1.2.4 Guiding Principles Underpinning the Development of the Model of Care

The Model of Care for IR aims to align with the Sláintecare objective of delivering a patient-centred service across community and hospital services and as close to patients' homes as possible.

Several important population health principles underpin this Model of Care and associated recommendations, including the following:

- **Equity in health:** The Model of Care outlines how IR services should be organised and delivered, prioritising equity of access across the country.
- **Sustainability:** The Model of Care considers workforce requirements from 2025 to 2040 and how these can be achieved. This is essential to address the current crisis in IR consultant numbers and the long-term sustainability of IR.

- **Integration of care:** The Model of Care promotes integration across the healthcare spectrum, including direct referrals from the community, joined-up pathways, and formal links with a wide range of acute specialties.
- **Population-Based Resource Allocation**: The Model of Care encourages the distribution of resources according to the relative needs of populations across each of the six new health regions, promoting equity and efficiency in health services.



### 1.2.5 Related National Strategies/Policies/Models of Care

In hospitals, IR works closely with many different medical and surgical specialties with significant codependencies. At a national level, IR also plays an important enabling role for many of the current national strategies and programmes, as will be outlined in the following chapters. The Model of Care for IR will support the implementation of the following:

- Sláintecare;
- Patient Safety Strategy;
- National Stroke Strategy;
- National Maternity Strategy;
- National Trauma Strategy;
- National Cancer Strategy;
- Women's Health Action Plan;
- Emergency Medicine Programme Model of Care;
- Vascular Surgery Model of Care;
- National Model of Care for Trauma and Orthopaedic Surgery;
- General Paediatric Surgery Model of Care;
- the objectives of the National Renal Office; and
- Surgery for Ireland: Report of the Short-Life Working Group on the Provision of Emergency Surgery.

### 1.2.6 Overview of Interventional Radiology Model of Care Development and Review Process

The development of the Model of Care for Interventional Radiology has been a collaborative journey involving a wide-range of multi-disciplinary groups including IR consultants (Body, Neuro and Paediatric), IR nurses, radiography representatives, other National Clinical Programmes and clinical specialties, the HSE National Doctors Training and Planning, the HSE Office of Nursing and Midwifery Services Director, national radiography groups and service users. During the broad consultation phase, wider groups including the new Health Regions and post-graduate training bodies had the opportunity to review and provide feedback. This wide input has been invaluable in ensuring that the design of future IR services is clinically-led, patient-centred, and builds upon and integrates with existing acute services and pathways.

### 1.2.7 Patient Involvement

The NCP IR recognises that working with patients and the public brings a wider perspective that guides the design, delivery, and evaluation of health services to better meet the needs of the people using them. Patient involvement is critical to delivering person-centred care. During the MOC development and review process, the NCP sought and reflected the thoughts and experiences of IR service users to help ensure that the vision for IR in Ireland meets patient needs and brings about improvements in patient experiences and outcomes in the future.

# 1.3 The National Clinical Programme for Interventional Radiology

The NCP IR started in October 2023. Its aim is to provide a framework for the delivery of high-quality, timely, accessible and equitable IR care for all patients and support improvements in how IR services are organised across the country.

## 1.3.1 Aims and Objectives

The aims and objectives of the NCP IR are to:

1. identify current best practice in the specialty of IR so that equitable and safe patient-centred care is delivered across each health region in line with Sláintecare principles;
2. assess the size and scope of the current and future IR workload and determine future workforce requirements;
3. identify unwanted clinical variation and make recommendations that will underpin the delivery of an improved national IR service; and
4. recommend restructuring of IR care across Ireland so that unscheduled and scheduled care is available in all health regions.

## 1.3.2 Organisation and Governance of the National Clinical Programme for Interventional Radiology

A multidisciplinary working group was established in 2023 to help the NCP IR achieve its objectives. This group includes consultant interventional radiologists, radiographers and nurses, as well as representatives from related clinical disciplines, including surgical specialties, trauma, anaesthesia and obstetrics. The Interventional Radiology Clinical Advisory Group provides clinical advice and oversight of the strategic direction and decisions of the NCP IR. The NCP IR governance structure is depicted in *Figure 2*.

*Figure 2* GOVERNANCE STRUCTURE OF THE NATIONAL CLINICAL PROGRAMME FOR INTERVENTIONAL RADIOLOGY

# 2. Interventional Radiology Scope, Emergency and Elective Care and Best Practice Service Delivery

# 2. Interventional Radiology Scope, Emergency and Elective Care, and Best Practice Service Delivery

## 2.1 Interventional Radiology Procedures

### Level 1 and Level 2 Procedures

Basic interventional radiology (IR) procedures (Level 1 procedures) differ from advanced IR procedures (Level 2 procedures) in terms of complexity and risk. All trainee radiologists who have completed a radiology training programme (5 years) are expected to be proficient in basic or Level 1 procedures. These 'diagnostic' radiologists perform Level 1 procedures in their area of interest, but do not engage in clinical practice (i.e. they do not admit patients, see patients in outpatient department clinics or perform ward rounds).

More extensive and dedicated IR training, which should take a minimum of 2 years, is required for advanced or Level 2 procedures. Training is curriculum based, includes clinical practice and should have an assessment of competency. Level 2 procedures require a higher level of technical skill and clinical expertise, which reflects the growing complexity of IR as a specialty. See Appendix 1 for details of Level 1 and Level 2 procedures.

#### BODY INTERVENTIONAL RADIOLOGY PROCEDURES (Adults and Paediatrics)

There are several broad categories of Body IR treatments, including embolisation, vascular IR, venous IR, non-vascular IR and interventional oncology. The main types of treatments performed by interventional radiologists are detailed below and summarised in Appendix 1.

**Embolisation, angioplasty and stenting procedures** are performed through small incisions made in an artery (usually in the groin or wrist) and involve the manipulation of small catheters and guidewires to the site of interest through the vascular tree under imaging guidance.

**Angioplasty** refers to the opening of blocked arteries using a balloon mounted on a catheter, while stenting involves the placement of a woven metal stent in the artery (e.g. to treat peripheral vascular disease, diabetic foot disease or dialysis arteriovenous fistula stenosis).

**Transcatheter embolisation** refers to the process whereby an artery or vein (blood vessel) is deliberately blocked either to occlude a bleeding artery or to occlude a tumour's circulation. Embolisation techniques can also be used to treat aneurysms (in the brain or the body) by packing them with special coils. IR allows rapid control of arterial haemorrhage by embolisation or by placing a stent graft without the risk of morbidity that comes with an open surgical procedure.

**Venous intervention** refers to intervention in the venous system and ranges from the insertion of a special tube for delivering chemotherapy (a peripherally inserted central catheter (PICC), Hickman catheter, or port catheter) to the insertion of a tunnelled haemodialysis catheter (the insertion of a tunnelled haemodialysis catheter) in patients with renal failure. Moreover, IR physicians also place stents in the venous system for iliofemoral venous reconstruction in patients with iliofemoral thrombosis, for superior vena cava obstruction in patients with lung cancer, or through the liver to control life-threatening bleeding from oesophageal varices in patients with cirrhosis (transjugular intrahepatic portosystemic shunt (TIPS)).

**Non-vascular IR** refers to image-guided biopsy or drainage procedures. Non-vascular procedures often use ultrasound (US) or computed tomography (CT) guidance, whereas vascular and embolisation procedures use X-ray guidance in IR suites that resemble operating theatres. **Image-guided biopsy** is a standard radiological procedure where a needle is inserted into a body organ to obtain a sample of soft tissue or fluid for diagnostic purposes (e.g. lung, liver, kidney, lymph nodes, thyroid, prostate, bone or soft tissue).

**Drainage procedures** refer to the drainage of obstructed visceral systems (e.g. biliary or urinary) or abscesses. Tubes are placed using image guidance to drain abscesses or obstructed urinary systems obviating the need for open surgery. These procedures are particularly important for treating patients with sepsis.

Non-vascular IR also incorporates **musculoskeletal procedures** that are directed at improving musculoskeletal function and treating pain originating in the musculoskeletal system via the image-guided therapeutic injection of steroids and other products. Procedures include image-guided cement injection and the delivery of screws and scaffolds for the treatment of pathologic fractures, including osteoporotic wedge compression fractures (vertebroplasty/osteoplasty).

**Interventional oncology** offers therapies to treat cancer in the kidneys, liver, lungs and bones, and uses image-guided ablative technology to deliver energy directly into the tumour through the skin, causing cancer cell death. **Transcatheter embolisation** can also be used to deliver chemotherapy or radiation to a tumour via a catheter, which can be intra-arterially manipulated directly into the tumour's arterial supply. Ablation and embolisation can also be used to increase the effect of immunotherapy in the treatment of cancer.

**Paediatric IR** includes a wide variety of emergent and elective procedures with a scope similar to those provided by adult IR services, although there are some differences due to the different spectrum of diseases seen in children versus adults (e.g. there is less emphasis on cancer and peripheral vascular disease in Paediatric IR).

Most Paediatric IR procedures are carried out under general anaesthesia. Procedures include a full range of solid organ, soft tissue, bone and tumour biopsies; a range of vascular access interventions, from a simple PICC for antibiotics to a chest port for enzyme replacement therapy to the insertion of a haemodialysis catheter for renal disease; drainage of abscesses and collections; insertion of feeding tubes; oesophageal dilatations; and sclerotherapy of vascular malformations. Paediatric IR can also be an alternative to surgery for serious medical conditions, such as cancer, vascular malformations, blood clots, and kidney or liver abnormalities.

## NEUROINTERVENTIONAL RADIOLOGY (Adults and Paediatrics)

Neuro IR procedures include a range of image-guided endovascular, endoluminal and percutaneous interventions of the neurological system and supporting structures performed by neurointerventional radiologists and appropriately trained radiologists (see *Appendix 1*).

Neurointerventional radiologists in Ireland require at least 2 years of dedicated neurointerventional fellowship training, as well as 1 year of diagnostic neuroradiology fellowship training, as per the European training standards endorsed by the European Union of Medical Specialists, the European Society of Neuroradiology, and the European Society of Minimally Invasive Neurological Therapy.

Neuro IR procedures include:

- endovascular treatment of intracranial aneurysms using coiling, balloon-assisted coiling, stent-assisted coiling, flow diversion or intrasaccular flow disruption;
- endovascular embolisation of arteriovenous shunting lesions of the brain, head, neck and spine;
- endovascular thrombectomy (EVT) for stroke caused by occlusion of the cervical or intracranial arteries;
- EVT for dural venous sinus thrombosis;
- carotid artery stenting for the treatment of acute or subacute or recurrent steno-occlusive carotid disease;
- intracranial arterial stenting for the treatment of acute or subacute intracranial atheromatous disease;
- middle meningeal artery embolisation for the treatment of chronic subdural haematoma;
- dural venous sinus stenting for the treatment of intracranial hypertension;
- cerebral angiography for diagnostic purposes;
- endovascular treatment of head and neck vascular trauma;
- neurophysiological interventions, including the Wada test and balloon test occlusion;
- cerebral angiography to confirm brain death;
- spinal interventions involving the axial skeleton; and
- interventions for pain management.

Paediatric neurointerventions may include any of the adult neurointerventions described above.

It is widely recognised that centralising adult and paediatric Neuro IR services ensures that highly specialised procedures are performed by experienced teams with high procedural volumes, which leads to the best patient outcomes for numerous reasons, including the following:[5]

- Expertise and experience: High patient volumes at centralised centres allow for the development of specialised expertise and experience among the medical staff.
- Resource utilisation: Centralised centres can better utilise advanced equipment and resources, ensuring that patients receive the best possible care.
- Consistency in care: A centralised system ensures that all patients receive consistent, high-quality care, regardless of the referring hospital.

In contrast, diluting Neuro IR services by opening additional centres leads to worse outcomes for the following reasons:

- Lack of specialised expertise: Lower patient volumes at smaller centres may result in less experience and expertise among the medical staff.
- Resource constraints: Smaller centres may not have access to the same level of advanced equipment and resources, leading to suboptimal care.
- Inconsistent care: Fragmentation of services can result in variability in the quality of care provided to patients.

## 2.2 Emergency and Elective Interventional Radiology

### 2.2.1 Emergency/Unscheduled Conditions Treated by Interventional Radiology

**BODY INTERVENTIONAL RADIOLOGY PROCEDURES (Adults and Paediatrics)**

Emergency Body IR procedures are often life-saving when performed in a timely fashion in adequately resourced hospital settings with appropriately trained interventional radiologists who have the skill to perform the range of emergency IR services that may be required both in and out of hours.

#### *Postoperative and spontaneous life-threatening haemorrhage events*

Body IR delivers rapid endovascular embolisation, stent grafting and balloon occlusion for postoperative and intra-operative life-threatening haemorrhage events.

Endovascular embolisation stops bleeding and reduces the necessity for blood transfusion and clotting factors in patients with acute, life-threatening haemorrhage. Endovascular embolisation services are called upon emergently in at-risk inpatient postoperative groups, including but not limited to those affected by post-pancreatic surgical bleeding from the gastroduodenal artery, hepatic artery bleeding after liver resection, and endovascular and open vascular surgical repair. Spontaneous haemorrhage is common from the retroperitoneal and abdominal wall in acute medical patients in hospital. Iatrogenic injury in cardiology and other surgical procedures can lead to spontaneous massive haemorrhage that can be life-threatening, and this can also be dealt with by Body IR.

#### Related guidelines and international guidance/recommendations

- National Clinical Guideline No. 29: *Unexpected Intraoperative Life Threatening Haemorrhage* (2022):[6]
  - Recommendation 3: All hospitals must have the National Life Threatening Haemorrhage Management Poster prominently on display in the operating theatre. All hospitals must also have an underpinning life-threatening haemorrhage policy and procedure/protocol which incorporates the recommendations of this guideline. IR personnel must be identified for immediate communication. All clinical, laboratory and support staff to maintain their competency must be familiar with the contents of the life-threatening haemorrhage protocol/ procedure.
  - Recommendation 10: In the event of a major vascular injury the designated emergency coordinator in association with the surgeon and anaesthesiologist, should request extra assistance as appropriate to the procedure and if promptly available locally (senior surgeon, vascular surgeon, interventional radiology, etc.) and request this assistance as soon as possible.

- Conventional angiography findings in hemodynamically unstable patients with acute abdominal hemorrhage and a negative CT bleeding study:[7]
- This study details the scope of upper and lower gastrointestinal (GI) haemorrhage and parenchymal, peritoneal and abdominal wall bleeding in a Model 4 hospital in cases that are effectively treated with angiography and embolisation.

### *Acute gastrointestinal haemorrhage*

Body IR delivers rapid endovascular embolisation and transjugular intrahepatic portosystemic shunt (TIPS) formation for arterial and venous haemorrhage in the bowel.

Body IR plays a life-saving role in stopping arterial GI bleeding. Upper GI haemorrhage is common, with an annual estimated incidence of between 61 and 78 cases per 100,000 population in the United States in 2009-2012.[8] Best practice guidelines for the treatment of GI bleeding require the availability of GI endoscopy, advanced CT imaging, IR clinical expertise, conventional angiography and arterial embolisation for the localisation and treatment of the bleeding.

IR delivers emergent immediate control of upper and lower GI haemorrhage in both stable and unstable patients by inserting a catheter into the arterial system and guiding it under X-ray to the bleeding location. The bleeding artery is then closed using small coils or other embolic devices. Many of these critically unwell patients are cared for in high-dependency and intensive care units, and there is a high mortality rate if patients are left untreated by IR. The immediate nature of bleeding control reduces the need for massive blood transfusion, the use of high-dependency care, the length of hospital inpatient stays, and morbidity and mortality.

A different cohort of patients, typically with chronic liver disease and portal hypertension, may develop venous varices and bleeding. The bleeding associated with venous haemorrhage is vigorous, and there is a high mortality rate if left untreated. IR plays a life-saving role in stopping venous GI bleeding by performing emergency TIPS formation, embolising bleeding varicose veins in the gut, or performing balloon-occluded retrograde transvenous obliteration (BRTO). Best practice guidelines for the treatment of venous bleeding require the availability of advanced CT imaging, IR clinical expertise, TIPS procedures and venous embolisation procedures for the localisation and treatment of variceal bleeding.

In high-level international centres, IR is part of a wider GI bleeding team that includes GI consultants and surgeons. In patients with upper GI bleeding, endoscopy can be used for diagnosis and treatment. If endoscopic treatment fails, embolisation of the bleeding site by IR is recommended.[9]

In patients with lower GI bleeding, if endoscopy is not available or feasible or it fails to locate a bleeding site in the colon, CT angiography should be utilised in an attempt to locate the bleeding site in the small bowel or colon and, if identified, embolisation is recommended.

#### Related guidelines and international guidance/recommendations

- National Confidential Enquiry into Patient Outcome and Death (NCEPOD) 2015 report: *Time to Get Control? A review of the care received by patients who had a severe gastrointestinal haemorrhage*:[10]
  - Recommendation 1: “Patients with any acute GI bleed should only be admitted to hospitals with 24/7 access to on-site endoscopy, interventional radiology (on-site or covered by a formal network), on-site GI bleed surgery, on-site critical care and anaesthesia.”

  - Recommendation 2: "Hospitals that do not admit patients with GI bleeds must have 24/7 access to endoscopy, interventional radiology and GI bleed surgery for patients who develop a GI bleed while as an inpatient for another condition by either an on-site service or a formal network."
  - Recommendation 13: "Resuscitation and airway support during endoscopy and interventional radiology procedures should be equivalent to facilities during emergency surgery. Unstable patients should have anaesthetic and/or critical care support."
  - Recommendation 19: "Hospitals should have contingency plans for failure of endoscopy, interventional radiology or surgical equipment."
- NICE Clinical Guideline CG141: *Acute upper gastrointestinal bleeding in over 16s - management* (2012):[11]
  - "Offer interventional radiology to unstable patients who re-bleed after endoscopic treatment. Refer urgently for surgery if interventional radiology is not promptly available."
  - For oesophageal varices: "consider transjugular intrahepatic portosystemic shunts (TIPS) if bleeding from oesophageal varices is not controlled by band ligation."
  - For gastric varices: "offer TIPS if bleeding from gastric varices is not controlled by endosopic injection of N-butyl-2-cyanoacrylate."
- American Gastroenterological Association (AGA): *Clinical Practice Update on Endoscopic Therapies for Non-Variceal Upper Gastrointestinal Bleeding: Expert Review* (2020):[8]
  - "In patients with endoscopically refractory [non-variceal upper gastrointestinal bleeding (NVUGIB)] the etiology of bleeding (peptic ulcer disease, unknown source, post-surgical); patient factors (hemodynamic instability, coagulopathy, multi-organ failure, surgical history); risk of rebleeding; and potential adverse events should be taken into consideration when deciding on a case-by-case basis between transcatheter arterial embolisation and surgery."
- American College of Radiologists (ACR) Appropriateness Criteria® Radiologic Management of Lower Gastrointestinal Tract Bleeding: 2021 Update;[12]
- Royal College of Surgeons in Ireland: *Surgery for Ireland: Report of the Short-Life Working Group on the Provision of Emergency Surgery* (2023):[13]
  - "Recommendation 5. Emergency surgery centres require 24/7 access to interventional radiology services and 24/7 availability of endoscopy."
- *The Irish Times*: "IR Call by coroner for specialist doctors to be available 24/7 in major hospitals" (2022):[14]
  - This article describes the call for specialist doctors to be available 24/7 in major hospitals after a death in a Dublin hospital due to the lack of 24/7 IR service delivery;
- AASLD Practice Guidance on the use of TIPS, variceal embolization, and retrograde transvenous obliteration in the management of variceal hemorrhage:[15]
  - "TIPS should be used as salvage treatment in patients in whom variceal bleeding cannot be controlled with medical and endoscopic therapy (failure of standard of care). TIPS should be used as rescue treatment in patients with early recurrent variceal bleeding despite medical and endoscopic therapy."
- Early-TIPS Versus Current Standard Therapy for Acute Variceal Bleeding in Cirrhosis Patients: A Systemic Review With Meta-analysis:[16]
  - Transjugular Intrahepatic Portosystemic shunt (TIPS) should be available within 24 hours of presentation with acute oesophageal variceal bleeding which fails endoscopic management.

### *Trauma*

Body IR for adults and children delivers rapid endovascular embolisation, stent grafting and balloon occlusion for major trauma.

Trauma is the leading cause of death in people aged 45 years and under, accounting for 10% of deaths globally per year. Exsanguination is a major cause of preventable mortality. The cornerstone of management of the severely injured and bleeding patient is represented by the early detection and aggressive management of haemorrhage. Uncontrolled haemorrhage results in trauma-induced coagulopathy, which is responsible for more than half of deaths within the first 48 hours after hospital admission.

Best practice guidelines from the American College of Surgeons Committee on Trauma state that the IR team should be available to perform procedures within 30 minutes in trauma centres in this low-volume but high-risk patient population. The Society of Interventional Radiology (SIR) Position Statement for Endovascular Interventions for Trauma[17] requires the IR team to be ready within 60 minutes of the time of the decision to proceed with angiography. In addition, SIR recommends that an angiography suite should be available 24/7. In facilities without a 24-hour angiography suite, a protocol should be in place to postpone elective procedures during trauma activation.

In cases of paediatric trauma, management is more complex due to the specific nature of care. Paediatric trauma care should be guided by the National Trauma Office and publications of relevant National Clinical Progammes. These include the Paediatric Model of Care and the document Improving Services for General Paediatric Surgery, developed by the National Clinical Programme for Paediatrics, and the National Models of Care for Trauma and Orthopaedic Surgery and for Paediatric Anaesthesia.

IR plays a key role in the management of major trauma victims by using embolisation and balloon occlusion techniques to arrest internal bleeding. These techniques are minimally invasive and often life-saving in patients with solid abdominal organ bleeding (e.g. in the liver, spleen or kidney) or in patients with pelvic fractures and pelvic arterial bleeding. IR techniques can also be used to treat bleeding from major arteries by blocking bleeding arteries with glue and coils or placing covered stents across the bleeding site. Best practice guidelines for the treatment of trauma require the availability of advanced CT imaging, IR clinical expertise, conventional angiography and arterial embolisation for the localisation and treatment of trauma-related bleeding.

Benefits of IR techniques include minimally invasive, rapid cessation of bleeding in haemodynamically unstable trauma patients; the restoration of normal circulation and reduction of harm caused by poor perfusion; the reduction of morbidity and mortality, reducing the need for massive transfusion and open surgical procedures; the facilitation of the early management of other critical injuries; and the preservation of organs. For example, loss of the spleen leads to lifelong immune suppression and is a leading cause of pneumococcal sepsis and death in trauma patients. Liver and kidney surgical procedures in trauma patients can be avoided by drainage of associated collections, blocking bleeding arteries, and endoluminal reconstruction of damaged bile ducts and ureters, as required.

Interventional radiologists also insert and remove inferior vena cava filters for patients with deep venous thrombosis (DVT) and pulmonary embolism (PE) that may develop in trauma patients who have a contraindication to anticoagulation.

Trauma occurs frequently in children in Ireland. The National Office of Clinical Audit revealed that children accounted for 5% of all major trauma cases in Ireland from 2014 to 2019, with 26% of paediatric trauma cases occurring in children aged under 2 years and 71% occurring due to falls, road traffic accidents and burns. Thirty-five per cent of children had an injury

severity score greater than 15 (severe), and 57% of children were transferred to another hospital for ongoing management.[18]

Despite there being external guidance and paediatric trauma being a daily event seen in children's hospitals in Ireland, paediatric patients who require IR management for trauma currently have no resourced team, room or equipment to facilitate timely management of haemorrhage. The planned opening of the National Children's Hospital on the St James's Hospital site provides only one component of the required solution with the provision of an IR theatre in the theatre complex. Paediatric interventional radiologists, nurses, radiographers and administrative support staff also need to be recruited and required infrastructure needs to be scoped using the population-based resource allocation (PBRA) model when planning and implementing the new IR service.

### Related guidelines and international guidance/recommendations

- *A Trauma System for Ireland: Report of the Trauma Steering Group* (2018):[19]
  - Recommended Designation Criteria for Major Trauma Centres and Trauma Units Number 27: 24/7 access to Interventional Radiology in Major Trauma Centres
  - Recommended Designation Criteria – Trauma Units Number 7: "Interventional radiology should be promptly available 9am-5pm, Monday-Friday, on-site in all Trauma Units, and outside these times at the network Major Trauma Centre via patient transfer in accordance with agreed protocols"
  - Recommended Designation Criteria for Major Trauma Centres and Trauma Units Number 19: "Adequately sized trauma bays in the resuscitation room with beds of an appropriate type, with an adjacent hybrid suite designed to allow immediate access to interventional radiology"
  - Recommended Designation Criteria for Major Trauma Centres and Trauma Units Number 12: Prescribed response times for specialties in trauma teams including IR (senior trainees resident 24/7 and consultants available for physical appearance within 30 minutes of call out).
- National Clinical Programme for Trauma and Orthopaedic Surgery. *National Model of Care for Trauma and Orthopaedic Surgery* (2015):[20]
  - There should be 24/7 IR access in major trauma centres as part of the multidisciplinary trauma team.
  - There should be IR access from 09:00 to 17:00, Monday to Friday in trauma units, with at least one whole-time equivalent (WTE) dedicated interventional radiologist.
- The Royal College of Radiologists. *Clinical Radiology: Major adult trauma radiology guidance* (2024):[21]
  - Royal College of Radiologists (RCR) Standard 2: Diagnostic imaging and intervention must be available and delivered by experienced staff.
  - RCR Standard 15: IR facilities should be co-located (on the same hospital campus) with the emergency department or transfers must be rehearsed and follow defined protocols.
  - RCR Standard 15: When IR is indicated in severely injured patients, rapid access to endovascular treatment is essential to minimise the time to arrest of haemorrhage. Angiographic and endovascular facilities should be located as close as possible to the emergency department, and future planning should aim to have acute theatre complexes co-located with the emergency department capable of both surgical and endovascular treatments with adequate anaesthetic support.

- The Royal College of Radiologists. *Clinical Radiology: Major paediatric trauma radiology guidance* (2024):[22]
  - RCR Standard 7: Patients who require interventional radiology input should initially be discussed with the receiving hospital's interventional radiology team, who may have appropriate skills and anaesthetic, intensive care and paediatric surgical support to treat locally. If the patient cannot be managed by interventional radiology at the receiving hospital, they should be transferred to an appropriate major trauma centre.
- NHS England. *Major Trauma Services Quality Indicators* (2016):[23]
  - T16-1C-107: There should be network agreed clinical guidelines for the management of Interventional radiology.
  - T16-2B-109: Interventional radiology should be available 24/7 within 30 minutes of a request. Interventional radiology should be located within operating theatres or resuscitation areas.
  - T16-2B-113: An interventional radiologist should be available to attend an emergency case within 30 minutes.
  - T16-2C-114: There should be facilities for endovascular treatment, including Endovascular Aneurysm Repair (EVAR), available 24/7.
- Society of Interventional Radiology Position Statement on Endovascular Trauma Intervention in the Pediatric Population (2024);[24]
- Society of Interventional Radiology Position Statement on Endovascular Intervention for Trauma (2020);[17]
- American College of Surgeons. *ATLS Advanced Trauma Life Support Guidelines* (2024):[25]
  - "Optimal care of patients with hemodynamic abnormalities related to pelvic fracture demands a team effort of trauma surgeons, orthopaedic surgeons, and interventional radiologists."
  - "Angioembolization of solid organ injuries in children is a treatment option, but it should be performed only in centres with experience in paediatric interventional procedures and ready access to an operating room."
  - "The priority of initial management is to stop the hemorrhage, by emergency operation or embolization."

## *Sepsis*

Sepsis remains a significant issue in the Irish healthcare service. There were 15,722 documented cases of sepsis in Irish hospitals in 2023 with a crude mortality rate of 19.3%, compared with a 4.8% mortality rate from myocardial infarction and a 6.8% mortality rate from stroke. Over 27% of sepsis patients were admitted to a critical care bed in 2023. Older age and chronic illness increases the risk of sepsis. With a crude mortality of over 25%, a person aged over 75 years is considered very high risk for sepsis mortality.[26]

Body interventional radiologists deliver rapid source control for adult and paediatric patients with sepsis. IR plays a pivotal role in the drainage of obstructed biliary systems in jaundiced patients with sepsis and in the drainage of the gall bladder in acute cholecystitis. IR services also include draining intra-abdominal abscesses and obstructed kidneys; the removal of implanted venous devices; and the maintenance and replacement or manipulation of IR drains, nephrostomies and biliary drains.

### *Related guidelines and international guidance/recommendations*

According to *Sepsis Management for Adults (including maternity) (National Clinical Guideline No. 26)*,[27] an adaptation of the Surviving Sepsis Campaign Guidelines (SSCG) from the Society of Critical Care Medicine,[28] image-guided percutaneous abscess drainage for source control of sepsis should be available within 12 hours of referral. Guidelines also identify access to IR as a requirement to achieve compliance with recommendations.

- National Clinical Guideline No. 26: *Sepsis Management for Adults (including maternity)* (2021):
  - "Infectious foci suspected to cause septic shock should be controlled as soon as possible following successful initial resuscitation. A target of no more than 6 to 12 hours after diagnosis appears to be sufficient for most cases."
  - "We recommend that a specific anatomic diagnosis of infection requiring emergent source control be identified or excluded as rapidly as possible in patients with sepsis or septic shock, and that any required source control intervention be implemented as soon as medically and logistically practical after the diagnosis is made (SSCG Section E, Recommendation 1)."
  - "We recommend prompt removal of intravascular access devices that are a possible source of sepsis or septic shock after other vascular access has been established (SSCG Section E, Recommendation 2)."
- National Clinical Guideline No. 30 (2023): *Infection Prevention and Control*[29]. In terms of intravascular access devices and other indwelling tubes placed by IR, good practice should be followed as outlined by

  Good Practice Statement 15. "Healthcare facilities should develop, implement and review processes to address the insertion, use, maintenance, and removal of invasive medical devices. These processes should be centered on the principles of only using devices if they are deemed essential, removing them as soon as they are no longer needed and using care bundles while they are in place".
- National Confidential Enquiry into Patient Outcome and Death (NCEPOD) 2015 report: *Just Say Sepsis!: A review of the process of care received by patients with sepsis*:[30]
  - Recommendation 9: "Where sepsis is suspected, early consideration should be given to the source of infection and the ongoing management plan recorded. Once identified, control of the source of infection should be undertaken as soon as possible. Appropriate staffing and hospital facilities (including theatre/interventional radiology) should be available to allow this to occur."

### *Venous thromboembolism*

IR uses advanced endovascular techniques (thrombolysis and thrombectomy) to remove blood clots (Iliofemoral DVT/massive pulmonary embolism) in symptomatic patients and those experiencing limb ischaemia or end organ failure due to pulmonary embolism. Interventional radiologists also insert and remove inferior vena cava filters for patients with DVT and pulmonary embolism who have a contraindication to anticoagulation (e.g. trauma patients).

Best practice in high-risk therapy with thrombolysis and thrombectomy is under investigation in the ongoing Strike-PE, Hi-PEITHO, PE_TRACT, PEERLESS 2, and PERSEVERE randomised controlled trials.

#### Related guidelines and international guidance/recommendations

- *National Clinical Guideline on Venous Thrombembolism (NCG-VTE) Eve Protocol* (2025):[31]
  - "Percutaneous catheter-directed therapy/ embolectomy may be considered for patients with high risk PE where thrombolysis has failed or is contraindicated, if the appropriate expertise and resources are available".
  - Patients with severe ilio-femoral DVT may be considered for catheter-directed procedures to treat their DVT (within 2 weeks of symptom onset), following appropriate counselling, particularly if the patient is very symptomatic or is at risk of immediate limb compromise (Eve Protocol Supplementary Appendix).

- NICE Guideline 158: *Venous thromboembolic diseases: diagnosis, management and thrombophilia testing* (2020):[32]
  - "Consider catheter-directed thrombolytic therapy for people with symptomatic iliofemoral DVT."
  - "Consider an IVC filter for people with proximal DVT or PE when anticoagulation treatment is contraindicated. Remove the IVC filter when anticoagulation treatment is no longer contraindicated and has been established."
  - "Consider an IVC filter for people with proximal DVT or PE who have a PE while taking anticoagulation treatment only after taking the steps outlined in the recommendation on treatment failure."
- NICE Interventional Procedures Guidance 524: *Ultrasound-enhanced, catheter-directed thrombolysis for pulmonary embolism* (2015):[33]
  - "PEs with haemodynamic instability are sometimes treated with systemic thrombolysis or, occasionally, with endovascular interventions such as catheter directed thrombolysis and percutaneous mechanical thrombectomy."
- NICE Interventional Procedures Guidance 778: *Percutaneous thrombectomy for intermediate-risk or high-risk pulmonary embolism* (2023):[34]
  - "High-risk pulmonary embolism (PE) when alternative treatments are not suitable."

### *Postpartum haemorrhage*

IR delivers rapid endovascular embolisation, stent grafting and balloon occlusion for postpartum haemorrhage (PPH) and major obstetric haemorrhage.

Arterial embolisation in instances of PPH is safe and minimally invasive, has low rates of complication, avoids peripartum hysterectomy, and allows patients to experience subsequent normal pregnancy. PPH remains a significant cause of maternal morbidity and mortality in Ireland. The *Irish Maternity Indicator System National Report 2023* indicates that there were 3,404 cases of PPH (>1,000 millilitres of blood loss) in 2023. This constitutes 6.4% of all births (5.3% of vaginal deliveries and 8.1% of caesarean sections).

Major obstetric haemorrhage (involving blood loss of more than 2,500 millilitres) complicated 2,080 births in Ireland between 2011 and 2022. The *Severe Maternal Morbidity in Ireland Annual Report 2022* published by the National Perinatal Epidemiology Centre indicates a major obstetric haemorrhage rate of 3.38 per 1,000 maternities in 2022, a 47% increase from 2011.[35]

Peripartum hysterectomy may be avoided by using embolisation. *Irish Maternity Indicator System National Report 2023* further reports that there were 25 cases of peripartum hysterectomies in 2023, a rate of almost 1 in 2,000 maternities. Based on the work of Knight *et al.*, it is estimated that 284 emergency hysterectomies for PPH were performed in the United Kingdom (UK) in 2023, with 17 associated maternal deaths from PPH occurring between 2019 and 2021 in the UK and Ireland.[36]

The Healthcare Commission's *Investigation into 10 maternal deaths at, or following delivery at, Northwick Park Hospital, North West London Hospitals NHS Trust, between April 2002 and April 2005* recommended access to IR services for all maternity services.[37]

Best practice is to consider early IR management of PPH. Arterial balloon occlusion and embolisation can prevent major blood loss, obviating the need for blood transfusion and hysterectomy. This reduces the need for intensive care and transfusion use, decreases maternal morbidity and mortality, and preserves fertility.

### Related guidelines and international guidance/recommendations

- Health Care Commission: *Investigation into 10 maternal deaths at, or following delivery at, Northwick Park Hospital, North West London Hospitals NHS Trust, between April 2002 and April 2005* (2006):[37]
  - National recommendation: "Given the potential to save the lives of patients who have catastrophic postnatal bleeding, trusts with delivery units should, where feasible, engage with their neighbouring trusts to discuss the formation of networks. The aim should be to provide an emergency interventional radiology service that is responsive to patients' needs wherever and whenever they arise."
- National Clinical Practice Guideline: *Prevention and Management of Primary Postpartum Haemorrhage* (2022):[38]
  - Recommendation 37: "the most appropriate surgical intervention should be determined by the cause of PPH, the haemodynamic stability of the woman, the available surgical expertise and access to supportive services (such as imaging and interventional radiology)."

## *Placenta accreta spectrum*

IR delivers rapid endovascular embolisation and balloon occlusion for placenta accreta haemorrhage.

### Related guidelines and international guidance/recommendations

- National Clinical Practice Guideline: *Diagnosis and Management of Placenta Accreta Spectrum (PAS)* (2022):[39]
  - "Adjunctive interventional radiology (IR) approaches aimed at reducing blood loss include internal iliac artery balloon occlusion, aortic balloon occlusion, and uterine artery embolization (UAE). These minimally invasive endovascular approaches have increased in availability, usage and evidence base over the last two decades, although there remains significant heterogeneity to practice patterns and care-pathways, even in high volume centres. The aims of IR techniques are to reduce massive haemorrhage, transfusion requirement, reduce requirement for hysterectomy and reduce maternal mortality."
  - Recommendations 34 and 35: The use of IR techniques in placenta accreta spectrum (PAS) should be decided on a case-by-case basis at the PAS multidisciplinary team (MDT) meeting, and where a decision is made to use IR, decisions regarding which IR technique to use should be determined by the expertise available and the MDT.
  - Preoperative internal iliac artery balloon occlusion or distal aortic balloon occlusion should be available to mothers with PAS disorders in specialised centres.

## NEUROINTERVENTIONAL RADIOLOGY (Adults and Paediatrics)

Emergency Neuro IR procedures include:

- Endovascular thrombectomy (EVT), which is used to treat acute ischaemic stroke by removing a blood clot from a blocked brain artery;
- intracranial aneurysm coiling, which involves placing coils within an aneurysm to prevent rupture;
- embolisation of arteriovenous malformations (AVMs), which involves injecting embolic agents to block abnormal blood vessels and reduce the risk of haemorrhage; and
- thrombectomy for dural venous sinus thrombosis, which removes clots from the dural venous sinuses to reduce intracranial pressure.

### *Endovascular thrombectomy for acute ischaemic stroke*

EVT for acute ischaemic stroke is the standard of care for selected patients with proximal large artery occlusion up to 24 hours following the onset of symptoms. Ischaemic stroke is the most common type of stroke, and is caused by a blood clot occluding an intracranial artery and cutting off blood flow to part of the brain. EVT is a procedure performed by neurointerventional radiologists and involves mechanically removing the obstructing blood clot using aspiration or stent-retriever devices. This restores blood flow and minimises permanent tissue damage. Occasionally, carotid stenting by a neurointerventional radiologist needs to be performed as part of the acute stroke procedure.

EVT is one of the most efficacious treatments in all of medicine, and has the potential for considerable medium- and long-term savings for the health service by reducing patient dependence and disability (see stroke thrombectomy patient story).

Of the 5,150 patients discharged with acute ischaemic stroke in Ireland in 2022, 484 patients underwent thrombectomy (9.4%). Ten per cent of patients had pharmacological thrombolysis in 2022. Almost 50% of stroke patients who underwent EVT were independent at 90 days after EVT.[40] The eligibility rate for mechanical thrombectomy among all stroke patients is expected to increase to between 15% and 20% by 2030, in line with the recent expansion of eligibility criteria. This may result in up to 750 EVTs being performed in Ireland annually.

#### Related guidelines and international guidance/recommendations

- *National Thrombectomy Service Annual Report 2022*;[40]
- European Stroke Organisation (ESO) – European Society for Minimally Invasive Neurological Therapy (ESMINT) Guidelines on Mechanical Thrombectomy in Acute Ischaemic Stroke Endorsed by Stroke Alliance for Europe (SAFE);[41]
- Standards of practice in acute ischemic stroke intervention: international recommendations;[42] and
- *National Clinical Guideline for Stroke for the United Kingdom and Ireland* (2023).[43]

## My Stroke Thrombectomy Story

On the 20th of September 2018, a few days after my 36th birthday, I suffered a major stroke. I had been unwell for the past few days with a chest infection and had a severe cough as a result. As I was driving to work, I began to feel very unwell and pulled the car over. I said something out loud to myself and thought my speech was funny. I remember looking in the mirror and seeing a facial droop on my left side. This is when I started to think, "Could I be having a stroke?" I remember saying to myself in the car, "You can't be having a stroke, you're really young, it just can't be happening."

I got myself out of the car and onto the ground and two people stopped, called an ambulance, and I was brought to the emergency department of Our Lady of Lourdes Hospital Drogheda. It was confirmed that I had a right middle cerebral artery infarct and that I was suitable for thrombectomy, and thus I was transferred to Beaumont Hospital.

I remember lying on the bed and hearing all the voices of the people who I knew were there to perform the procedure. Now the experts can correct me on this, but how I recall it is that you don't really feel anything until – I'm assuming – they are at the point of retrieving the clot. It is painful but for a very short period of time. I heard someone else describe it as like a hot poker being poked into your brain. For me it was very similar; I felt like someone was stabbing me inside my head, but honestly it was for only a few minutes, or maybe even seconds.

The most amazing thing about having the thrombectomy was the almost immediate return of function. I remember being asked to lift my left leg in the air, and I could do it straight after the procedure! By the time I had returned from Beaumont Hospital, I had a small party of professionals and my family waiting for me in Our Lady of Lourdes Hospital Drogheda, and apparently the first thing I did was wave at them with my left hand. I had my stroke at 8:15 am and had returned from Beaumont Hospital with almost all function by approximately lunchtime. And that's the power of thrombectomy!

**Majella Cassidy, Co Louth**

### *Management of subarachnoid haemorrhage*

If possible, endovascular treatment of subarachnoid haemorrhage (SAH) is preferred over open surgery, as it is known to lead to better functional outcomes.

The short-term management of post-SAH vasospasm in neurointensive care after SAH also involves collaboration with Neuro IR, vascular neurosurgery and neurocritical care. Neurointerventional radiologists deliver emergent intravascular pharmacological infusion or balloon angioplasty to restore normal blood flow to the patient's intracranial circulation when arterial spasm occurs with new symptoms in the weeks after SAH.

#### Related guidelines and international guidance/recommendations

- Guideline for the Management of Patients With Spontaneous Intracerebral Hemorrhage: A Guideline From the American Heart Association/American Stroke Association (2022);[44]
- *National Clinical Guideline for Stroke for the United Kingdom and Ireland* (2023);[43]
- Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association (2015);[45]
- The Barrow Ruptured Aneurysm Trial: 6-year results[46]
  - ~ This trial compared coiling and clipping and found that coiling had better outcomes for patients with good preoperative neurological status.
- The International Subarachnoid Aneurysm Trial (ISAT): a position statement from the Executive Committee of the American Society of Interventional and Therapeutic Neuroradiology and the American Society of Neuroradiology[47]
  - ~ This trial compared endovascular coiling with surgical clipping in patients with ruptured intracranial aneurysms. The results showed that coiling was associated with better functional independence at 1 year, although there was a higher risk of rebleeding.

### *Endovascular treatment of head and neck vascular trauma*

Neurointerventional radiologists treat acute head and neck vascular trauma, which includes injuries to the carotid and vertebral arteries. These injuries can result from blunt or penetrating trauma and carry a considerable risk of morbidity and mortality.

Common procedures include embolisation to control bleeding, stenting to repair damaged vessels, and thrombectomy to remove blood clots that are obstructing blood flow.

## 2.2.2 Elective/Scheduled Conditions Treated by Interventional Radiology

### BODY INTERVENTIONAL RADIOLOGY PROCEDURES (Adults and Paediatrics)

Body interventional radiologists provide a wide range of elective endovascular treatments for adults and children in the arterial and venous systems throughout the body, as well as non-vascular procedures (e.g. biopsy of focal and non-focal lesions, drainage of infected systems and abscesses, and thermal ablation of tumours) in all organ systems.

IR for the paediatric population differs from IR for adults in that there is no need for the treatment of diseases related to atherosclerosis, degenerative joint disease and cancers. However, while the Paediatric IR case profile may be different, with a lower incidence of cancer and less peripheral vascular work, the requirement for care and the complexity of care is similar to adult practice, and the IR service needs for children in terms of elective care are just as vital as for adults.

Currently, there is variation in the availability of elective IR services in Ireland based on patient age, with children lacking access to IR services that are available to adults. The 2023 RCR publication *Improving Paediatric Interventional Radiology (PIR) services in the UK*[48] states:

- Although image-guided IR treatments are widely considered the gold standard of care in many established adult treatment pathways such as adult cancer care, this is still not acknowledged in the UK for children. For example, a high proportion of children with cancer in the UK undergo invasive open surgery for both cancer biopsy and for vascular catheter placement for subsequent chemotherapy. These procedures, and a number of other operations that could be delivered by paediatric interventional radiologists, are performed by paediatric surgeons. Shouldering this workload takes the surgeons away from other specialist work they should be focusing on and limits surgical operating theatre availability for other services. In addition, there is unambiguous evidence that if these procedures are performed 'open' (using a surgical approach), there is an increased risk of complications, and the length of hospital stay for the child is longer than delivering them using a minimally invasive IR approach.

The 2021 *Paediatric General Surgical and Urology GIRFT Programme National Specialty Report*[49] highlighted "variation in the availability of critical co-dependencies for paediatric surgery such as interventional radiology".

### *Arterial disease*

IR plays a pivotal role in the treatment of peripheral vascular disease in the lower limbs, aortic vascular disease, renal artery disease, and carotid and mesenteric artery diseases through the delivery of both peripheral vascular intervention and endovascular aneurysm repair in collaboration with vascular surgery. There has been a progressive shift from open surgical techniques to endovascular techniques, including angioplasty and stenting, since the early 2000.

*Vascular Surgery: A model of care for Ireland 2023*[50] recognises "the enormous advances in interventional radiology techniques, equipment and expertise that have revolutionised the care of patients with vascular disease."

Elective embolisation procedures include treating patients with fibroid disease, testicular varicocoele, benign prostatic hyperplasia, and arteriovenous malformations, as well as providing local treatments for cancer patients that are not in the scope of practice or skill set of vascular surgery or other specialties.

*Vascular Surgery: A model of care for Ireland 2023* states that "vascular surgery and interventional radiology should continue to work collaboratively to provide excellent quality patient-centred care. Expansion of interventional radiologist numbers will be required to support arterial hub sites as the vascular surgery workload expands."

IR delivers expertise in vascular diagnosis and intervention in conditions such as:

- visceral aneurysm repair;
- renal and mesenteric artery stenting;
- lower limb endovascular treatments (angioplasty and stenting) for critical limb ischaemia/ diabetic foot disease;
- upper limb angioplasty and stenting for subclavian steal syndrome and critical limb ischaemia;
- endoleak repair after aortic aneurysm stent graft;
- thrombolysis or thrombectomy for acute limb ischaemia and surgical graft occlusion;
- abdominal aortic aneurysm endovascular repair in conjunction with vascular surgery;
- thoracic aortic aneurysm endovascular repair;
- treatment of complicated type B aortic dissection; and
- iatrogenic arterial pseudoaneurysm thrombosis.

In complex cases, interventional radiologists deliver problem-solving input in the preparation and delivery of patients for endovascular aneurysm repair of abdominal aortic aneurysm and iliac aneurysm. Interventional radiologists perform complex interventions to treat arteriovenous malformations and endovascular aneurysm repair endoleak.

### *Vascular malformations*

Interventional radiologists with additional fellowship training perform complex Level 2 interventions in children and adult patients with vascular malformations in a multidisciplinary group setting that includes plastic surgeons, vascular surgeons, neurosurgeons, thoracic surgeons and respiratory physicians, depending on the affected area.

### *Venous disease*

IR provides:

- chronic DVT/iliac venous obstruction with recanalisation and stenting;
- embolisation for pelvic congestion syndrome in women;
- embolisation for men with symptomatic testicular varicoceles;
- treatment of liver failure due to hepatic venous thrombosis (Budd-Chiari Syndrome);
- Inferior vena cava (IVC) filter insertion for pulmonary embolus protection;
- retrievable IVC filter removal;
- Transjugular intrahepatic portosystemic shunt (TIPS) and variceal embolisation;
- Balloon-occluded retrograde transvenous obliteration (BRTO) of gastric varices;
- thrombolysis and mechanical thrombectomy for iliofemoral DVT and pulmonary embolism; and
- embolisation of pulmonary arteriovenous malformations in patients with hereditary haemorrhagic telangiectasia.

### *Cancer*

Interventional oncology describes a range of vascular and non-vascular procedures that treat or palliate patients with cancer. The widespread use of CT and magnetic resonance imaging (MRI) is detecting smaller tumours that can be treated by minimally invasive techniques without the morbidity and mortality of conventional surgical treatments. Ablative procedures (such as radiofrequency ablation, cryotherapy, microwave ablation and irreversible electroporation) and embolisation procedures (such as transarterial chemoembolisation (TACE) and selective internal radiotherapy (SIRT)) provide minimally invasive targeted treatment options for patients with solid tumours.[51,52]

The use of interventional oncology treatments confers significant benefits to patients, including improved outcomes, and can convert many previously prolonged hospital admissions to short day case or overnight procedures. In addition, the treatment of obstructive lesions of both vascular and non-vascular systems can provide invaluable palliation for patients with advanced disease.

Cancer protocols differ between adult and paediatric patients. Interventional oncology treatments are not available for children at present.

IR provides:

- chemoembolisation and radioembolisation for liver cancer and some liver metastases (neuroendocrine tumours, ocular melanoma, etc.);
- radiofrequency or microwave ablation for cancers of the lung, liver, kidney or bone;
- thrombolysis, recanalisation and stenting for venous, superior vena cava (SVC)or inferior vena cava (IVC) obstruction in cancer;

- SVC stenting for SVC syndrome, most commonly in lung cancer;
- superior vena cava stent for acute obstruction;
- nephrostomy and antegrade ureteric stenting for malignant ureteric obstruction;
- central venous access: tunnelled central line insertion, chest and arm ports, and PICC insertion for the administration of chemotherapy;
- preoperative embolisation of tumours such as juvenile nasopharyngeal angiofibroma, giant renal cell tumours, hypervascular spinal metastases, and brain haemangioblastomas to prevent operative haemorrhage;
- tunnelled pleural drain insertion;
- tunnelled paracentesis catheters to control recalcitrant malignant ascites;
- paracentesis for symptomatic ascites;
- thoracentesis for symptomatic pleural effusion;
- portal vein embolisation to prepare patients for major hepatic resection for cancer;
- biliary stenting for malignant disease;
- biliary endoscopy and biopsy for the diagnosis of liver cancer;
- vertebroplasty for vertebral fracture and pain;
- large bowel stent for intestinal obstruction; and
- enteral access for feeding, medication and decompression.

### *Kidney disease*

Improving renal dialysis provision and maintaining vascular access for dialysis is a major service provided by IR. Approximately 100 patients per million population start dialysis each year, of which 70 per million will undergo haemodialysis. The number of patients requiring treatment by dialysis or kidney transplantation in Ireland increased to 5,404 (5,337 adults and 67 children) in 2024 and 2,232 patients receive in-centre haemodialysis using a catheter (>70% of patients) or fistula. More than 470,000 dialysis treatments were delivered by the HSE in 2024.[53]

The most effective and safest form of dialysis is via surgical arteriovenous fistula. Dialysis fistula stenosis or thrombosis occurs frequently, at a rate of about 15 per hundred fistula/years, and IR intervention is required to maintain fistula patency.

IR provides:

- central venous access with temporary and tunnelled dialysis catheters;
- complex dialysis access (interventional radiologists are experts in venous recanalisation and difficult venous access cases, such as the placement of translumbar and hepatic venous catheters when no other venous access is available);
- fistuloplasty and stenting for patients with a failing arteriovenous fistula who are failing to dialyse;
- arteriovenous fistula thrombectomy/thrombolysis for acute occlusion;
- renal artery stenting in patients with deteriorating renal function;
- peritoneal dialysis catheter insertion and maintenance; and
- percutaneous haemodialysis fistula creation and care.

### *Musculoskeletal and pain intervention*

IR provides:

- embolisation for osteoarthritis and tendonitis;
- facet joint injection for back pain;
- joint aspiration for septic arthritis;
- coeliac axis blocks for abdominal pain;
- epidural blocks for pain; and
- percutaneous vertebroplasty treatment for symptomatic osteoporotic compression fractures.

### *Gynaecological conditions*

IR is used to treat abnormal uterine bleeding or pressure-related symptoms due to uterine fibroids or adenomyosis. With adequate bed access and resources IR can deliver uterine artery embolisation and avoid hysterectomy in a large proportion of women. Uterine artery embolisation (UAE) is an established and highly cost-effective treatment for symptomatic fibroids – both large and small – and is as clinically effective as hysterectomy and myomectomy. Hysterectomy results in longer hospital stays, longer time until return to normal activities and higher hospital costs than UAE. UAE is efficacious and relieves and stabilises the symptoms of menorrhagia and pain in more than 90% of patients, and relieves pressure symptoms in 60–80% of patients. It has a high success rate and low complication rate that are sustained in the long term. While there is limited patient satisfaction data available, the data that are available favour UAE as the treatment of choice. UAE is a less expensive option when compared with hysterectomy, even when the costs of repeat procedures and associated complications are factored in.

Interventional radiologists also provide essential embolisation treatments for symptomatic women with debilitating pelvic congestion syndrome.

IR provides:

- UAE for symptomatic fibroids, adenomyosis, retained products of conception, and uterine arteriovenous malformations to avoid hysterectomy;
- fallopian tube recanalisation in subfertility;
- pelvic vein embolisation for pelvic congestion syndrome or pelvic venous disorder; and
- US-guided removal of Implanon implants (subcutaneous hormone-eluting implants) that are not amenable to standard removal.

UAE for symptomatic uterine fibroids is underutilised in Ireland. There were 3,415 hysterectomies in 2021 in public hospitals in Ireland for diseases other than cancer.[54] Approximately 40% of hysterectomies are for abnormal uterine bleeding. Only 206 patients had a UAE for fibroids in the same period. This represents only 8% of the total number of hysterectomies performed in the public health system and implies underutilisation of UAE as an alternative to surgery. There is a lack of awareness about this safe, effective and less invasive therapy among both referring clinicians and the public.

### *Gastrointestinal, hepatobiliary and pancreatic diseases*

IR is widely used in the treatment of patients with obstructive biliary pathology such as cholangiocarcinoma, stone disease or biliary strictures. The treatment options for these patients are often divided between hepatobiliary surgical management, endoscopic management by a gastroenterologist and percutaneous management by an interventional radiologist.

Interventional radiologists provide biliary stone procedures using percutaneous biliary endoscopy to clear the bile duct of obstructions. Interventional radiologists also manage benign biliary strictures after complex biliary bypass.

Percutaneous gastrostomy is also provided for patients who cannot swallow by placing gastrostomy catheters directly into the stomach to provide nutrition as an alternative to parenteral nutrition.

Patients with chronic liver disease and portal hypertension have improved outcomes with prompt access to a transjugular intrahepatic portosystemic shunt (TIPS), balloon retrograde transvenous occlusion (BRTO), tunnelled peritoneal drainage insertion for refractory ascites and transvenous obliteration for varices.

IR provides:

- palliation of obstruction due to tumours at many sites, including the upper and lower GI tract;
- biliary stent or drainage for benign or malignant jaundice;
- biliary endoscopy and lithotripsy;
- benign biliary stricture dilatation and drainage;
- long-term biliary drain management;
- percutaneous cholecystostomy in patients with acute cholecystitis that is not responding to antibiotic therapy;
- long-term cholecystostomy management;
- enteral access for feeding, medication and decompression;
- Transjugular intrahepatic portosystemic shunt (TIPS) for bleeding varices;
- Balloon retrograde transvenous occlusion (BRTO);
- transhepatic or trans-splenic embolisation for bleeding varices;
- tunneled peritoneal drainage insertion for refractory ascites;
- oesophageal/gastric/duodenal stents for malignancies;
- percutaneous gastrostomy in patients who require medium- to long-term enteral nutrition;
- percutaneous caecostomy in patients with large bowel distension or obstruction;
- diverticular disease management with catheter drainage of diverticular abscesses;
- US-guided percutaneous focal and non-focal liver biopsy;
- portal vein pressure measurement and transhepatic liver biopsy in patients with coagulopathies;
- pancreatic pseudocyst drainage;
- peripancreatic pseudoaneurysm embolisation; and
- pancreatic necrosis collection drainage and management.

### *Venous access*

IR provides:

- chest ports and Hickman catheter lines for cancer patients to facilitate chemotherapy;
- outpatient parenteral antibiotic therapy using image-guided PICCs or midlines to achieve long-term intravenous access with significant cost savings for the patient and hospital;
- Hickman catheters for the delivery of chemotherapy and total parenteral nutrition; and
- tunnelled haemodialysis catheters to dialyse patients with renal failure.

Venous access procedures should be performed outside of an operating theatre environment in line with international best practice.

### *Transplant interventions*

IR provides:

- liver transplant arterial, venous or biliary intervention;
- portal vein stenting; and
- renal transplant ureteric arterial or venous intervention.

### *Renal and genitourinary disease*

IR provides:

- prostate embolisation for benign prostatic hyperplasia;
- renal drainage procedures, including nephrostomy;
- antegrade ureteric stenting for stone disease and malignancy;
- varicocele embolisation for symptomatic varicocoele; and
- JJ stent change in women.

## NEUROINTERVENTIONAL RADIOLOGY (Adults and Paediatrics)

Elective/scheduled Neuro IR includes:

- neurovascular procedures:
  - endovascular treatment of aneurysms;
  - dural arteriovenous fistula (dAVF) and arteriovenous malformation (AVM) embolisation;
  - elective carotid stenting;
  - dural venous stenting for intracranial hypertension;
  - middle meningeal artery (MMA) embolisation; and
  - embolisation of cerebrospinal fluid-venous fistula for cerebrospinal fluid leaks.
- spinal procedures:
  - myelography for cerebrospinal fluid leaks;
  - targeted blood patching for cerebrospinal fluid leaks;
  - vertebroplasty;
  - image-guided lumbar puncture; and
  - spinal pain injections.

### *Middle meningeal artery embolisation for chronic subdural haematomas*

MMA embolisation is a minimally invasive procedure performed by neurointerventional radiologists to treat chronic subdural haematoma (cSDH). MMA embolisation is indicated for patients with symptomatic cSDH (particularly those with mild to moderate symptoms), and for those at elevated risk of recurrence due to factors such as brain atrophy, liver or kidney failure, or the need for blood-thinning medication. It is also used as an adjunct therapy to prevent recurrence in surgically evacuated cSDH. The procedure involves the selective catheterisation of the MMA using angiography and blocking the artery. A number of clinical trials published between 2021 and 2024 suggest that MMA embolisation will become part of a new standard of care for cSDH, offering better outcomes and fewer repeat surgeries.[55,56,57]

### *Dural arteriovenous fistula and arteriovenous malformation embolisation*

Embolisation is generally the first-line therapy in patients with dural arteriovenous fistula (dAVF) embolisations. The benefits of embolisation over open surgery include a reduced risk of haemorrhage, improved neurological outcomes and quicker recovery. For the health service, embolisation offers a cost-effective treatment option, reduces the need for prolonged hospital stays, and lowers the risk of complications associated with more invasive procedures.

While embolisation is effective in managing acute bleeding points in AVMs, open surgery and radiosurgery are often the preferred definitive treatments. Open surgery involves the resection of the AVM, while radiosurgery uses focused radiation to obliterate the abnormal vessels over time, aiming to provide long-term resolution and prevent the recurrence of haemorrhage.

Neurointerventional radiologists who have undertaken additional fellowship training manage paediatric and adult patients with head and neck AVMs in a multidisciplinary group that includes plastic surgeons, neurosurgeons, and ear, nose and throat (ENT) surgeons, who treat facial and intracranial malformations, with embolisation.

### *Carotid artery stenting*

Carotid artery stenting is a highly effective and less invasive alternative to carotid endarterectomy for the treatment of symptomatic atheromatous carotid artery disease, particularly in patients who are considered poor surgical candidates.[58,59]

Carotid artery stenting is performed in the hyperacute setting during EVT in cases of acute carotid artery occlusion. It is also performed in the acute and subacute setting to treat symptomatic carotid atheromatous disease.

## 2.3 Interventional Radiology Service Delivery

This section encompasses Body IR and Neuro IR for adults and children. 'Interventional Radiology' is used as an encompassing term to describe Body IR, Paediatric IR and Neuro IR. Where there are specific differences among these three areas, the relevant discipline is referred to explicitly.

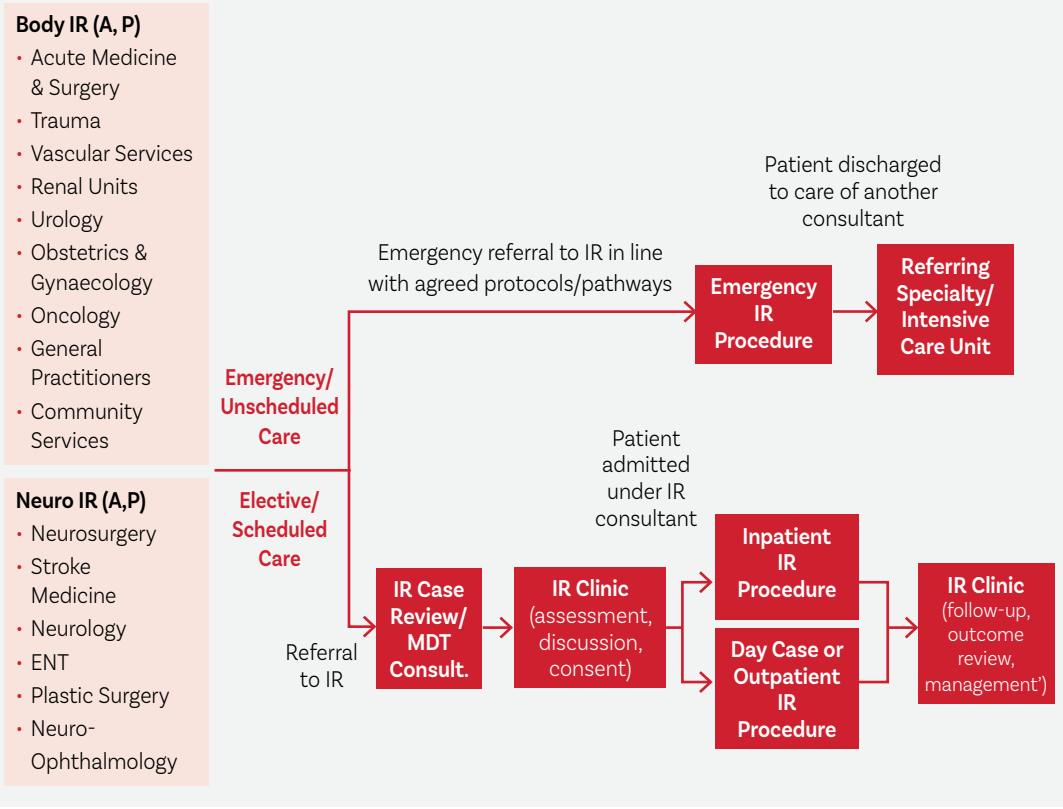
### 2.3.1 Interventional Radiology Pathways

#### Overview

IR care is a longitudinal continuum. It begins with an initial consultation that is either formalised in a clinic setting or originates from discussion with a referring clinician, where a plan of care is defined that may include a diagnostic or therapeutic intervention. It evolves to an eventual resolution of the clinical problem or the establishment of an alternative care plan.

The optimal patient pathway for IR, covering adults (A) and the paediatric population (P) for both emergency and elective cases, is depicted in *Figure 3*. Each stage is described in more detail in the following subsections.

*Figure 3* OPTIMAL PATIENT PATHWAY FOR INTERVENTIONAL RADIOLOGY



### Referral

Inpatients are referred from medical, surgical, paediatric, obstetric and gynaecological, and community services directly for consultation, evaluation and treatment by body interventional radiologists.

Most referrals to Neuro IR come via neurosurgery, stroke medicine, neurology, neuro-ophthalmology, ENT and plastic surgery. Patients with a stroke who are being considered for endovascular thrombectomy (EVT) are referred by stroke physicians around Ireland via a pathway identified in "Guidelines for the management of patients with acute ischaemic stroke requiring inter hospital transfer for Emergency Endovascular Thrombectomy."[60]

Selected IR services should also be directly available to community care services and general practitioners.

### Pre-procedural care

*Case review:* IR consultants (working in Body IR, Neuro IR and Paediatric IR) should review each patient's clinical information and imaging and decide whether further tests, imaging, clinical consultation or an interventional procedure are appropriate.

*Clinical review:* Interventional radiologists should see IR patients clinically in an outpatient clinic or, if admitted, in an inpatient care setting to acquire their clinical history, perform a physical examination, and discuss management options and informed consent.

*Multidisciplinary team (MDT) consultation:* Some IR patients are discussed at MDT meetings and opinions on specialist IR care are provided.

### Procedure

Interventional radiologists (working in Body IR, Neuro IR and Paediatric IR) can take care of selected inpatient, outpatient and day-case patients directly. Interventional radiologists admit and discharge patients directly for some procedures (e.g. fibroid embolisation or biopsy procedures) after recovery from sedation or an overnight stay. Interventional radiologists are also consulted to perform procedures on inpatients under the care of other clinical services.

Most adult IR procedures are performed under local anaesthesia and/or conscious sedation. Some painful adult elective procedures, most adult emergency procedures, paediatric procedures, and neurointerventional procedures require monitored sedation or general anaesthesia under the care of a consultant anaesthesiologist and anaesthetic nurse.

### Post-procedure

Interventional radiologists (working in Body IR, Neuro IR and Paediatric IR) should perform direct patient follow-up, providing advice to the patient, GP and community services as required. Clinical follow-up is required to identify complications and record outcomes to help guide further follow-up, imaging or intervention. Adverse event records should be collected directly in the post-procedure period to inform quality assurance and morbidity and mortality programmes.

Day-case patients may require phone consultation or nursing follow-up in the outpatient setting to support outpatient care, reassure patients and avoid admission. Community and patient support services are required to assist with maintaining adequate records of patient progress, the maintenance of devices, and problem-solving in cases of device or drain malfunction.

Emergent access to the IR team is required for some patients who experience drain displacement or maintenance issues in the community and require treatment advice or device rescue.

Interventional radiologists see postoperative patients in an outpatient setting where available. Specialist IR follow-up imaging is reviewed by the interventional radiologist after treatment and is often subsequently discussed with the referring clinical service at an MDT meeting. Further specialised imaging may be advised and reviewed to confirm the efficacy of the treatment or provide advice regarding further management of the patient.

It is important to note that while the pre-procedure, procedure and post-procedure stages are presented in this document as distinct steps on the patient's IR journey, from a hospital coding perspective, they constitute a single episode of patient care.

### Links with community

Access to IR by community services is an important aspect of integrated care. Many patients with chronic and acute disease who are living in the community have catheters placed by interventional radiologists to deliver enteral feeding, chemotherapy, or dialysis access, or have long-term drainage catheters such as nephrostomy tubes, biliary tubes or abscess drainage catheters. For many of these patients, catheter problems such as blockage, catheter-induced sepsis and catheters falling out may result in a trip to an emergency department with inpatient admission to access IR services. Interventional radiologists can play a more active role in prevention (by scheduled catheter exchanges and catheter checks), and when catheter problems do develop, direct access to IR could prevent the need for transfer to an emergency department with an inpatient admission by allowing more efficient access to the most appropriate team (IR) and faster transfer back to the community.

## 2.3.2 The Interventional Radiology Team

This section encompasses Body IR and Neuro IR for adults and children.

The complex nature of IR requires an extended team of healthcare professionals. These include consultant interventional radiologists (working in Body IR, Paediatric IR and Neuro IR), radiology specialty registrars, specialist IR nurses, specialist IR radiographers, healthcare assistants (HCAs), and clerical staff, in addition to the referring clinical teams and anaesthesiologists.

Complex combined procedures require advanced planning and discussion with gastroenterology (rendezvous procedures), urology (stone access and rendezvous procedures), orthopaedics (trauma embolisation or preoperative bone tumour embolisation) and liver surgery (portal vein embolisation or combined liver tumour ablation and hepatic resection).

Working effectively as a team with shared responsibilities is essential if the team is to deliver coordinated care with task interdependency and the best patient outcomes. All team members must understand their individual roles but also be prepared to work flexibly to ensure successful outcomes.

The importance of effective team working is reflected in the recent guidance by the Cardiovascular and Interventional Radiological Society of Europe's (CIRSE) IR safety checklist[61] based on the World Health Organization (WHO) *Surgery Safety Checklist*[62].

### 2.3.2.1 Members of the interventional radiology team

#### *Interventional radiology consultants*

Interventional radiologists (working in Body IR, Paediatric IR and Neuro IR) have a responsibility to lead and work within teams that encourage and accept participation from all team members. The role of the IR consultant is outlined in detail in section 2.3.3.

### *Interventional radiology nurses*

IR nursing teams, including registered nurses and HCAs, provide care for patients throughout the IR continuum of care. IR nursing roles and responsibilities include pre-procedure, perioperative, intra-operative, postoperative and discharge care.

IR nursing involves a unique body of nursing knowledge, skills and competencies that are specific to the disease process in the IR unit's scope of practice. IR nurses possess the knowledge and skills of a perioperative/post-anaesthesia care unit nurse and a detailed knowledge of the equipment used and procedures performed within IR units. Nurses working with the interdisciplinary team play a vital role in ensuring safe and successful procedures in both the elective and emergency settings. IR-educated/trained nurses are fundamental to the delivery of safe and sustainable IR services both in hours and out of hours.

IR nurses have the experience and education/training to counsel patients and community services with regard to their experience of the treatments provided, potential outcomes, and common side effects, and they can also identify the warning signs of issues with devices or drains. IR nurses are knowledgeable about outcomes of IR procedures and know how to manage nausea and pain (for example, associated with uterine fibroid embolisation). Patient experiences and outcomes are determined not only by procedural success, but also by the early identification of adverse events and side effects of treatments.

IR nurses build strong nurse–patient relationships as a substantial amount of patient care and treatment is delivered on an outpatient basis; for example, clinical care of surgical drains and intravenous catheter lines. IR nurses provide answers to clinical queries from both patients and their carers in the community and from inpatient teams during IR ward rounds.

IR nurses have expanded roles, including:

- administering sedation under medical supervision;
- managing the sedated patient;
- assisting the interventional radiologist during procedures;
- providing specific device management and knowledge; and
- focusing on patient safety, including accurate patient identification, monitoring, clinical evaluation and leading time-out before IR procedures.

Nursing structures within IR units require the right mix of HCAs and registered nurses, supported by specialist and managerial roles.

#### Registered nurses/healthcare assistants

Appropriate numbers of staff nurses working together with HCAs and the interdisciplinary team are required for the optimal delivery of safe and successful IR procedures (see *section 2.3.2.2*) and to safely care for patients in IR reception bays pre- and post-procedure, in biopsy rooms, and in IR day-case units.

While never replacing the role of registered nurses, HCAs enable registered nurses to expand their role within the IR setting and aid nursing staff in the patient care setting. HCAs are fundamental in assisting nursing staff to prepare and turn over the IR suites in a timely fashion, in addition to cleaning, stocking and assisting with patient movement and preparation. In IR, HCAs often help with biopsy and simple drainage procedures, obtaining equipment for a procedure. In cases where sedation or analgesia is given, registered nurses are essential in providing appropriate monitoring of the patient in addition to patient support and care.

### Clinical nurse manager

The clinical nurse manager (CNM) has a pivotal role in IR service planning, coordinating and managing activity and resources within the IR unit. Their main responsibilities are quality assurance, resource management, staffing and staff development, practice development, facilitating communication, and providing professional/clinical leadership. In IR units, CNMs or their designates act as 'clinical coordinators' to coordinate the list of patients, ensure appropriate patient preparation, manage communications with the wider team, and keep the IR suites running smoothly.

### Clinical skills facilitator

Clinical skills facilitators (or education coordinators) are nursing staff who are responsible for the continuous education, training and skill development of IR staff. The role of the clinical skills facilitator is to support IR nurses in developing the clinical skills and competencies that they need to fulfil their roles and responsibilities in an ever-changing health service. They assess the learning needs and competencies of the learners, design and deliver learning materials and resources, facilitate group discussions and simulations, observe and coach the learners in clinical practice, provide constructive and timely feedback, and document and report the learning outcomes and progress.

### Clinical nurse specialists

Clinical nurse specialist (CNS) practice encompasses a major clinical focus of care for patients or clients and their families in hospital, community and outpatient settings. The CNS works with medical colleagues and with health and social care professional colleagues. The CNS role centres on five core competencies: (1) clinical focus (direct care and indirect care); (2) patient/client advocate; (3) education and training; (4) audit and research; and (5) consultancy including leadership in clinical practice.[63]

In IR, CNSs use their specialist knowledge, skills and attitudes to enhance patients' preparedness for pre- and post-procedure care, supporting patients in the community and integrating services. Specifically, CNS roles in IR include coordinating and communicating with IR clinic referrals, developing and implementing protocols for patient discharge and follow-up, coordinating early patient discharge and prescriptions, ordering follow-up imaging tests for cancer patients treated by IR, and coordinating reviews. CNSs also liaise with other specialties and with patients, participate in or lead IR ward rounds, and undertake device and supplies coordination.

### Registered advanced nurse practitioners

In Ireland, registered advanced nurse practitioners (RANPs) are highly skilled clinicians and clinical leaders who deliver high-quality, safe and effective person-centric care to a defined caseload of patients and their families. RANPs are nurses who have undertaken a master's-level education in clinical practice and are registered with the Nursing and Midwifery Board of Ireland. RANPs have authority in patient diagnosis and independently assess, diagnose, plan, manage and deliver care for patients with complex clinical issues.[64] There is a potential for RANP roles within IR pathways in the future.

### *Interventional radiology radiographers*

IR radiographers have an in-depth knowledge of IR and of CT and US imaging techniques and modalities, as well as expertise with processing, including image overlay, fusion and guidance. IR radiographers are trained in the IR procedures being carried out. This allows optimisation of imaging strategies while reducing the risk of ionising radiation to both the patient and the performing radiologist. Some procedures – for example, PICC insertion – are being performed by radiographers, predominantly in Model 4 hospitals. Currently, training is provided locally with policies, governance and structures in place. The scope of the IR

radiographer's role is laid out in the Irish Institute of Radiography and Radiation Therapy's *Scope of Practice of a Diagnostic Radiographer*.[65]

Radiography structures within IR units require the right mix of radiography assistants and basic and senior radiographers, supported by specialist and managerial roles.

**Basic and senior grade radiographers**

The IR radiographer is an expert in integrating areas of key importance in the IR department. These include patient care, the use of technology, the optimisation of radiation dose, clinical responsibility, organisation, quality assurance, justification of X-ray exposures, knowledge of legal responsibilities, diagnostic decision-making, and education and training.

The IR radiographer has a direct and supervisory role regarding the welfare of the patients in their care. This includes assessing a patient's ability to undergo the radiographic examination and, in the case of diagnostic radiography, whether an examination is justified, in accordance with Council Directive 2013/59/Euratom, S.I. No. 256/2018, and their role as practitioner. The radiographer is the expert in the production of diagnostic images using ionising and non-ionising radiation. The diagnostic radiographer is therefore continuously making decisions regarding the use of technology to acquire the most appropriate images in order to best inform the management of the patient.

The senior IR radiographer possesses all the competencies of the basic grade radiographer while also having strong leadership qualities and management skills. They have greater knowledge of the roles, abilities and limitations of all members of the MDT and are capable of strategically managing the workflow through the IR suite/department.

**Radiography assistants**

Radiography assistants are tasked with supporting the IR service and staff in providing an efficient and effective service. They play a key role in patient care and support, efficient workflow, and throughput. It should be noted that, as they are not currently under statutory registration, ultimate responsibility for any tasks they may be delegated lies with the registered practitioner from whom the task has been delegated.

**Clinical specialist radiographers**

The IR clinical specialist radiographer (CSR) must as a baseline meet the eligibility criteria as set down by the HSE's Criteria-Grade Code 3131[66]. The CSR has strong leadership qualities and management skills, as well as an in-depth knowledge of all IR procedures, workflow, patient care, technology, equipment, radiation safety, service provision and development, quality assurance, and audit.

CSRs work in tandem with the CNM in service planning and managing activity/resources. The CSR leads the team of radiographers and has responsibility for their training in the area of IR. Radiographic/US equipment management also falls under the CSR's remit. The CSR role involves clinical audit, radiation protection, health and safety, attendance at MDT meetings, scheduling and review of waiting lists and requests, and quality assurance.

The CSR works closely with the consultant interventional radiologists and also undertakes management and service planning responsibilities.

With the broadening of scope of IR procedures, the IR CSR also works with other sub-departments within radiology to provide a comprehensive and safe IR service for patients and staff, including CT CSRs, US CSRs, MRI CSRs and the radiation protection officer, specifically around dosimetry, personal protective equipment and diagnostic reference levels.

**Advanced practitioners**

The development of enhanced and advanced practice radiography roles in IR services enables career progression, aids staff recruitment and retention, and improves the delivery of high-quality, safe patient care.

The advanced practice grade code for radiographers was approved by the Department of Health in 2025, and a structured IR-led educational programme is required in order to provide suitable training for the national roll-out of advanced practice IR roles.

**Radiography service managers**

Radiography service managers work across the wider radiology service with responsibility for leadership, planning, operations, personnel management, finance, and quality assurance. They liaise closely with the CSR, CNM, consultant radiologists and wider hospital management to provide strategic and clinical leadership in the delivery of an effective, efficient, quality-assured and patient-centred service. They work closely with the CSR to ensure the adequate use of resources and adherence to legislation, to promote a healthy work environment, and to encourage participation in continuing education, research and development.

### *Anaesthesiology*

Although most adult Body IR procedures are performed with conscious sedation and local anaesthesia administered by the IR team, many Neuro IR and Paediatric IR cases require general anaesthesia or monitored anaesthetic care delivered by consultant anaesthesiologists, anaesthetic nurses and post-anaesthesia care nurses.

Anaesthesiology is an important part of the IR team, and anaesthesiologists must understand the unique nature of IR procedures and the radiology environment. Some patients will require positioning and respiratory rate and depth manipulation to facilitate image-guided access to areas of the body to facilitate treatment.

Indications for general anaesthesia for IR procedures include:

- cardiovascular shock requiring intensive care management and vasopressor support;
- a reduced level of consciousness;
- a patient's inability to comply with instructions or remain still for extended treatments;
- painful complex Body IR procedures (tumour ablation; complex biliary, vascular and oncology cases; and TIPS procedures);
- complex airway unsuitable for conscious sedation (Mallampati grade 3 and 4); and
- many Paediatric IR cases and Neuro IR procedures, including, but not limited to endovascular aneurysm treatments, arteriovenous malformations (AVM)and arteriovenous fistula (AVF) embolisation, middle meningeal artery (MMA) embolisation, dural venous sinus stenting, and certain endovascular thrombectomy (EVT) procedures depending upon the location of the occlusion and the clinical condition of the patient.

As a general guide for the planning of services, the use of general anaesthesia in Paediatric IR and Neuro IR cases reduces the number of cases that a Paediatric IR/Neuro IR service can perform in a procedure room by 50% in comparison with adult Body IR services.

### *Administrative support*

Grade 5 clerical officers in the IR unit can register patients in the radiology system, run IR clinics, provide appointments, schedule IR lists, provide patient information, coordinate IR admission and ongoing care and communication, and manage and validate waiting list cases.

An additional clerical resource with adequate training and experience is required to collect and enter data in order to comply with key performance indicators and audit reporting, as specified in Chapter 6: Governance, Quality Assurance and Patient Safety.

### *Porters*

IR is a high-turnover clinical area, and a dedicated resource is required with extended hours to facilitate the preparation of patients for early and late appointments.

### *Others*

In Paediatric IR, play therapists can have a preoperative role.

#### 2.3.2.2 Ways of working within an interventional radiology team

### *Staffing requirements for interventional radiology procedures*

All IR procedures require an IR consultant or an appropriately trained registrar, an appropriate complement of IR nurses (the specific number is determined by IR procedure type), one senior IR-trained radiographer and one basic grade radiographer.

IR nursing requirements are similar to and informed by operating department requirements, including those developed by the Association for Perioperative Practice[67] and the New Zealand Nurses Organisation statement, Safe Staffing in the Perioperative Setting,[68] for nursing care in IR.

- Biopsies or drainages performed under US or CT guidance are generally performed in non-IR suites and require an IR doctor and one circulating trained staff member (who is experienced in the procedure and equipment) to adjust and provide equipment and to monitor and maintain the safety of the sterile environment. With appropriate training, this role could be undertaken by a qualified HCA (Quality and Qualifications Ireland (QQI) Level 5) with IR training, subject to expansion of the HCA role within policy and role guidelines.
- Vascular procedures and complex Level 2 procedures are performed in dedicated IR suites that are similar to operating theatres, with the majority of patients receiving conscious sedation. This type of procedure requires a scrub nurse and a nurse who is trained in the administration of conscious sedation. A trained scrub nurse is responsible for maintaining the sterile field during the surgery. The scrub nurse and the interventional radiologist work together as a team, handling sterile instruments, sutures and supplies. Scrub nurses are knowledgeable about specialised IR equipment such as catheters, wires, stents, embolic material and angioplasty balloons. They maintain a vigilant eye on the patient's safety during the procedure, maintaining good communication with both the operating interventional radiologist and the other nursing staff in the IR suite. The conscious sedation nurse has a sole duty to administer sedation and provide monitoring and observation of the patient as needed.[68] There will often be a third nurse in the IR suite to circulate and assist with getting equipment and assisting both the scrub nurse and the conscious sedation nurse.
- For patients undergoing general anaesthesia, a trained nurse whose sole duty is to provide monitoring and observation of the patient is needed.[68] In Ireland, this is the responsibility of the anaesthesiologist, with assistance from anaesthesia nurses. For IR procedures requiring general anaesthesia, the anaesthesia nurse is present in addition to the scrub nurse and the circulating staff member.

An anaesthesiology consultant and anaesthesia nursing staff are required for many Paediatric IR cases and Neuro IR procedures, as outlined above.

### *On-call arrangements*

The delivery of 24/7 on-call IR requires a team of IR consultants, trained IR nurses, dedicated IR radiographers and, occasionally, anaesthesiologist support.

### *Interventional radiology ward rounds and conferences*

A postoperative ward round run by all IR consultants, an IR nurse and IR trainees allows the appropriate management of inpatients following IR procedures and consultation on the management of conditions and complications. IR conferences and MDT meetings allow the IR team to determine appropriate imaging, intervention and consultation before the safe discharge of the patient from hospital to the community with appropriate support. The IR ward round allows the assessment of patient outcomes and complications.

## 2.3.3 The Role of the Interventional Radiologist

This section encompasses Body IR and Neuro IR for adults and children.

All interventional radiologists apply their advanced knowledge of the anatomy and physiology of the body, as well as their knowledge of devices, indications, contraindications, outcomes, pathology and pharmacology (including coagulation pathophysiology and the use of anticoagulant, antiplatelet and procoagulant medications), to the clinical management and treatment of selected elective and emergency conditions. All interventional radiologists should be involved in pre-intervention assessment, outpatient clinics, informed consent, ward activities and follow-up.

### *Interventional radiologist work plans*

Work planning should take account of all IR activity as direct clinical care, including sufficient flexibility to support daytime emergency and urgent cases.

Work plans should reflect the breadth of the interventional radiologist role and include clinical time for:

- IR clinics;
- on-call activity;
- participation in MDT meetings;
- patient communication and follow-up;
- measuring outcomes; and
- quality improvement (e.g. submitting data to audits or registries).

Most IR consultants have a component of diagnostic activity in their work plan. There is no fixed ratio of interventional to diagnostic activity due to variation in the services supported. All new interventional radiologists should have 0.8 WTE IR service and 0.2 WTE diagnostic responsibilities in their work plan.

### Key aspects of the role of the interventional radiologist

### *Responsibility for full patient pathway*

IR is developing rapidly, and there are now several dedicated image-guided procedures where the interventional radiologist is the primary clinician responsible for the episode of patient care. The interventional radiologist's responsibilities encompass the entire patient journey, from initial assessment and treatment planning to procedure performance and post-procedure management.

Dedicated IR time that is free from diagnostic radiology duties is crucial for ensuring optimal patient selection, timely intervention, optimal management of procedure failure, adverse event management and quality assurance data collection. To ensure patient safety and

administer the highest quality of care, selected patients should be admitted under a named interventional radiologist or, for more complex cases, in partnership with a clinical specialist where junior cover can be appropriately shared. IR consultants should be available to advise on clinical management and should take shared (or, where appropriate, sole) responsibility for the hospital episode of care. Interventional radiologists therefore need to have the appropriate clinical time, admission rights at their hospital and access to inpatient and day-case beds as the primary named clinician.

After discharge, the interventional radiologist takes responsibility for the ongoing management of the patient in the community, assessing their response and outcomes, detecting complications, and managing catheter changes and the further care of drains.

### *Patient communication and informed consent*

IR is a unique field of expertise. Interventional radiologists are uniquely positioned to communicate with patients; clinically assess patients; interpret imaging studies; explain treatment options, alternative treatments and complications; and discuss therapeutic interventions with the patient. Paediatric interventional radiologists interact directly with patients and their families and guardians, and counsel them regarding diagnostic and therapeutic options for their medical conditions.

Indeed, all medical practitioners operating on patients in Ireland have a duty of care when obtaining consent to provide patient-centred care, which involves conveying information about the proposed procedure in a comprehensive manner, including the nature, potential risks and benefits of the proposed intervention, and providing information about alternative interventions. Patients also require adequate time to make a voluntary decision. This is in line with the HSE's *National Consent Policy*.[69] Regarding consent, point 15.3 of the recent 9th Edition of the Medical Council's *Guide to Professional Conduct & Ethics for Registered Medical Practitioners*[70] states that "[medical practitioners] should consider the timing for providing information and, where possible, provide time for patients to consider the information they have been given before reaching a decision".

Referring clinicians often may not fully understand the patient journey through an IR procedure. Therefore, the primary responsibility to ensure that patients have sufficient information to make informed treatment decisions lies with the interventional radiologist.

### *Working with other clinical specialties*

Most interventional radiologists work within a team of colleagues to provide an IR service to a hospital or a number of hospital units. They play a vital role in the support of a range of services across the hospital, including acute medical, obstetric and surgical specialties.

### *Patient safety protocols*

Interventional radiologists should use structured patient safety checklists to reduce human error (i.e. verifying the procedure and marking the side and site of the procedure; fasting status; antibiotic prophylaxis requirement; coagulation status; allergy status; and renal function).[61] This safety checklist was adapted for IR by the Cardiovascular and Interventional Radiology Society of Europe (CIRSE) from the WHO *Surgical Safety Checklist*.[62] The HSE's *National Policy & Procedure for Safe Surgery* can also be adapted for IR.[71] Interventional radiologists should engage in accurate scrutiny of imaging studies to help choose the safest approach.

### *Measuring outcomes and quality assurance*

Measuring outcomes beyond the immediate post-procedure period is mandatory in demonstrating the true efficacy of a procedure and the complication profile of an individual interventional radiologist's practice. Adverse events should be reviewed within morbidity and mortality/audit meetings.

### *Participating in multidisciplinary team meetings and morbidity and mortality meetings*

It is important to note that in an age of increasing subspecialisation, even within specialties, patients with complex clinical problems are best treated in a multidisciplinary setting with referral to other services as required. If treatment is deemed necessary, all relevant treatment options should be discussed with the patient to enable them to make an informed decision. All hospital-based specialties, including IR, should continue to work with allied specialties to ensure that patients are optimally managed, recognising the need for fully resourced MDT meetings as part of that process.

IR input is an essential part of the MDT meeting and allows for appropriate patient management. MDT meetings of specialties that make regular IR referral and treatment decisions should be attended by interventional radiologists. In many hospitals, this will include virtually all admitting medical and surgical specialties.

Interventional radiologists will participate in all relevant mortality and morbidity conferences, discussing the details of such cases in an open forum to identify potential quality improvement findings.

### *Providing on-call services*

All interventional radiologists have an increasingly vital role to play in the provision of on-call services (see *Table 1*). Many interventional radiologists are providing a first on-call service with limited support from junior staff and are both the first contact and responsible clinician for the delivery of care. It is important that rotas are sustainable; therefore, larger units should have daily add on emergency slots to avoid compromising routine care.

Services consisting of six or more interventional radiologists in hub hospitals will usually be able to provide an effective and sustainable local IR service, as well as networked regional services. Networks should aim for a rota with a minimum frequency of 1:6 in the hub hospital. Units covering populations of more than 1 million or units with a significant out-of-hours caseload will require IR on-call rota frequencies of 1:8 or greater.

*Table 1* INDICATIONS FOR EMERGENCY INTERVENTIONAL RADIOLOGY

| | Indication for Emergency IR |
|---|---|
| **BODY IR** | |
| 1 | Percutaneous nephrostomy insertion for renal obstruction, percutaneous transhepatic biliary drainage for biliary obstruction, and image-guided percutaneous abscess drainage for source control of sepsis |
| 2 | Arterial embolisation for upper and lower gastrointestinal bleeding in unstable patients where endoscopy is not successful, available or indicated |
| 3 | Arterial embolisation for bleeding due to tumours or arterial vessel rupture in unstable patients |
| 4 | Arterial embolisation for bleeding due to trauma (pelvic or solid organ) or arterial vessel injury in trauma |
| 5 | Uterine artery and pelvic arterial embolisation for primary and secondary postpartum haemorrhage |
| 6 | Transjugular intrahepatic portosystemic shunt (TIPS) for acute oesophageal variceal bleeding |
| 7 | Percutaneous thrombin injection for arterial pseudoaneurysm |
| 8 | Aortic aneurysm stent graft insertion for rupture or acute aortic syndromes |
| 9 | Arterial thrombolysis/thrombectomy for acute limb ischaemia |
| 10 | Palliative drainage of symptomatic pleural effusions or ascites |
| 11 | Inferior vena cava filter insertion for patients with pulmonary embolism and a contraindication to anticoagulation |
| **NEURO IR** | |
| 1 | Endovascular thrombectomy (EVT) for stroke |
| 2 | Endovascular treatment of ruptured intracranial aneurysm |
| 3 | Endovascular treatment of ruptured arteriovenous malformations (AVM) |
| 4 | Endovascular treatment of head and neck vascular trauma, epistaxis, and head and neck tumours in the setting of acute haemorrhage |

### 2.3.4 Interventional Radiology Infrastructure

This section encompasses Body and Neuro IR for adults and children.

#### 2.3.4.1 Interventional radiology suite

IR procedures are provided in radiology departments in dedicated IR suites with advanced fluoroscopy units (single plane or biplane units) and built-in US machines or a separate mobile compact US machine designed for IR use for vascular, transabdominal, endocavitary and endovascular imaging and needle guidance. IR suites should be sufficiently spacious to accommodate the above equipment and should be ergonomically designed. Fluoroscopy suites require cone beam CT in order to guide percutaneous procedures and allow image fusion and guidance software applications. Intravascular ultrasound is essential to IR procedures and should be routinely available within the IR suite. Access to non-invasive imaging using US, CT and MRI is essential for performing and planning non-vascular and vascular IR procedures.

Ideally, each IR unit in a large, high-volume hospital providing 24/7 on-call service should have a minimum of two IR suites. All IR suites require the infrastructure for general anaesthesia provision both inside and outside the suite. A recovery area within an IR unit functions to provide pre- and post-procedure care to patients. Ideally, there should be a three-bed recovery area per IR suite.

For Paediatric IR, there must be an appropriate separate space for parents and a space where play therapists can provide a preoperative role.

#### 2.3.4.2 Radiology day ward/day-case beds

As healthcare expenditure increases on a yearly basis in Ireland, finding ways to reduce healthcare spending and use funding more efficiently is paramount. IR is well-suited to ambulatory care because it does not require the provision of anaesthesiology services for most procedures and can more easily change many IR procedures to the day care setting. The advantages of this transition would be substantial, with a decrease in cost, increase in patient throughput and reduction of waiting lists.

The day care unit should be within the IR/radiology department where possible. A day ward should be nurse-provided and IR consultant-led to coordinate IR pre-procedure patient care and monitor patients after their procedures. The IR team will admit these patients to the radiology day ward on the day of the procedure.

A dedicated radiology day ward improves efficiency in patient management, reduces avoidable downtime in IR suites and increases patient throughput. A day ward allows for appropriate tariff reimbursement and the opportunity to deliver more cost-effective care. IR would also be eminently suitable for the elective hospital setting when developed under the National Elective Hospitals Programme.

#### 2.3.4.3 Access to anaesthesia

Body IR procedures are becoming more complex and difficult, are sometimes painful, and are being performed on patients with increasingly complex medical needs. Routine anaesthetic support should be available in IR units for elective and emergency cases as required. This can be facilitated by including IR sessions in new anaesthesiology job descriptions to service local needs. Paediatric IR is heavily reliant on anaesthesiology support, and the provision of fixed Paediatric IR sessions for elective and emergency procedures is required in Paediatric IR centres.

Many of the complex Neuro IR procedures require general anaesthesia. This includes endovascular aneurysm, arteriovenous malformations (AVM) and dural arteriovenous fistula (dAVF) embolisations treatments. Therefore, Neuro IR centres require anaesthesia cover from 08:00 to 17:00, Monday to Friday (and access to emergency cover out of hours). This includes increasing access to consultant anaesthesiologists and non-consultant hospital doctors (NCHDs), as well as appropriate access to recovery bays and recovery nursing staff.

See *section 4.3.2* for further details on anaesthetic and monitoring equipment required for certain IR procedures.

#### 2.3.4.4 Information technology estate

All public and private hospitals should have networked radiology information systems (RIS) radiology information system and a picture archiving and communication system (PACS) to allow immediate patient image transfer to the IR unit. Mobile applications and support are required to allow on-call staff to review imaging from mobile devices. For Neuro IR, decision support software for the interpretation of non-contrast CT, multiphase CT angiogram, and perfusion imaging should be available to assist in the rapid diagnosis of an acute ischaemic stroke. This software also facilities rapid communication of the results to the relevant clinical and radiological teams.

# 3. Current Interventional Radiology Services in Ireland

# 3. Current Interventional Radiology Services in Ireland



The data presented in this chapter were collected and analysed by the National Clinical Programme for Interventional Radiology (NCP IR) in late 2023 and early 2024. They were obtained via structured surveys, engagements with interventional radiology (IR) consultants, and local and national IR systems. The NCP IR acknowledges the time and efforts of all involved in the data collation and submission process.

## 3.1 Geographical Distribution in Delivery of Interventional Radiology Services

### 3.1.1 In Hours

**BODY INTERVENTIONAL RADIOLOGY**

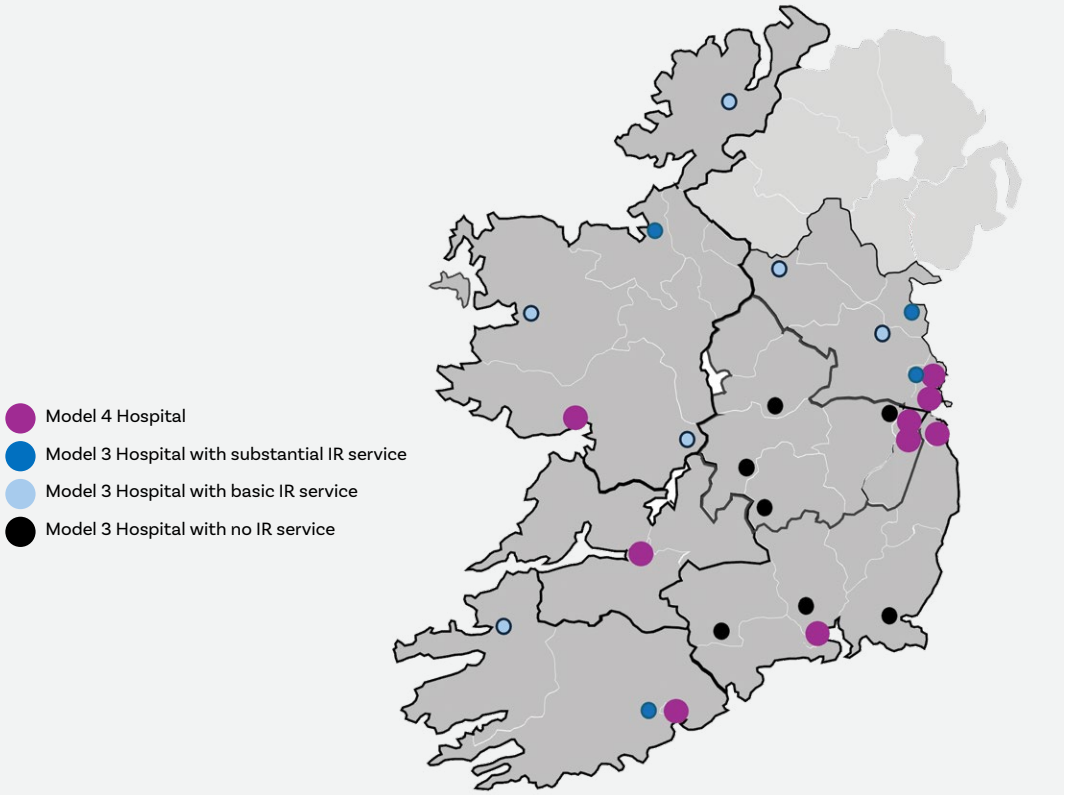
Based on analysis of survey data and activity data, and engagement with IR units, Model 4 and Model 3 hospitals have been categorised into four groups in order to differentiate the level of IR services provided by each. The categorisation of hospitals was based on factors including the type, complexity (see *Appendix 1*) and number of IR procedures performed annually; the number of trained IR consultants; the number of half-day IR sessions per week; and the presence of an angiographic suite.

Based on these criteria, the 9 Model 4 hospitals and 17 Model 3 hospitals surveyed offer the following categories of IR services (see *Figure 4*):

- Nine Model 4 hospitals have a full IR service in hours.
- Four Model 3 hospitals have a substantial IR service in hours.
- Six Model 3 hospitals have a basic IR service in hours.
- Seven Model 3 hospitals have no IR service.*

*Note: Model 3 hospitals classified as having no IR service may still perform basic IR procedures within their diagnostic radiology departments.

*Figure 4* MAP OF THE CATEGORIES OF BODY INTERVENTIONAL RADIOLOGY UNITS IN IRELAND




All 9 Model 4 hospitals and 10 of the 17 Model 3 hospitals provide an IR service within core working hours.

Level 1 procedures are performed in both Model 4 and Model 3 hospitals in hours. Complex (Level 2) procedures are delivered in Model 4 hospitals, with a small number of Model 3 hospitals also providing some complex IR procedures in hours.

Emergency (unscheduled) IR procedures are provided in hours in all 9 Model 4 hospitals and in 9 of the 10 Model 3 hospitals with an IR service. Model 4 hospitals provide emergency IR services, including complex (Level 2) procedures such as embolisation for postpartum haemorrhage (PPH) or gastrointestinal (GI) bleeding; transjugular intrahepatic portosystemic shunt (TIPS) for variceal haemorrhage; and IR trauma services. Model 3 hospitals provide Level 1 emergency IR services such as nephrostomy, biliary drainage for sepsis and abscess drainage.

## PAEDIATRIC INTERVENTIONAL RADIOLOGY

Paediatric IR is currently an unfunded service and is often not included in service planning. Paediatric IR procedures are undertaken in Children's Health Ireland (CHI) at Temple Street and CHI at Crumlin. Paediatric IR cases are treated electively on one 4-hour general anaesthetic list per month in CHI at Temple Street and on two 4-hour general anaesthetic lists in CHI at Crumlin. Unscheduled Paediatric IR cases are treated in an operating theatre environment on emergency theatre lists if general anaesthesia is required.

Because of the lack of a Paediatric IR service, children in Ireland have surgical procedures under general anaesthesia, using valuable operating theatre capacity and resources. Low-complexity, routine Paediatric IR procedures, such as venous access, are being performed by surgical teams in an operating theatre environment due to a lack of consultant

appointments in Paediatric IR services and a lack of resources, including out-of-theatre anaesthesiology. Paediatric interventional radiologists performed 624 IR procedures in children's hospitals in Ireland in 2023; by comparison, a Paediatric IR service at one large children's hospital in the United Kingdom (UK) with a similar population served as the population of Ireland performed more than 2,600 procedures (in 2,100 patient episodes) in a similar period. Based on analysis of data submitted by CHI on procedures undertaken in 2017, up to 7% of the surgical procedures performed in theatres in CHI at Crumlin could have been performed in a Paediatric IR environment if there was an appropriately resourced service. In addition, 26% of Paediatric IR procedures in 2023 were performed outside of CHI (Crumlin and Temple Street), with almost half of these performed in Cork University Hospital.

There is no agreed paediatric trauma network emergency cover or networked arrangement for access to IR.

Neurointerventional procedures for children are performed by adult neurointerventionalists in the adult neurosurgical centres in Beaumont Hospital and Cork University Hospital, as well as in CHI when necessary.

## NEUROINTERVENTIONAL RADIOLOGY

In hours, adult Neuro IR services are provided predominantly in two hospitals in Ireland: Beaumont Hospital in Dublin and Cork University Hospital.

### 3.1.2 Out of Hours

## BODY INTERVENTIONAL RADIOLOGY

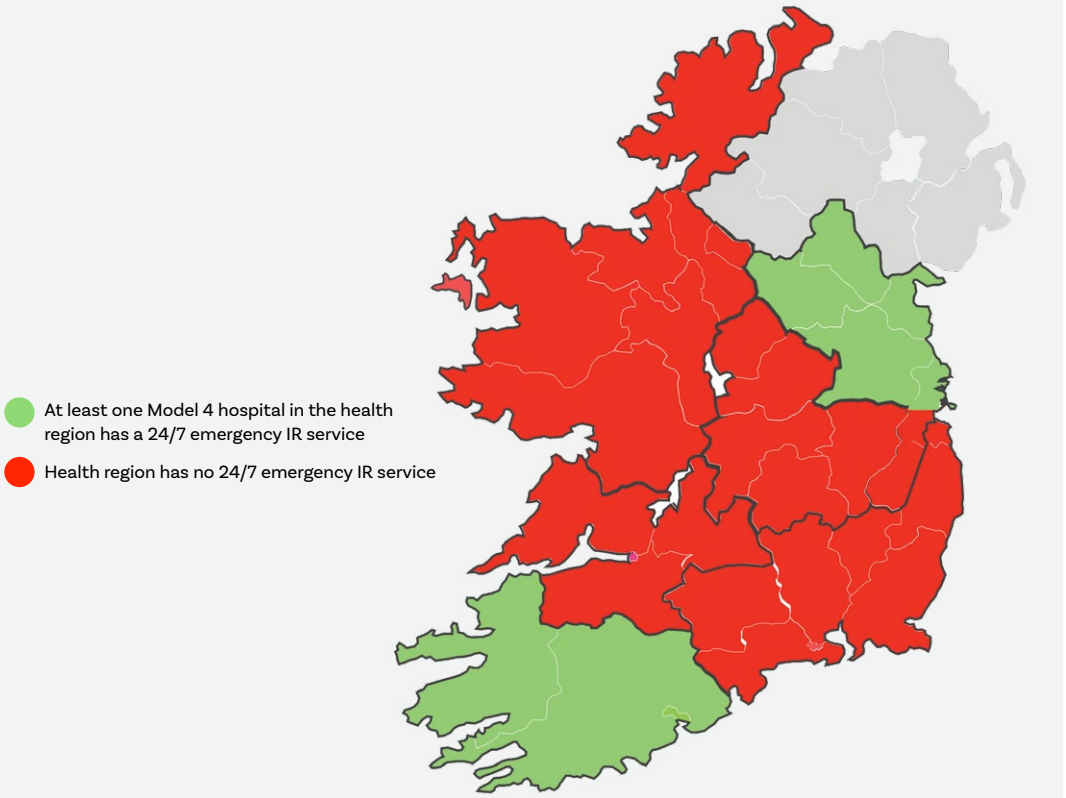
The provision of emergency IR services out of hours is highly variable within and across health regions. Only three of the nine Model 4 hospitals provide a full 24/7 IR service: Beaumont Hospital and Mater Misericordiae University Hospital in the HSE Dublin and North East health region, and Cork University Hospital in the HSE South West health region (see *Figure 5*).

Of the other six Model 4 hospitals across four health regions, two reported that they have an ad hoc out-of-hours IR service with no formal on-call rotas. One hospital has a formal on-call rota until 22:00, with an ad hoc service beyond this time. These are not considered safe out-of-hours IR services.

Three Model 4 hospitals provide an in-hours IR service only.

There are no Model 3 hospitals providing an out-of-hours IR service.

*Figure 5* INTERVENTIONAL RADIOLOGY FORMAL ROTA FOR OUT-OF-HOURS SERVICE PROVISION IN NEW HEALTH REGIONS IN IRELAND, 2023




**Four health regions are unable to provide formal 24/7/365 access to an out-of-hours IR service**.

### *Formal transfer arrangements*

None of the hospitals with out-of-hours IR service provision have formal transfer arrangements with other hospitals in their health regions. Very few hospitals have a service level agreement or formal pathway for out-of-hours services.

The current practice of arranging transfers of patients who urgently need IR out of hours is ad hoc and therefore unsustainable. It involves making telephone calls to different hospitals to see if they can take the patient. In addition to the availability of IR staff, the availability of regular ward beds and intensive care unit beds are often limiting factors.

## PAEDIATRIC INTERVENTIONAL RADIOLOGY

There is no funded out-of-hours Paediatric IR service in the current Children's Health Ireland hospitals in Temple Street and Crumlin. A paediatric interventional radiologist will often attend on evenings/weekends if a child requires their expertise. This is a 'goodwill' service that is provided following contact from the paediatric consultant caring for the child or the paediatric radiologist on call.

There is no agreed paediatric trauma network on-call cover or networked arrangement for access to Paediatric IR.

## NEUROINTERVENTIONAL RADIOLOGY (Adults and Paediatrics)

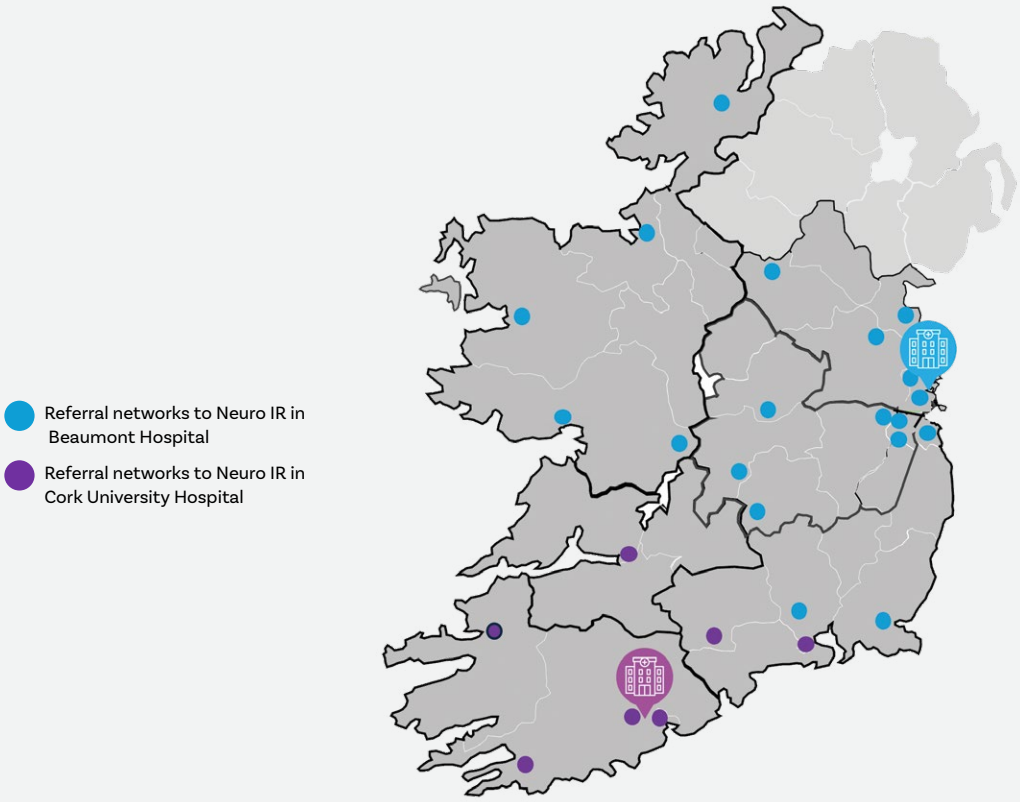
There are 24/7 Neuro IR services available in the two designated Neuro IR units in Ireland: Beaumont Hospital and Cork University Hospital.

### *Formal transfer arrangements*

Referral pathways for endovascular thrombectomy (EVT) for patients with acute ischaemic stroke in Ireland are fully defined in the (unpublished) "Guidelines for the management of patients with acute ischaemic stroke requiring inter hospital transfer for Emergency Endovascular Therapy Thrombectomy."

Referral processes for patients with other acute/emergency conditions– including ruptured aneurysms, symptomatic/high-grade/ruptured dural arteriovenous fistula, and chronic subdural haematoma – are also well-defined. All Model 3 and Model 4 hospitals in the Munster region refer to Cork University Hospital, and hospitals in the rest of the country refer to Beaumont Hospital (see *Figure 6*).

*Figure 6* REFERRAL NETWORKS TO NEUROINTERVENTIONAL RADIOLOGY UNITS IN BEAUMONT HOSPITAL AND CORK UNIVERSITY HOSPITAL



### 3.1.3 Overview of Current Interventional Radiology Services in Ireland by Condition Treated

*Table 2* OVERVIEW OF CURRENT IR SERVICES BY CONDITION TREATED

| Condition treated | Overview of current IR services |
|---|---|
| **EMERGENCY CONDITIONS TREATED BY IR** | |
| Postoperative and spontaneous life-threatening haemorrhage | • IR treatments to arrest haemorrhage are routinely performed in all Model 4 hospitals and a minority of Model 3 hospitals in hours. Out-of-hours IR service provision is limited. |
| Acute gastrointestinal haemorrhage | • Embolisation for gastrointestinal (GI) bleeding is provided in all Model 4 hospitals and a small number of Model 3 hospitals in hours.<br>• IR service provision is limited out of hours.<br>• There are no formal arrangements for endovascular embolisation of children with GI bleeding.<br>• Transjugular Intrahepatic Portosystemic shunt (TIPS), venous embolisation and balloon-occluded retrograde transvenous obliteration (BRTO) are available in a small number of Model 4 hospitals in hours. IR service provision is extremely limited out of hours. |
| Trauma | • IR is available 24/7 in the two adult hospitals with major trauma units (Mater Misericordiae University Hospital and Cork University Hospital). IR is not available in all trauma units or in Children's Health Ireland (CHI) either in hours and out of hours.<br>• At present, there is no dedicated Paediatric IR service or suite available to treat trauma in either of the Dublin tertiary paediatric centres. Ad hoc access to the Cardiac Catheterisation room in CHI at Crumlin occurs occasionally. |
| Sepsis | • IR drainage procedures, venous access device removal, and drainage catheter management/replacement/manipulation are routinely performed in all Model 4 hospitals and most Model 3 hospitals in hours.<br>• Formal out-of-hours IR service provision is not available in six of the nine Model 4 hospitals or in four of the six health regions.<br>• Currently, Paediatric IR drainage procedures, venous access device removal, and drainage catheter management/replacement are performed in CHI but on an ad hoc/'goodwill' basis. Out-of-hours IR service provision is unavailable. |
| Venous thrombo-embolism | • Venous thrombolysis and thrombectomy for deep venous thrombosis are routinely performed in all Model 4 hospitals and some Model 3 hospitals in hours (depending on the skill mix and competence of interventional radiologists available). Out-of-hours IR service provision is variable.<br>• Pulmonary artery thrombolysis and thrombectomy for pulmonary embolism (PE) are performed in some Model 4 hospitals and no Model 3 hospitals. Out-of-hours IR service provision is variable.<br>• There is ad hoc provision of venous thrombolysis and thrombectomy for PE and deep venous thrombosis in CHI. |

| | |
|---|---|
| Postpartum haemorrhage and placenta accreta spectrum | • Embolisation procedures for postpartum haemorrhage (PPH) are underutilised in Ireland, with many maternity units currently operating without direct 24/7 access to IR services for embolisation.<br>• There are no formal agreed protocols for the transfer of patients from maternity units to IR facilities.<br>• Embolisation for PPH is emergently performed in designated Model 4 hospitals.<br>• Out-of-hours IR service provision is variable.<br>• Balloon occlusion and embolisation procedures for placenta accreta are underutilised, with many maternity units currently operating without direct 24/7 access to IR services for this technique.<br>• Elective balloon occlusion is performed in three Model 4 hospitals and no Model 3 hospitals in hours. Out-of-hours IR service provision is variable. |
| **ELECTIVE CONDITIONS TREATED BY IR** | |
| Arterial disease | • In half of the Model 4 hospitals in Ireland, interventional radiologists perform endovascular intervention in patients with intermittent claudication, critical limb ischaemia and diabetic foot disease. The treatment is decided at joint multidisciplinary team (MDT) meetings with vascular surgery colleagues. |
| Arteriovenous malformations | • Arteriovenous malformation treatments are delivered in four Model 4 hospitals |
| Venous disease | • Venous treatments are delivered in all Model 4 and some Model 3 hospitals, with an ad hoc service in CHI. |
| Cancer | • Interventional oncology procedures are delivered in eight Model 4 hospitals. Hepatocellular cancer treatment and MDT meetings are delivered in St Vincent's Healthcare Group. |
| Kidney disease | • Dialysis catheter insertion and care is provided by interventional radiologists in all nine Model 4 hospitals and some Model 3 hospitals Percutaneous arteriovenous fistula creation is provided in one of the nine Model 4 hospitals. Access to prompt fistula maintenance and salvage remains variable across Ireland. |
| Musculoskeletal (MSK) and pain intervention | • Level 1 and Level 2 MSK procedures are delivered in all Model 4 hospitals. Level 1 MSK procedures are delivered in many Model 3 hospitals. |
| Gynaecological conditions | • Uterine fibroid embolisation is performed in all Model 4 hospitals and one Model 3 hospital. |
| Gastrointestinal, hepatobiliary and pancreatic diseases | • Care for gastrointestinal, hepatobiliary and pancreatic diseases is delivered in the majority of Model 4 and some Model 3 hospitals. |
| Venous access | • Venous access procedures are delivered in all Model 4 and some Model 3 hospitals.<br>• Surgical and anaesthesia teams deliver venous access in the theatre environment.<br>• A once a month/ad hoc Paediatric IR venous access service exists in CHI. |
| Transplant interventions | • Transplant interventions are provided for liver, renal and pancreatic transplant in St Vincent's University Hospital and for renal transplant in Beaumont Hospital |
| Renal and genitourinary disease | • Renal and genitourinary procedures are delivered in all Model 4 and some Model 3 hospitals. |

## 3.2 Interventional Radiology Activity

### 3.2.1 Methodology

The NCP IR obtained IR activity data for 2019, 2022 and 2023 from the National Integrated Medical Imaging System (NIMIS) for all Model 4 and Model 3 hospitals that use this system. This includes 6 of the 9 Model 4 hospitals and 16 of the 17 Model 3 hospitals and represents 85% of all hospitals providing IR in the public healthcare system in Ireland. For those hospitals not using NIMIS, data were obtained directly from the hospitals.

Neuro IR data were provided by the two Neuro IR units in Beaumont Hospital and Cork University Hospital. Paediatric IR data were provided by CHI.

The NCP IR applied a standard methodology to code, clean, group and aggregate individual IR procedures into categories and complexity levels, in hours and out of hours, and by regional distribution.

Additional NIMIS data from 2017 and 2018 was obtained by the Irish Society of Interventional Radiology and the Faculty of Radiologists and Radiation Oncologists for a previous IR service model[4]. The 2024 methodology was applied to these data to allow changes over time from 2017 to 2023 to be analysed.

#### *Limitations*

**Hospital In-Patient Enquiry limitations***

- IR activity is not recorded in the Hospital In-Patient Enquiry (HIPE) system for national inpatient or day care IR admitting consultants. The HIPE system only records activity by clinical service or admitting consultant, which does not include an 'interventional radiology service'.
- HIPE uses the International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification (ICD-10-AM). Codes in this system do not exist for any IR procedures, including peripherally inserted central catheters (PICCs). A range of consultant IR activities (e.g. inpatient and outpatient consultation by IR consultants, IR opinion in MDT meetings, and IR drain rounds) are not recorded as activities in the HIPE system. For these reasons, the scope of IR practice is underestimated in the Irish hospital system.

**The NCP IR is actively engaging with the HSE HIPE teams to address these limitations.*

**National Integrated Medical Imaging System limitations***

- NIMIS codes are used at each Model 3 and Model 4 hospital site on the NIMIS platform. When IR procedures are performed, the radiographer selects a code or codes on the NIMIS platform to reflect the procedure delivered. The NIMIS codes available for IR procedures are limited and do not reflect the nature or complexity of some procedures, or do not cover the scope of IR practice.
- At hospital level, there is variability in the use of NIMIS codes for the same procedure, and multiple additional codes are used in some sites for the same patient procedure.
- NIMIS was unable to identify if procedures were performed out of hours after the end of routine service; it could only identify cases completed before 09:00 and after 17:00 Monday to Friday and on the weekend as 'out of hours'. Bank holidays could not be isolated for analysis as being out of hours.

- Procedure coding on the NIMIS platform does not take account of the effort involved in performing the IR procedure; for example, a transjugular intrahepatic portosystemic shunt (TIPS) that takes 3 hours under general anaesthesia results in a single NIMIS TIPS code, while a PICC insertion may take 10 minutes and also generates a single NIMIS PICC code.

**The NCP IR is actively engaging with the HSE NIMIS team to address these limitations.*

### Scope limitations

- Data relate to IR activity in IR units in Model 3 and Model 4 hospitals in the public healthcare system. IR activity in private healthcare settings is not considered in this Model of Care.
- Small volumes of IR activity in Model 2 hospitals have been excluded from the analysis.

### Patient age profile data limitations

Patient age profile data were obtained from NIMIS only, with two associated limitations:

1. Age profile data are based on IR procedures undertaken in 85% of hospitals (i.e. age profile data for patients treated in non-NIMIS hospitals are not reflected).
2. Age profile data received from NIMIS were not broken down by hospital. This means that a small number of IR procedures undertaken in Model 2 or specialist hospitals (e.g. National Orthopaedic Hospital Cappagh) could not be disaggregated.

### Changes over time data limitations

Data from 2017 and 2018 were obtained from NIMIS only; therefore, changes over time (2017–2023) are based on IR procedures undertaken in 85% of hospitals.

## 3.2.2 Overview of Interventional Radiology Activity in Ireland in 2023 and Over Time

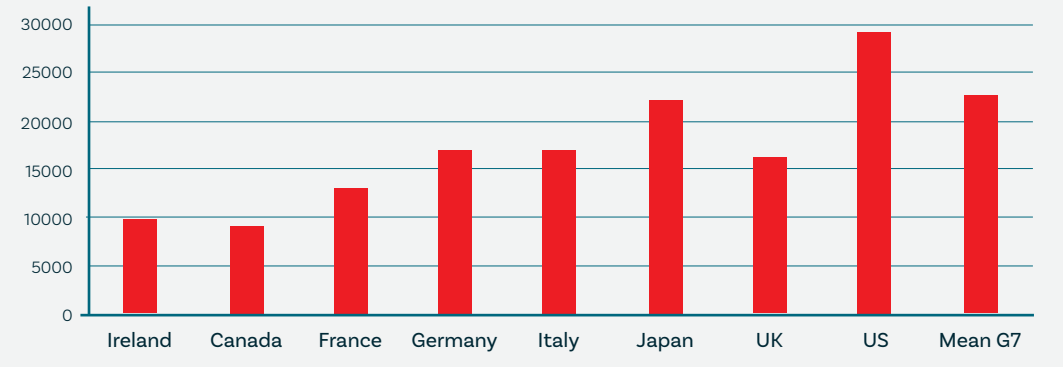
This section includes data from all Model 4 hospitals and all Model 3 hospitals (i.e. it includes data from Model 3 hospitals that were subsequently classified as not having an IR service).

## BODY INTERVENTIONAL RADIOLOGY

### *All (in hours and out of hours)*

In 2023, 50,488 Body IR procedures were performed in public hospitals in Ireland. The per capita number of IR procedures performed in Ireland in 2023 was 9,728 per 1 million inhabitants. Compared with other G7 countries, this is half the average number of per capita IR procedures performed (see *Figure 7*). However, it should be noted that there has been no update of G7 data since 2010.

*Figure 7* INTERVENTIONAL RADIOLOGY TREATMENTS PER CAPITA, BY COUNTRY, FOR G7 COUNTRIES IN 2010 AND IN IRELAND IN 2023



In 2023, 25,596 Level 1 IR procedures and 13,466 Level 2 procedures were performed in Model 4 hospitals. In Model 3 hospitals, these figures were 9,515 Level 1 procedures and 1,911 Level 2 procedures (see *Table 3*).

*Table 3* LEVEL AND CATEGORY OF BODY INTERVENTIONAL RADIOLOGY PROCEDURES IN MODEL 3 & MODEL 4 HOSPITALS IN 2023

| Level | Model 4 (n=9) No. of cases | Model 3 (n=17) No. of cases |
|---|---|---|
| **LEVEL 1 PROCEDURES** | | |
| Aspiration and drainage | 4485 | 2111 |
| Biopsy | 8213 | 2035 |
| Gastrointestinal *(tube injection or replacement)* | 363 | 88 |
| Musculoskeletal Intervention | 5211 | 3667 |
| Venous access *(non-tunnelled catheter placement and line checks)* | 6561 | 1569 |
| Venous intervention *(venous Digital Subtraction Angiography (DSA))* | 763 | 45 |
| **Total** | **25 596** | **9515** |
| **LEVEL 2 PROCEDURES** | | |
| Aspiration and drainage *(tunnelled catheters for ascitic drainage)* | 68 | 22 |
| Biliary and gall bladder intervention | 1479 | 281 |
| Transjugular liver biopsy | 37 | 4 |
| Arterial intervention | 2084 | 3 |
| Embolisation | 933 | 91 |
| Gastrointestinal | 398 | 64 |
| Genitourinary | 3567 | 771 |
| Interventional oncology | 286 | 40 |
| Miscellaneous | 150 | 5 |
| Musculoskeletal Intervention | 48 | 25 |
| Neurointervention* | 16 | 0 |
| Venous access | 3769 | 561 |
| Venous intervention | 631 | 44 |
| **Total** | **13 466** | **1911** |
| **OVERALL TOTAL** | **39 062** | **11 426** |

**Procedures classified by the NCP IR as 'neurointerventional' but performed by Body IR consultants in hospitals with no dedicated neurointerventional radiologists. Neurointerventional procedures performed in Beaumont Hospital and Cork University Hospital are presented separately (see Table 12).*

### *Out of hours*

The six health regions' Model 3 and Model 4 hospitals provided 1,919 out-of-hours procedures in 2023 (completed Monday to Friday before 09:00 and after 17:00, and on weekends) (see *Table 4*).

*Table 4* OUT-OF-HOURS BODY INTERVENTIONAL RADIOLOGY PROCEDURES IN 2023, BY PROCEDURE CATEGORY

| IR PROCEDURE CATEGORY | Number of procedures |
|---|---|
| Arterial intervention | 144 |
| Aspiration and drainage | 425 |
| Biliary and gall bladder intervention | 86 |
| Embolisation | 170 |
| Gastrointestinal | 29 |
| Genitourinary | 399 |
| Miscellaneous | 7 |
| Musculoskeletal Intervention | 34 |
| Non-specified | 30 |
| Venous access | 460 |
| Venous intervention | 135 |
| **NATIONAL TOTAL** | **1919** |

## *Regional distribution*

A regional review of the total and out-of-hours IR procedure number performed in 2023 shows geographic variation in Body IR utilisation (see *Table 5*).

*Table 5* TOTAL AND OUT-OF-HOURS BODY INTERVENTIONAL RADIOLOGY PROCEDURES BY HEALTH REGION IN 2023

| Health region | Hospitals | Total number of procedures | Out-of-hours procedures* |
|---|---|---|---|
| HSE Dublin and North East | Beaumont Hospital, Mater Misericordiae University Hospital, Cavan General Hospital, Connolly Hospital, Our Lady of Lourdes Hospital Drogheda, Our Lady's Hospital, Navan | 14 549 | 781 |
| HSE Dublin and Midlands | St James's Hospital, Tallaght University Hospital, Regional Hospital Mullingar, Midland Regional Hospital Portlaoise, Midland Regional Hospital Tullamore, Naas General Hospital | 10 449 | 790 |
| HSE Dublin and South East | St Vincent's University Hospital, University Hospital Waterford, St Luke's General Hospital Kilkenny, Tipperary University Hospital, Wexford General Hospital | 11 442 | 197 |
| HSE South West | Cork University Hospital, Mercy University Hospital, University Hospital Kerry | 4666 | 77 |
| HSE Mid West | University Hospital Limerick | 2744 | 34 |
| HSE West and North West | University Hospital Galway, Letterkenny University Hospital, Mayo University Hospital, Portiuncula University Hospital, Sligo University Hospital | 6638 | 40 |
| **NATIONAL TOTAL** | | **50 488** | **1919** |

**Procedures completed Monday to Friday before 09:00 and after 17:00, and on weekends.*

## *Changes over time*

A review of the changes in the use of IR Level 2 and out-of-hours procedures demonstrates that IR is being performed more often with time (see *Tables 6, 7 and 8*). The total number of Body IR procedures (Level 1 and Level 2) increased by 12% between 2017 and 2023, an average of 2% per year.

*Table 6* ALL BODY INTERVENTIONAL RADIOLOGY PROCEDURES, 2017–2023 (NIMIS HOSPITALS ONLY)

| | 2017 | 2018 | 2019 | 2022 | 2023 |
|---|---|---|---|---|---|
| Total procedures | 31 255 | 31 843 | 32 856 | 32 758 | 34 950 |
| Cumulative year-on-year change | | 2% | 5% | 5% | 12% |

*Note: The above changes over time comparison is based on data from hospitals that use NIMIS (6 out of 9 Model 4 hospitals and 16 out of 17 Model 3 hospitals, as well as CHI).*

The total number of Level 2 Body IR procedures increased by 18% between 2017 and 2023 (an average of 3% per year).

*Table 7* LEVEL 2 BODY INTERVENTIONAL RADIOLOGY PROCEDURES, 2017–2023 (NIMIS HOSPITALS ONLY)

| | 2017 | 2018 | 2019 | 2022 | 2023 |
|---|---|---|---|---|---|
| Total procedures | 7653 | 7719 | 8038 | 8346 | 9065 |
| Cumulative year-on-year change | | 1% | 5% | 9% | 18% |

*Note: The above changes over time comparison is based on data from hospitals that use NIMIS (6 out of 9 Model 4 hospitals and 16 out of 17 Model 3 hospitals, as well as CHI).*

The total number of out-of-hours Body IR procedures has increased by 11% between 2019 and 2023.

*Table 8* OUT-OF-HOURS INTERVENTIONAL RADIOLOGY PROCEDURES BY CATEGORY, 2019–2023 (ALL HOSPITALS)

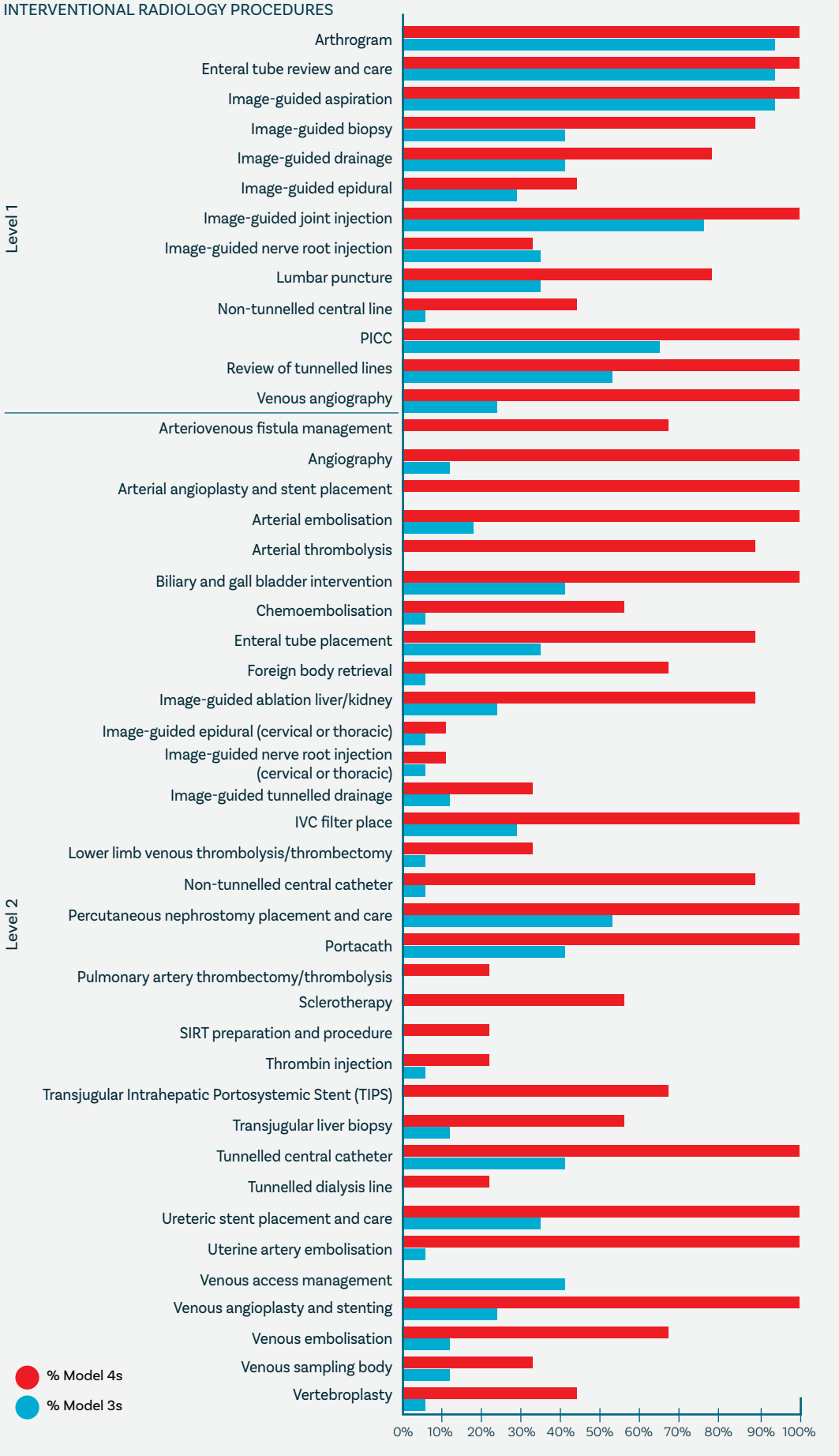
| Body IR procedure category | 2019 | 2022 | 2023 |
|---|---|---|---|
| Arterial intervention | 118 | 131 | 144 |
| Aspiration and drainage | 473 | 408 | 425 |
| Biliary and gall bladder intervention | 79 | 84 | 86 |
| Embolisation | 141 | 127 | 170 |
| Gastrointestinal | 22 | 25 | 29 |
| Genitourinary | 325 | 377 | 399 |
| Miscellaneous | 13 | 15 | 7 |
| Musculoskeletal intervention | 30 | 24 | 34 |
| Neurointervention* | 1 | 2 | 0 |
| Non-specified | 30 | 30 | 30 |
| Venous access | 378 | 463 | 460 |
| Venous intervention | 113 | 113 | 135 |
| **NATIONAL TOTAL** | **1723** | **1799** | **1919** |

**Procedures classified by the NCP IR as 'neurointerventional' but performed by Body IR consultants in hospitals with no dedicated neurointerventional radiologists. Neurointerventional procedures performed in Beaumont Hospital and Cork University Hospital are presented separately (see Table 13).*
*Note: The above changes over time comparison is based on data from all Model 4 and Model 3 hospitals.*

## *Geographic variation in interventional radiology services in Model 4 and Model 3 hospitals*

There is some variation in the delivery of procedures in different radiology departments that may be due to local referral patterns, hospital case mix, and IR consultant training and expertise (see *Figure 8*).

*Figure 8* THE PERCENTAGE OF MODEL 3 AND MODEL 4 HOSPITALS PROVIDING SPECIFIC LEVEL 1 AND LEVEL 2 INTERVENTIONAL RADIOLOGY PROCEDURES




*Note: Percentage of hospitals in which at least one IR procedure per category was performed in 2023.*

## PAEDIATRIC INTERVENTIONAL RADIOLOGY (BODY AND NEURO)

Most Paediatric IR procedures are delivered in Children's Health Ireland (CHI) at Crumlin and CHI at Temple Street.

### *All (in hours and out of hours)*

The number of completed Paediatric IR procedures doubled in the period from 2019 to 2023 (see *Table 9*). A broad scope of procedures was delivered.

*Table 9* PAEDIATRIC INTERVENTIONAL RADIOLOGY PROCEDURES UNDERTAKEN IN CHI AT CRUMLIN AND CHI AT TEMPLE STREET 2019–2023

| Paediatric IR procedure category | 2019 | 2022 | 2023 |
|---|---|---|---|
| Arterial intervention | 0 | 0 | 3 |
| Aspiration and drainage | 31 | 46 | 45 |
| Biliary and gall bladder intervention | 2 | 0 | 1 |
| Biopsy | 46 | 75 | 103 |
| Embolisation | 0 | 0 | 0 |
| Gastrointestinal | 121 | 165 | 203 |
| Genitourinary | 10 | 9 | 11 |
| Interventional oncology | 0 | 3 | 1 |
| Miscellaneous (sclerotherapy) | 8 | 57 | 95 |
| Musculoskeletal intervention | 35 | 31 | 26 |
| Neurointervention | 0 | 0 | 5 |
| Venous access | 60 | 115 | 134 |
| Venous intervention | 0 | 2 | 2 |
| **TOTAL** | **313** | **503** | **629** |

*Source: CHI data*

A small number of Paediatric IR procedures are performed by adult interventional radiologists with IR training in treating paediatric patients in other Model 4 hospitals that admit paediatric patients (see *Table 10*). In 2023, 42% of all Paediatric IR cases outside of CHI were undertaken in Cork University Hospital, 27% were undertaken in Tallaght University Hospital, 7% were undertaken in University Hospital Limerick, and 6% were undertaken in University Hospital Waterford. The remaining 18% were undertaken in University Hospital Galway, Cavan General Hospital, Midland Regional Hospital Tullamore, Mercy University Hospital, University Hospital Kerry, and Sligo University Hospital.

*Table 10* PAEDIATRIC INTERVENTIONAL RADIOLOGY PROCEDURES UNDERTAKEN OUTSIDE CHI AT CRUMLIN AND CHI AT TEMPLE STREET 2019–2023

| Paediatric IR procedure category | 2019 | 2022 | 2023 |
|---|---|---|---|
| Arterial intervention | 2 | 0 | 3 |
| Aspiration and drainage | 10 | 24 | 26 |
| Biliary and gall bladder intervention | 3 | 0 | 0 |
| Biopsy | 14 | 10 | 11 |
| Embolisation | 37 | 6 | 17 |
| Gastrointestinal | 17 | 18 | 19 |
| Genitourinary | 7 | 0 | 0 |
| Interventional oncology | 1 | 0 | 0 |
| Miscellaneous | 0 | 1 | 0 |
| Musculoskeletal intervention | 19 | 38 | 26 |
| Neurointervention | 0 | 0 | 1 |
| Venous access | 88 | 71 | 71 |
| Venous intervention | 3 | 13 | 4 |
| **TOTAL** | **201** | **181** | **177** |

*Source: NIMIS data*

There is no out-of-hours Paediatric IR service in Ireland.

### *Paediatric neurointerventional radiology*

*Table 11* shows the number of paediatric neurointerventional cases undertaken in one of Ireland's two Neuro IR centres between 2019 and 2023. Note that these figures are also included in the overall Neuro IR figures in *Table 12*.

*Table 11* NEUROINTERVENTIONAL RADIOLOGY PROCEDURES IN THE PAEDIATRIC POPULATION, 2019–2023

| Neuro IR procedures (paediatric population) | 2019 | 2022 | 2023 |
|---|---|---|---|
| Neurointervention procedures | 29 | 28 | 26 |
| Cerebral angiography | 28 | 24 | 23 |
| Other Neuro IR procedures | 1 | 4 | 3 |

*Source: Neuro IR centre in Beaumont Hospital*

## NEUROINTERVENTIONAL RADIOLOGY

### *All (in hours and out of hours)*

The overall number of Neuro IR procedures performed annually increased by 27% between 2019 and 2023, an increase driven by a 47% rise in the number of stroke thrombectomy procedures during the same period (see *Table 12*).

*Table 12* ALL NEUROINTERVENTIONAL RADIOLOGY PROCEDURES UNDERTAKEN IN BEAUMONT HOSPITAL AND CORK UNIVERSITY HOSPITAL, 2019–2023

| Neuro IR procedures | 2019 | 2022 | 2023 |
|---|---|---|---|
| Cerebral aneurysm coiling | 320 | 340 | 372 |
| Cerebral angiography | 1456 | 1512 | 1709 |
| Stroke thrombectomy | 384 | 484 | 566 |
| Other procedures | 647 | 858 | 927 |
| **TOTAL NUMBER OF PROCEDURES PERFORMED BY NEUROINTERVENTIONAL RADIOLOGISTS** | **2807** | **3194** | **3574** |

*Source: Neuro IR centres in Beaumont Hospital and Cork University Hospital*

### *Out of hours*

For out-of-hours Neuro IR procedures, the increase between 2019 and 2023 (43%) is even more substantial. This includes a 62% increase in the number of out-of-hours stroke thrombectomy procedures (see *Table 13*).

*Table 13* OUT-OF-HOURS NEUROINTERVENTIONAL RADIOLOGY PROCEDURES UNDERTAKEN IN BEAUMONT HOSPITAL AND CORK UNIVERSITY HOSPITAL, 2019–2023

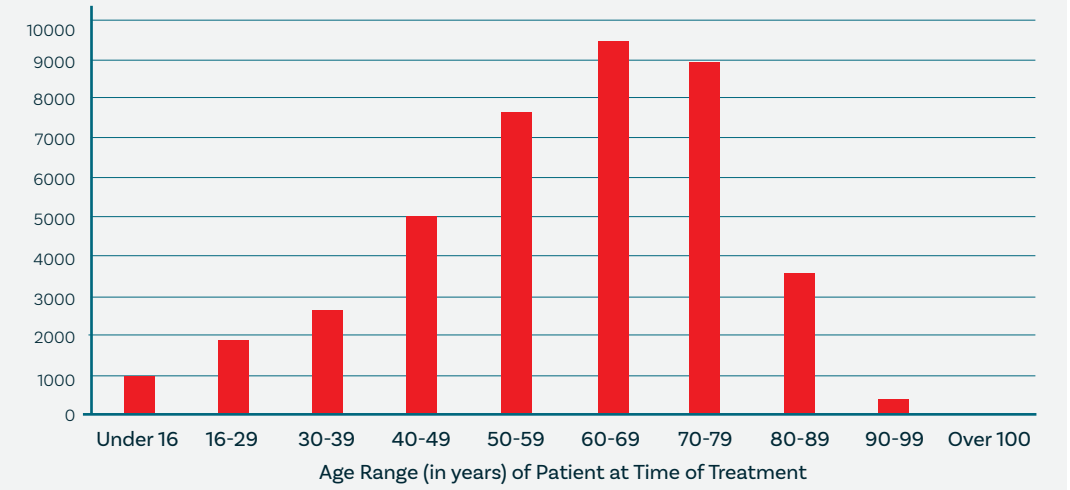
| Neuro IR procedures | 2019 | 2022 | 2023 |
|---|---|---|---|
| Cerebral aneurysm coiling | 84 | 56 | 61 |
| Cerebral angiography | 310 | 372 | 440 |
| Stroke thrombectomy | 229 | 310 | 370 |
| Other procedures | 50 | 86 | 90 |
| **TOTAL NUMBER OF PROCEDURES PERFORMED BY NEUROINTERVENTIONAL RADIOLOGISTS** | **673** | **824** | **961** |

*Source: Neuro IR centres in Beaumont Hospital and Cork University Hospital*

### 3.2.3 Patient Age Profile

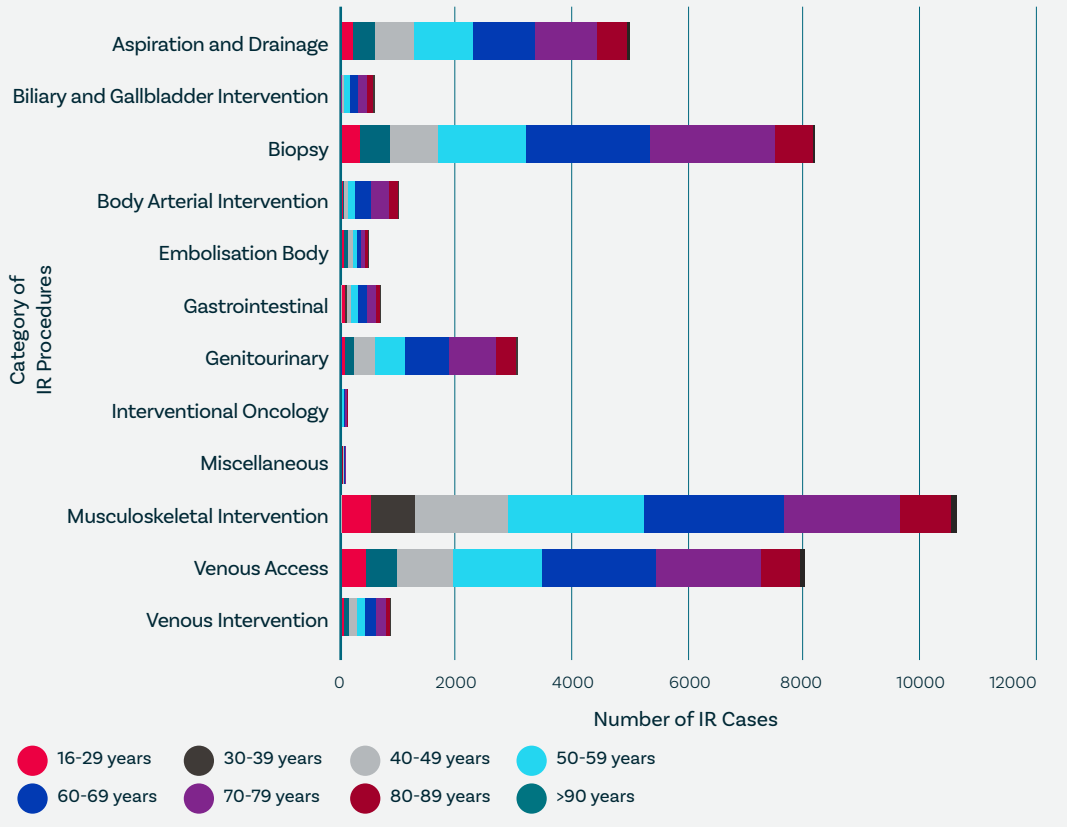
IR patients of a broad range of ages were treated in 2023. The ages ranged from the paediatric population to the oldest patient, who was aged over 100 years (see *Figures 9, 10 and 11*).

*Figure 9* BODY INTERVENTIONAL RADIOLOGY PROCEDURES BY PATIENT AGE IN 2023



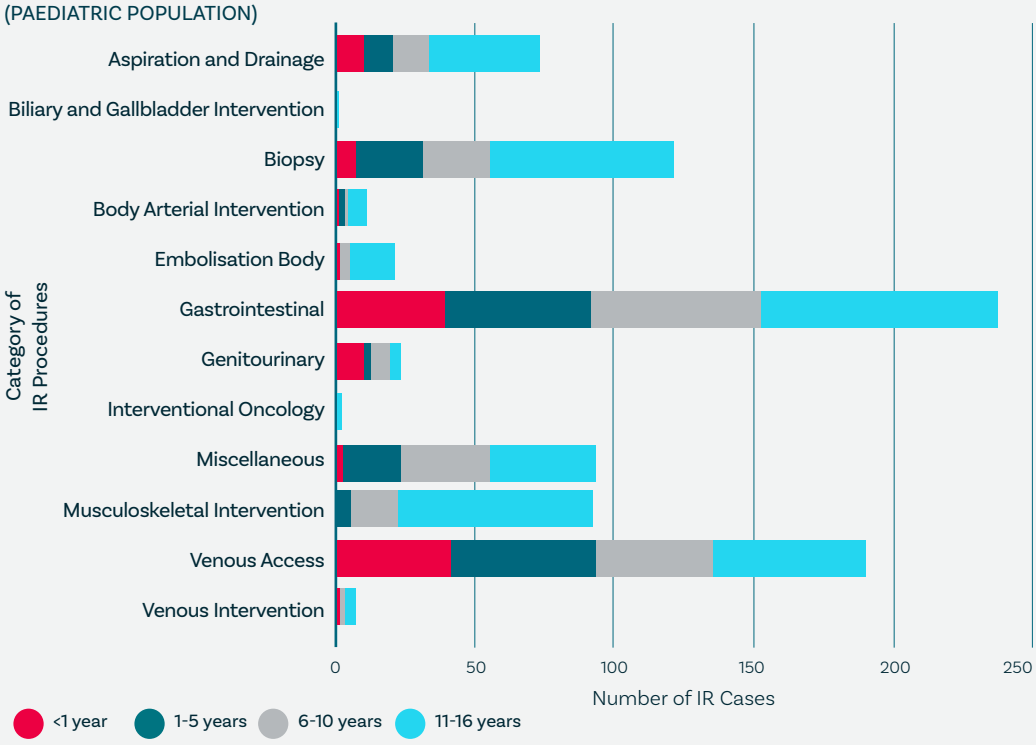

*Source: NIMIS data (covering 85% of Model 4 and Model 3 hospitals providing IR services, and CHI)*

*Figure 10* BODY INTERVENTIONAL RADIOLOGY PROCEDURE CATEGORIES BY PATIENT AGE IN 2023 (ADULTS)




*Source: NIMIS data (covering 85% of Model 4 and Model 3 hospitals providing IR services, and CHI)*

*Figure 11* BODY INTERVENTIONAL RADIOLOGY PROCEDURE CATEGORIES BY PATIENT AGE IN 2023 (PAEDIATRIC POPULATION)




*Source: NIMIS data (covering 85% of Model 4 and Model 3 hospitals providing IR services, and CHI)*

## 3.3 Current Interventional Radiology Unit Organisation

For Body IR, this section of the Model of Care focuses on all 9 Model 4 hospitals, the 10 Model 3 hospitals that are classified as having an IR service, and CHI. For Neuro IR, it presents data from the two Neuro IR centres in Ireland. Data were obtained via two surveys issued by the NCP IR in December 2023 and January 2024 and validated via subsequent correspondence with interventional radiologists.

### 3.3.1 Interventional Radiology Staffing Resources

#### In-hours staffing

The number of staff in each health region is sufficient to deliver an IR service within normal working hours. However, provision of out-of-hours services is variable across all health regions.

#### *Consultants*

**Body IR:** IR consultants are distributed throughout the six health regions across Ireland (see *Table 14*). Staffing of IR facilities is provided through the recruitment of specialists from the whole-time equivalent (WTE) complement in radiology departments. Only one type of interventional radiologist appointment is recognised in Ireland: consultant radiologist with a special interest (SI) in IR, which is equivalent to up to 0.5 WTE interventional radiologists. There are currently no full-time dedicated interventional radiologists in Ireland. Some interventional radiologists are employed on general consultant radiologist contracts.

There is a significant deficiency in the number of IR consultants across all health regions, with only two Model 4 hospitals having at least six IR consultants (equating to three WTEs).

**Paediatric IR:** There are three diagnostic consultant radiologists providing Paediatric IR services across the two clinical sites in CHI at Temple Street and CHI at Crumlin. There are also adult interventional radiologists providing Paediatric IR services, within their scope of practice, in some Model 4 and Model 3 hospitals.

**Neuro IR:** There are currently 10 neuroradiologists with SI in neurointervention in Beaumont Hospital and Cork University Hospital. They provide 0.5 WTE Neuro IR services and diagnostic radiology services. There is currently no full-time dedicated neurointerventional radiologist in Ireland. The five neurointerventional radiologists in Beaumont Hospital and the five in Cork University Hospital also staff extensive out-of-hours services for triage and emergency treatment of stroke patients from all health regions in Ireland. There are no neurointerventional radiologists in any other Model 3 or Model 4 hospitals.

*Table 14* CONSULTANT INTERVENTIONAL RADIOLOGISTS, PAEDIATRIC INTERVENTIONAL RADIOLOGISTS AND NEUROINTERVENTIONAL RADIOLOGISTS, BY HOSPITAL AND HEALTH REGION (2023)

| Health Region | Model | Hospital | IR consultants | | |
|---|---|---|---|---|---|
| | | | WTEs | Headcount | with SI in IR |
| **BODY INTERVENTIONAL RADIOLOGISTS** | | | | | |
| HSE Dublin & North East | 4 | Beaumont Hospital | 2.25 | 5 | 4 |
| | 4 | Mater Misericordiae University Hospital | 3.5 | 6 | 4 |
| | 3 | Cavan General Hospital | 0.4 | 1 | 0 |
| | 3 | Connolly Hospital | 1.25 | 3 | 1 |
| | 3 | Our Lady of Lourdes Hospital, Drogheda | 1 | 2 | 1 |
| | 3 | Our Lady's Hospital, Navan | 0.1 | 1 | 0 |
| HSE Dublin and Midlands | 4 | St James's Hospital | 2.5 | 5 | 3 |
| | 4 | Tallaght University Hospital | 2 | 4 | 1 |
| HSE Dublin and South East | 4 | St Vincent's University Hospital | 3 | 6 | 3 |
| | 4 | University Hospital Waterford | 1 | 2 | 2 |
| HSE South West | 4 | Cork University Hospital | 2.5 | 5 | 3 |
| | 3 | Mercy University Hospital | 1.2 | 3 | 1 |
| HSE Mid West | 4 | University Hospital Limerick | 1.5 | 3 | 1 |
| HSE West and North West | 4 | University Hospital Galway | 2 | 4 | 4 |
| | 3 | Letterkenny University Hospital | 0.2 | 1 | 0 |
| | 3 | Mayo University Hospital | 0.2 | 1 | 0 |
| | 3 | Sligo University Hospital | 1 | 2 | 2 |
| **TOTAL BODY INTERVENTIONAL RADIOLOGISTS** | | | **25.6** | **53*** | **30** |
| **NEUROINTERVENTIONAL RADIOLOGISTS** | | | | | |
| HSE Dublin and North East | 4 | Beaumont Hospital (Neuro) | 2.5 | 5 | 0 |
| HSE South West | 4 | Cork University Hospital (Neuro) | 2.25 | 5 | 0 |
| **TOTAL NEUROINTERVENTIONAL RADIOLOGISTS** | | | **4.75** | **10** | **0** |
| **PAEDIATRIC INTERVENTIONAL RADIOLOGISTS** | | | | | |
| HSE Dublin and Midlands | Speci-alist | CHI | 0.25 | 3 | 0 |
| **TOTAL PAEDIATRIC INTERVENTIONAL RADIOLOGISTS** | | | **0.25** | | |

**includes one co-appointment between Mater Misericordiae University Hospital and Our Lady's Hospital, Navan.*

Ireland has lower levels of staffing than the UK which results in a lower rate of IR procedures being performed annually. In the UK there are 11.5 WTE interventional radiologists (paediatric, neurointerventional and body interventional radiologists) per 1 million population. Current demand for adult Body IR is estimated based on the current UK population ratio of 10.2 WTE consultants per million;[72] this compares with 6.0 WTE consultants per 1 million population in Ireland. Interventional radiologists in Ireland make up a smaller proportion of the radiology workforce compared with the UK (9% in Ireland versus 17% in the UK).

### *Nursing*

**Body IR:** IR departments in 8 of the 9 Model 4 hospitals and 8 of the 10 Model 3 hospitals that are classified as having an IR service have dedicated IR nurses. The number of WTEs vary across these hospitals. IR nurses in hospitals providing Neuro IR are shared between Body and Neuro IR units.

All Model 4 hospitals and 6 of the 10 Model 3 hospitals that are classified as having an IR service have dedicated clinical nurse managers. One Model 4 hospital has a clinical nurse specialist and one Model 4 hospital has recently received approval for an advanced nurse practitioner.

IR nurses have specialist knowledge and a skill set that is often underutilised in IR units in Ireland. While IR nurses in all or most Model 4 hospitals give sedoanalgesia and monitor patients during procedures, run time out safety checks before and after procedures, and evaluate patients pre- and post-procedure, it is not as common for nurses in Model 3 hospitals to routinely undertake these duties. Nurses in very few hospitals (Model 4 or Model 3) participate in rounds of inpatients with IR drains or schedule follow-up appointments for patients going home with an IR drain. IR nurses in approximately two-thirds of hospitals with an IR service routinely scrub and assist with IR procedures, or schedule and organise patient lists.

**Paediatric IR:** No radiology nursing service is dedicated to Paediatric IR.

**Neuro IR:** The role of nurses currently working in Neuro IR broadly reflects what is described above for Body IR.

### *Radiographers*

**Body IR:** The number of WTE radiographers trained in IR varies between IR units in Model 4 hospitals. Radiographers are part of a wider radiography pool and work across diagnostic and interventional radiology services. Usually, two radiographers work in each IR suite per day. IR units in Model 4 hospitals have at least one clinical specialist radiographer.

A radiographer is available each day in IR units in Model 3 hospitals with an IR service.

**Paediatric IR:** There are no radiography specialists in Paediatric IR in Ireland.

**Neuro IR:** Radiographers in hospitals providing Neuro IR work across Body IR and Neuro IR units.

### *Fellows and interns*

Two Model 4 hospitals have at least one IR fellow in their IR unit. Three Model 4 hospitals have an IR intern; in two of these hospitals, the intern works full time in IR.

One of the neurointerventional units has two Neuro IR fellows. There are no clinical fellows in Paediatric IR in Ireland.

### *Healthcare assistants*

Healthcare assistants work directly with the IR unit in all Model 4 hospitals and in 5 of the 10 Model 3 hospitals that are classified as having an IR service.

### *Administrative support*

Six of the 9 IR units in Model 4 hospitals and 3 of the 10 units in Model 3 hospitals have dedicated administrative support. In most hospitals, administrative support duties include booking IR cases, organising charts and scheduling day cases, and typing letters to referrers. In some IR units in Model 4 hospitals, administrative staff help to run IR clinics.

## Out-of-hours staffing

### *Interventional radiology consultants*

**Body IR:** There are 24/7 on-call consultant rotas in only three of the nine Model 4 hospitals. The frequency of call is 1:4 in two of these hospitals and 1:6 in one hospital. One additional hospital has an on-call rota until 22:00.

**Paediatric IR:** There is no formal out-of-hours Paediatric IR service in Ireland.

**Neuro IR:** There is a formal on-call rota for IR consultants in both of the Neuro IR units in Ireland. The frequency of call is 1:5 and 1:4.

### *Nursing*

**Body IR:** Three of the nine Model 4 hospitals (in two health regions) have IR nursing cover out of hours (i.e. a formal 24/7 rota). The number of nurses on call per night varies, from one in Body IR units to two in units providing both Body and Neuro IR services. In all hospitals with 24/7 on-call IR nurses, IR is the primary responsibility of the out-of-hours on-call nurse.

Where emergency IR procedures are performed out of hours in other hospitals (those with no formal IR nursing rota), nurses providing cover often do not have the specialist skills required of an IR nurse (e.g. they are often not trained in sedation, familiar with the workings of an IR suite, or familiar with IR equipment and location of stock).

### *Radiography*

**Body IR:** Three of the nine Model 4 hospitals (in two health regions) have IR radiography cover out of hours (i.e. a formal 24/7 rota). The number of radiographers on call per night varies between one and two.

Where emergency IR procedures are performed out of hours in other hospitals (those with no formal IR radiography rota), radiographers providing cover are not always experienced in IR.

**Paediatric IR:** There is no formal out-of-hours Paediatric IR service in Ireland.

**Neuro IR:** There is a formal on-call rota for radiographers in both of the Neuro IR units in Ireland. One radiographer is rostered per night.

### *Anaesthesia*

Out-of-hours anaesthesia cover for emergency IR cases is variable.

The NCP IR survey, as well as a previous IR service model developed by the Irish Society of Interventional Radiology and the Faculty of Radiologists and Radiation Oncologists[4], identified geographic deficits in elective and emergency anaesthesia arrangements in all health regions.

## 3.3.2 Interventional Radiology Facilities and Equipment Resources

### *Interventional radiology suite*

**Body IR:** IR units in all Model 4 hospitals and 8 of the 10 Model 3 hospitals with an IR service have at least 1 dedicated IR suite. Four IR units in Model 4 hospitals have more than one dedicated IR suite.

IR units in all Model 4 hospitals and all Model 3 hospitals with an IR service have a ceiling- or floor-fixed angiographic unit. Such a unit is needed to perform Level 2 IR procedures. Three

IR units in Model 4 hospitals have more than one angiographic unit. Two Model 3 hospitals and three Model 4 hospitals use an angiographic unit that is more than 10 years old.

**Paediatric IR:** Neither CHI in Crumlin or CHI in Temple Street has an IR facility. These hospitals use theatre fluoroscopic units for X-ray guidance. Both CHI hospitals acquired portable ultrasound units in 2024 from charitable funds.

**Neuro IR:** The Neuro IR services in Beaumont Hospital and Cork University Hospital operate out of dedicated biplane Neuro IR suites (two in Beaumont Hospital and one in Cork University Hospital) with fixed ceiling- or wall-mounted angiographic units.

### *Access to anaesthesia*

**Body IR**: For Body IR, there is consultant anaesthetic coverage for monitored sedation or general anaesthesia in 6 of the 9 Model 4 hospitals and 4 of the 10 Model 3 hospitals with an IR service. The rest of the Model 4 hospitals and Model 3 hospitals with an IR service do not have any out-of-theatre consultant anaesthesiology service for monitored sedation or general anaesthesia.

Among the hospitals with access to anaesthesia cover, the extent of formal cover across the six Model 4 hospitals ranges from less than one half-day per week (two hospitals) to two half-days per week (one hospital). Only one Model 3 hospital has any formal anaesthesia cover (one half-day per week).

**Paediatric IR:** Most Paediatric IR procedures are undertaken in the operating theatre. In CHI at Temple Street, there is one half-day IR elective general anaesthesia session every 5 weeks, and in CHI at Crumlin, two half-day general anaesthesia sessions are provided per month for IR procedures.

**Neuro IR:** The Neuro IR service in Beaumont Hospital currently has 2.5 days of anaesthetic cover per week, and the Neuro IR unit in Cork University Hospital has 1 day of anaesthetic cover per week. Outside of this, emergency cover is provided for acute cases. The level of anaesthetic cover is insufficient in both Beaumont Hospital and Cork University Hospital. In 2023, 372 Neuro IR procedures were performed using general anaesthesia procedures in Beaumont Hospital.

### *Access to day care beds*

**Body IR:** Currently, 7 of the 9 IR units in Model 4 hospitals and 8 of the 10 IR units in Model 3 hospitals with an IR service have access to communal day care beds for admission of their patients. Of these, only two Model 4 hospitals and five Model 3 hospitals have access to radiology day care beds that are in the radiology department and ring-fenced for IR.

Three hospitals in which day care beds are communal beds in the hospital report that 30–40% of IR patients are cancelled per year.

The number of day cases per year ranges from 100 to more than 1,000 in Model 4 hospitals and from 50 to 400 in Model 3 hospitals.

**Paediatric IR:** Neither Paediatric IR unit has dedicated radiology day ward bed access. One of the two Paediatric IR units has access to communal day care beds. There are approximately 35 Paediatric IR day cases per year.

**Neuro IR:** Neither Neuro IR unit in Ireland has access to IR day care beds. It is estimated that 1,700 patients per annum could be facilitated in a Neuro IR day ward.

### *Access to inpatient beds*

Body IR units in 5 of the 9 Model 4 hospitals and 1 of the 10 Model 3 hospitals with an IR service have access to IR inpatient beds.

Neither Neuro IR unit in Ireland has access to IR inpatient beds. Neither Paediatric IR unit has access to ring-fenced IR beds for inpatients.

### *Links to community services*

Of the eight hospitals with IR clinics, seven accept direct general practitioner referrals to IR.

## 3.3.3 Clinical Practice

### *Formal arrangements for clinical practice*

No IR in Ireland has a contract that includes clinical practice sessions.

### *Interventional radiology clinics*

**Body IR:** IR departments in six of the nine Model 4 hospitals have an IR clinic, with 83% of the clinics taking place in the IR consultant's office. However, 16 of the 35 WTE IR consultants in Model 4 hospitals participate in outpatient department (OPD) clinics, with numbers varying from 1 out of 5 WTE consultants in one hospital to 4 out of 4.5 WTE consultants in another hospital.

Two of the 10 Model 3 hospitals with an IR service have an IR clinic, with 1 of these taking place in the IR consultant's office.

One IR clinic per week (4 hours) is available in Model 4 hospitals. Clinic hours are shorter in Model 3 hospitals (30 minutes to 1 hour).

Of the hospitals with IR clinics, four offer virtual consultations, seven accept general practitioner referrals, and all have access to secretarial services.

**Paediatric IR:** No Paediatric IR service in Ireland runs an IR clinic. Ad hoc attendance to the Vascular Anomaly Clinic in Crumlin occurs infrequently.

**Neuro IR:** Cork University Hospital runs Neuro IR clinics for the counselling and consent of patients with intracranial aneurysms. No Neuro IR clinics are run in Beaumont Hospital.

### *Patient consent*

**Body IR:** IR consultants and the wider IR team currently play a small role in obtaining informed patient consent in advance of IR procedures. Due to a lack of formal clinical practice sessions, a low proportion of patients are consented by IR clinicians.

For inpatients in Model 4 hospitals:

- An average of 13.5% (range: 0–70%) of patients receive patient information leaflets from a member of the IR team describing the procedure to be performed. In three of the nine Model 4 hospitals, inpatients do not receive this information from IR consultants.
- Patient consent is obtained outside the door or in the IR suite for 35% of patients and on the wards by clinical teams for 65% of patients.

For outpatients in Model 4 hospitals:

- Forty per cent of outpatients receive patient information leaflets from a member of the IR team before their intended procedure.
- An average of 26% of outpatients are seen in the OPD to discuss their intended procedure.
- On average, procedural consent is obtained in the following locations:
  - OPD clinic: 16% of patients;
  - on the ward by clinical teams: 52% of patients; and
  - outside the door of the IR suite: 32% of patients.

**Paediatric IR:** Parental or guardian consent is obtained at the time of admission to day wards for elective paediatric patients. Some inpatient procedures have consent performed in the day ward by the paediatric interventional radiologist.

**Neuro IR:** Elective Neuro IR patients are initially counselled about the procedure by the admitting clinical team in an outpatient clinic.

All elective Neuro IR patients are then consented by Neuro IR consultants or Neuro IR fellows. However, this consent is often performed immediately prior to the procedures, either on the ward or, commonly, in the pre-procedure area.

Consent (either from neurointerventional radiologists or the admitting clinical team) is often not possible for emergency Neuro IR procedures (such as endovascular thrombectomy (EVT) or treatment of ruptured aneurysms), as the patient often does not have capacity to give consent. An attempt to contact the patient's next of kin is made in such cases to obtain assent.

### *Multidisciplinary team meetings*

**Body IR:** IR consultants in 8 of the 9 Model 4 hospitals and all 10 Model 3 hospitals with an IR service in Ireland attend at least 1 MDT meeting per week. The number of meetings attended each week varies considerably (0–12).

**Paediatric IR:** No formal Paediatric IR opinion is provided for IR procedures in MDT meetings.

**Neuro IR:** Neurointerventional radiologists in Beaumont Hospital and Cork University Hospital attend weekly neurovascular and EVT/stroke meetings.

### *Interventional radiology ward rounds and conferences*

**Body IR:** Only 2 of the 9 IR units in Model 4 hospitals and 2 of the 10 IR units in Model 3 hospitals with an IR service have an IR group meeting each morning for discussion and handover of IR cases. Three of the 9 IR units in Model 4 hospitals and 4 of the 10 IR units in Model 3 hospitals have weekly consultant-led IR patient dry rounds or ward rounds. Three of the 9 IR units in Model 4 hospitals and 2 of the 10 units in Model 3 hospitals have regular morbidity and mortality meetings for IR cases.

**Paediatric IR:** No Paediatric IR ward rounds are performed in CHI.

**Neuro IR:** Both Neuro IR units have a meeting each morning for discussion and handover of Neuro IR cases. Only one Neuro IR unit has regular morbidity and mortality meetings. Neither Neuro IR unit has weekly consultant-led IR patient dry rounds or ward rounds.

### *Patient safety protocols*

**Body IR:** Consultants in eight of the nine Model 4 hospitals use a safety checklist, and consultants in all nine Model 4 hospitals engage in time out before procedures. Consultants in 9 of the 10 Model 3 hospitals with an IR service use a safety checklist, and consultants in 7 of the 10 Model 3 hospitals engage in time out.

**Paediatric IR:** Consultants in both CHI at Crumlin and CHI at Temple Street use the WHO safe surgery checklist[62] when performing procedures in operating theatres; time out is performed in both the CHI at Temple Street and CHI at Crumlin Paediatric IR units.

**Neuro IR:** Consultants in one of the two Neuro IR units use a safety checklist and perform time out before procedures.

### *Awareness of policies and protocols for emergency interventional radiology management*

**Body IR:** While there are published guidelines and protocols around the management of several emergency conditions, including postpartum haemorrhage, trauma and sepsis, awareness of these among IR staff is low. For example, only three of the nine Model 4 hospitals indicated that they have a copy of the national postpartum life-threatening haemorrhage protocol[6] in their IR department. Five out of nine IR consultants (survey

respondents) in Model 4 hospitals were aware of the HSE's publication, *A Trauma System for Ireland: Report of the Trauma Steering Group*[19].

**Neuro IR:** Both Neuro IR units adhere to well-defined guidelines and care pathways.

### *Summary of clinical practice*

In summary, it is widely recognised that clinical practice is crucial for ensuring high-quality, patient-centred healthcare. However, at a time when interventional radiologists are performing more complex procedures, the necessary clinical practice that should accompany this is severely lacking, reflecting the untenable current work practices for interventional radiologists in Ireland, which include:

- IR consultant positions with no clinical time allotted;
- too few IR trainees or appropriately trained nursing staff; and
- increasing diagnostic radiology workload.

## 3.4 Summary of Current Interventional Radiology Service Deficits

On a population basis, the size of the current IR workforce and service in Ireland is too small (see *Chapter 5*).

### BODY INTERVENTIONAL RADIOLOGY (Adults)

#### *Geographic variation*

- geographic variation of elective IR services;
- geographic variation of out-of-hours IR services;
- geographic variation in staffing levels (IR consultants, IR nurses and IR radiographers);
- geographic variation in the availability of anaesthesia support for IR procedures; and
- geographic variation in the availability of IR facilities.

#### *Lack of formal transfer arrangements*

There are no formal network links and protocols for IR care in health regions to allow Model 3, Model 2 and standalone maternity hospitals to refer patients to hub Model 4 hospitals.

#### *Smaller number of interventional radiology procedures compared to G7 countries*

In 2023, 50,488 IR procedures were performed in Irish public hospitals. The per capita number of IR procedures performed in Ireland in 2023 was 9,728 per 1 million inhabitants. Compared with other G7 countries in 2010, this is half the average number of per capita IR procedures performed.

#### *Clinical risks*

- Maternity units in Ireland are currently operating without direct access to IR services for embolisation. Most city-based maternity services are not co-located on an adult hospital site, and 13 of the 17 Model 3 hospitals provide maternity services, with most having no clear referral pathways for emergency IR services within their regions. Embolisation procedures for postpartum haemorrhage are underutilised in Ireland.
- Patients with sepsis in four of the six health regions have no access to out-of-hours emergency source control by catheter drainage.
- Patients in four of the six health regions who present out of hours with GI bleeding or other forms of life-threatening bleeding have no access to IR within their regions.

## BODY INTERVENTIONAL RADIOLOGY (Paediatrics)

There is no Paediatric IR service in Ireland. Because of the lack of a Paediatric IR service, children in Ireland have surgical procedures under general anaesthesia, using valuable operating theatre capacity and resources.

## NEUROINTERVENTIONAL RADIOLOGY

Significant growth in the number of out-of-hours Neuro IR procedures, such as stroke thrombectomy, will require additional staffing resources in the future. Neurointerventional radiologists require access to a radiology day ward.

Paediatric Neuro IR is currently an ad hoc system that requires significant reconfiguration. The opening of the National Children's Hospital is an ideal time to formalise the current pathway and governance structures.

### *Deficits in clinical practice*

- Interventional radiologists in Ireland do not have clinical integration appropriate to their role.
- There is limited access to radiology day care facilities for scheduled in-hours IR services.
- It is difficult to identify radiology consultants who provide IR based on their contract description.
- IR consultant appointments are not linked to IR service needs.
- There are variable work plans among radiologists practicing IR.
- There is variation in pre-procedural care provided to patients referred for IR procedures, impairing the process of obtaining patient consent.
- There are variations in post-procedure care and in the clinical follow-up of IR patients.
- There is variable participation in quality assurance initiatives, such as morbidity and mortality conferences and audits.

## BODY INTERVENTIONAL RADIOLOGY, PAEDIATRIC INTERVENTIONAL RADIOLOGY AND NEUROINTERVENTIONAL RADIOLOGY

### *Deficits in clinical practice*

- Interventional radiologists in Ireland do not have clinical integration appropriate to their role.
- There is limited access to radiology day care facilities for scheduled in-hours IR services.
- It is difficult to identify radiology consultants who provide IR based on their contract description.
- IR consultant appointments are not linked to IR service needs.
- There are variable work plans among radiologists practicing IR.
- There is variation in pre-procedural care provided to patients referred for IR procedures, impairing the process of obtaining patient consent.
- There are variations in post-procedure care and in the clinical follow-up of IR patients.
- There is variable participation in quality assurance initiatives, such as morbidity and mortality conferences and audits.

# PART 2
# The Future of Interventional Radiology in Ireland

# 4. A New Service Delivery Model

# 4. A New Service Delivery Model



The vision and recommendations presented in this chapter are underpinned by a number of key publications including the Provision of Interventional Radiology Services documents developed by the Faculty of Radiologists and Radiation Oncologists[73] and the Royal College of Radiologists[74] and the condition-specific evidence presented in Chapter 2.

A robust interventional radiology (IR) service delivery model is essential to cater to the diverse needs of patients requiring both emergency and elective IR care in Ireland. All six health regions will need designated Model 4 hospitals to provide a regional out-of-hours IR service with adequate resourcing to sustain the service into the future. Model 3 hospitals will continue to serve their local communities with IR services that are integrated with community medicine and primary care services in each health region. Formal network links and protocols for IR care in the health regions will allow Model 3 and Model 2 hospitals to refer patients to Model 4 hospitals for services outside the scope of practice of the local IR consultants.

IR must adopt clinical practice e to meet international best practice and regulatory requirements. Multidisciplinary team (MDT) meetings including IR will deliver the full range of advice necessary for patients' treatment decisions to be fully informed and effective. Where possible, patients will meet the IR team as an outpatient. Informed consent will be obtained through full discussion of the procedure, expected outcomes, and alternatives with fully trained interventional radiologists. Post-procedure care will be provided by interventional radiologists, who are the experts in assessing patient outcomes after IR care. Integrated care pathways will provide the best handover information for community services, quality assurance, and care delivery in a streamlined manner.

A national Paediatric IR service will deliver services to children in the new National Children's Hospital (NCH). Paediatric IR has a significant role to play in the delivery of safe and effective care by reducing risks, decreasing length of stay, improving the patient experience and lowering costs. With appropriate funding and resources, Paediatric IR will allow children to have image-guided procedures when required, reduce the need for open surgery procedures, and free up operating space for more elective procedures to be performed in the operating theatre. It is therefore critical that the current un-resourced provision of Paediatric IR on a 'goodwill' basis is replaced by a sustainable service delivery model that enables consistent IR access and quality of care for the children of Ireland.

Neuro IR for adults and children will operate as a highly specialised service delivered through two comprehensively equipped neuroscience centres (in Beaumont Hospital and Cork University Hospital. These centres will provide 24/7 network coverage for the full spectrum of neurointerventional procedures. Paediatric neurointerventional radiology care may in the future be provided by a paediatric interventional radiologist in the NCH.

4



## 4.1 Benefits of Change

### Interventional Radiology Care by Optimally Trained and Accredited Interventional Radiologists as Close to Home as Possible

Interventional radiologists undergo rigorous training and certification, which now includes many complex image-guided interventions and a substantial role in the clinical management of patients. Currently, some adult and paediatric patients cannot receive medical care outside of the operating theatre environment, the treatment requires travel to another hospital outside the country, or no treatment is provided. Formal links to Community Healthcare Networks will allow direct access to IR services for the prevention and timely treatment of issues for patients with indwelling catheters, avoiding emergency department visits and inpatient admission.

### Patient Recognition of Interventional Radiology Services

In today's world, patients are increasingly aware of the variability in treatment available. This Model of Care for IR will allow patients to easily identify those with the appropriate skills to manage their care; ensure that IR procedures are discussed at MDT meetings; ensure that patients receive the best standard of care treatment advice and enable clinicians in the community to directly refer patients to the correct clinical service.

### Workforce Planning for Ireland

An essential part of managing a health system is planning for appropriate staffing to meet clinical needs. This Model of Care is a prerequisite for that planning, both for training programme support and for workforce recruiting. In the past, there has not been an easy means of distinguishing those trained and skilled in interventional procedures and patient care from the pool of diagnostic radiologists. This Model of Care will allow health planners and managers to identify an interventional radiologist unequivocally and will facilitate the planning that is essential to meet patient needs.

### Equitable and Timely Access for Patients to Trained Interventional Radiologists

Patients deserve access to IR on an equitable basis. By delivering the Model of Care for IR, Ireland will enable equitable and timely access to appropriate IR services by general practitioners (GPs), community health services and hospital specialists in all health regions.

### Clinical Practice

IR is a clinical specialty. Provision of the full range of clinical care (including outpatient consultation, periprocedural care and long-term outpatient follow-up) is essential to the delivery of high-quality care in IR and is one of the features that distinguishes this specialty from diagnostic imaging. Clinical practice is essential for optimal patient care in IR. There are some resources, such as clinic space, that are needed to support the modern IR practice. Easily identifying interventional radiologists in practice facilitates planning for their practice needs and will also allow patients to know where IR expertise is available.

### Providing Appropriate Emergency Services

Many IR procedures, performed on patients in an emergency are the most effective treatment with the highest risk/benefit balance. Whether it is a patient with gastrointestinal (GI) bleeding, infection due to an obstructed kidney, bleeding from major trauma, or any of a range of other emergency situations, a qualified interventional radiologist is essential if the patient is to successfully recover. The planning for emergency IR services and for patient access to these services depends on identifying those with the needed skills. This Model of Care for IR will make that possible.

# 4.2 Service Model for Body Interventional Radiology, Paediatric Interventional Radiology and Neurointerventional Radiology In Hours and Out of Hours

## 4.2.1 BODY INTERVENTIONAL RADIOLOGY

IR must develop as a clinical specialty that is available through a hub-and-spoke hospital model within each health region. The IR service must expand its capacity to care for patients as an independent clinical service.

Note: the term 'hub' is used to describe Model 4 hospitals in which 24/7 emergency IR services are provided. Ideally, in the future, all Model 4 hospitals should provide 24/7 emergency IR services. In the meantime, there must be at least one Model 4 hospital designated as an out-of-hours IR hub per health region. The latter arrangement will not interfere with established national trauma pathways. Some health regions in which IR services are well-established will have two out-of-hours IR hubs from the outset; others will need to develop this level of service over time.

### 4.2.1.1 Overarching principles/recommendations

- IR consultation and services should be available both in and out of core hours in every Model 4 hospital. Ideally, out-of-hours emergency IR services should be available in all Model 4 hospitals; at a minimum, at least one Model 4 hospital in each health region should act as a regional out-of-hours IR hub.
- All Model 3 hospitals should offer a defined scope of IR services – particularly biopsy and drainage procedures – in hours.
- The new health regions should integrate IR services across hospital sites to ensure that the needs of each patient requiring IR can be met.
- Emergency IR networks should be developed in each of the new health regions with agreed written pathways that facilitate the flow of patients between network locations depending on the patients' needs.
- IR services should be directly available to community care services and general practice.
- IR should work with other healthcare services to develop policies and guidelines to deliver the recommended level of access to IR treatments and care.
- All Model 4 hospitals should develop IR day care facilities for elective referrals from Model 3 hospitals, Model 2 hospitals and the community.

### 4.2.1.2 In hours

IR is safest when performed during normal working hours by fully trained staff, and when sufficient volumes of IR procedures are performed to maintain the expertise of the multidisciplinary team.

Under this new Model of Care (see *Figure 12*):

- Model 4 hospitals will provide elective and emergency IR services in hours (Level 1 and Level 2 procedures).
- Model 3 hospitals and paediatric services in Model 4 hospitals will continue to provide IR services within the skill mix that the interventional radiologists staffing the unit can provide based on their areas of competence and training. It is clear that not all Model 3 hospitals with emergency departments can provide a comprehensive IR service, because more complex IR procedures are best performed in high-volume Model 4 centres for best patient outcomes. However, all Model 3 hospitals should be able to provide basic level 1 IR services in hours. Model 3 centres designated as trauma units (TUs) should

deliver Level 1 and Level 2 IR procedures in hours. This will mean that designated TUs should have an IR suite, an appropriate number of whole-time equivalent (WTE) IR consultants and appropriate ancillary staffing support to provide the latter IR service. Clear transfer protocols to the regional hub centre must be developed to facilitate the provision of appropriate care for patients requiring IR expertise beyond the scope of local IR expertise and out of hours.

- The scope of IR services provided by each hospital within the proposed hub and spoke network will be clearly defined and supported by formal protocols and transfer arrangements. These will not compromise existing patient referral pathways e.g. the national trauma network.
- Referral within a health region from Model 3 hospitals and Model 2 hospitals to Model 4 hospitals will occur for specialist opinions, MDT discussion and treatment outside the competence and training of the interventional radiologists in the Model 3 and Model 2 hospitals.
- Elective IR will be accessed through IR clinics. Hospital clinical services, community services and GPs will be able to access IR through IR units and clinics like any other clinical service.
- There should be a shift towards ambulatory care, as many IR procedures can be provided as outpatient procedures or same-day IR admissions. All IR services in Model 4 hospitals should have governance over and scheduled access to day care beds, preferably close to the IR unit or clinics.

#### 4.2.1.3 Out of hours

Patient safety, the efficacy of IR embolisation procedures, the number of out-of-hours procedure referrals, and changes in the IR workforce all require that the number of hospitals providing a 24/7 emergency IR service be increased.

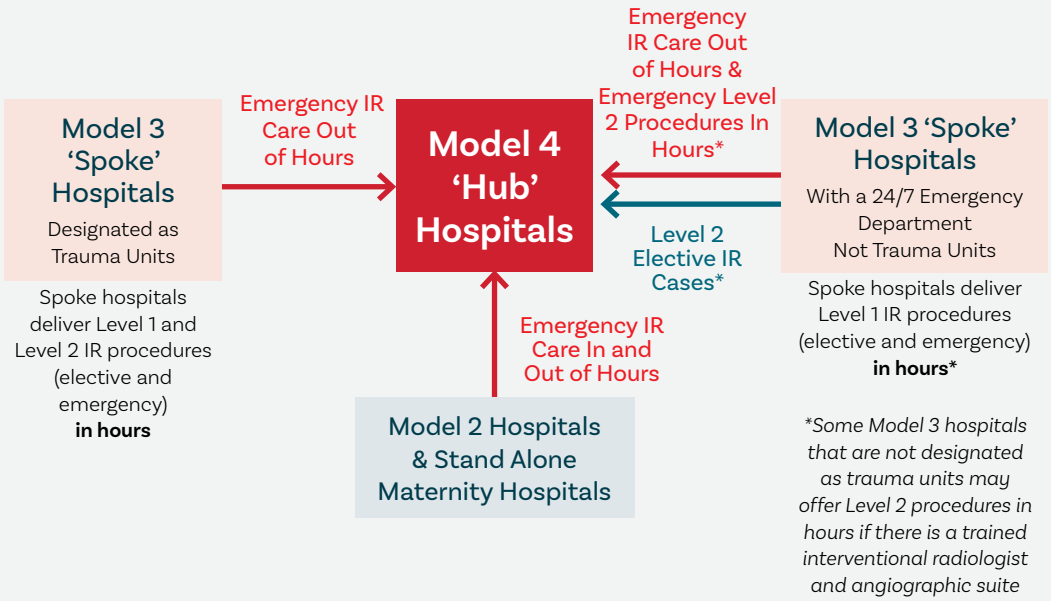
Under this new Model of Care (see *Figure 12*):

- Hub hospitals in each health region (ideally all Model 4 hospitals, but at least one Model 4 hospital per health region) will offer 24/7 emergency IR services with formal on-call rotas for IR consultants, IR nurses and radiographers. In health regions where there are two Model 4 hospitals, a joint rota could be organised depending on resources. There may be procedures beyond the capability of some Model 4 hospitals that will require transfer to other Model 4 hospitals where the required procedures can be performed.
- Emergency IR networks in each health region will comprise Model 4 hospitals, Model 3 hospitals, Model 2 hospitals, maternity hospitals and acute surgical assessment units
- These networks of hospitals will agree pathways for the transfer and acceptance of patients for urgent IR treatment. The following are required for such networks:
  - care pathways that define the roles and responsibilities of each hospital within the emergency IR network;
  - no refusal, escalation and repatriation of patients within each defined emergency network; and
  - ambulance services to support all components of the emergency IR care network, including formal transfer arrangements.
- Emergency IR centres will require 24/7 access to emergency surgery services, out-of-theatre anaesthesiology support, and 24/7 availability of intensive care medicine.

- Networked on-call IR service pathways will enable 24/7 access to:
  - ~ percutaneous nephrostomy insertion for renal obstruction, percutaneous transhepatic biliary drainage for biliary obstruction, and image-guided percutaneous abscess drainage for source control of sepsis.
  - ~ arterial embolisation for upper and lower gastrointestinal bleeding and general haemorrhage in unstable patients within 1 hour of transfer to an IR hub;
  - ~ endovascular intervention (e.g. for acute limb ischaemia or inferior vena cava filter insertion) within 4 hours of transfer to an IR hub;
  - ~ uterine artery and pelvic arterial embolisation for primary and secondary postpartum haemorrhage (PPH); and
  - ~ embolisation and stent graft insertion to control haemorrhage for traumatic or iatrogenic injuries where direct transfer to a major trauma centre is considered unsafe.

*Note: Implementation of the proposed model for emergency out-of-hours IR will not compromise existing patient referral pathways (e.g. the national trauma network).*

*Figure 12* HIGH-LEVEL OVERVIEW OF BODY INTERVENTIONAL RADIOLOGY REFERRAL PATHWAYS UNDER THE NEW INTERVENTIONAL RADIOLOGY MODEL OF CARE




*Note: Figure 12 depicts the ideal 'hub and spoke' arrangement in which all Model 4 hospitals offer full 24/7 'hub' IR services. At a minimum, at least one Model 4 hospital per health region must act as an out-of-hours hub.*

## *Key Recommendations* for the **BODY INTERVENTIONAL RADIOLOGY** SERVICE MODEL

**1.** A nationwide 24/7 emergency body interventional radiology (IR) service must be based in hub Model 4 hospitals in each health region, with on-call rotas for IR consultants (minimum of six), IR nurses and radiographers. Ideally, out-of-hours emergency IR services should be available in all Model 4 hospitals; at a minimum, at least one Model 4 hospital in each health region must act as a regional out-of-hours IR hub. In health regions where there are two Model 4 hospitals, a joint or shared rota could be organised, depending on resources.

**2.** Model 3 hospitals should provide in-hours IR services within the skillmix that the radiologists staffing the unit can provide based on their areas of competence and training. Joint appointments between Model 4 and Model 3 hospitals could help maintain IR services in Model 3 hospitals and contribute to a robust IR on-call rota in Model 4 hospitals that are designated as out-of-hours IR hubs.

**3.** Emergency IR services in Model 3 hospitals must align with patient care pathways in surgery, trauma, obstetrics and gynaecology, and other clinical services in their health region. Formal arrangements are required for network access from spoke hospitals and maternity hospitals to Body IR services in Model 4 hospitals that are designated as out-of-hours IR hubs. NB implementation of the proposed model for emergency out-of-hours IR will not compromise existing patient referral pathways e.g. the national Trauma network.

**4.** Ambulance services must be configured to support all components of the emergency IR care network, including any necessary transfer arrangements protocols.

## 4.2.2 PAEDIATRIC INTERVENTIONAL RADIOLOGY

Paediatric IR must develop as a clinical specialty that is available through a hub-and-spoke hospital model with a single hub hospital at the National Children's Hospital (NCH). This will be the nation's first full-time Paediatric IR service. Most Paediatric IR procedures performed in Ireland will be performed in the NCH. The Paediatric IR needs of the service will increase over time, as many children are now living longer and their management requires the use of minimally invasive treatments (e.g. advanced lymphatic imaging and lymphatic interventions for congenital cardiac patients, and local therapy with ablation for the oncology service).

The IR services in spoke hospitals (Model 3 hospitals and paediatric services in Model 4 hospitals) will continue to provide Paediatric IR services within the skill mix that the interventional radiologists staffing the unit can provide based on their areas of competence and training.

### 4.2.2.1 Overarching principles/recommendations

- The NCH will deliver simple and complex Paediatric IR procedures, including trauma care, for referred children.
- The NCH will offer 24/7 emergency Paediatric IR services with formal on-call rotas for IR consultants, IR nurses and radiographers.
- Model 3 and Model 4 hospitals with paediatric centres should perform Paediatric IR procedures within their scope of practice in line with the Slaintecare principle that care should be delivered as close to home as possible.
- Paediatric IR services will be delivered in the NCH within the skill mix that the interventional radiologists staffing the unit can provide based on their areas of competence and training. Paediatric IR services will also continue to be provided in those Model 4 and Model 3 hospitals where adult interventional radiologists currently provide services within their scope of practice. Certain services within the NCH will be supplemented by body interventional radiologists or neurointerventional radiologists outside the NCH under an agreed service level agreement (SLA) with appropriate centres.
- Paediatric IR referral arrangements must be in place between health regions.

### 4.2.2.2 In hours

When the NCH opens, there will be no resourced IR service. A Paediatric IR implementation committee liaising with the NCH management should be set up to develop the Paediatric IR service to provide a sustainable in-hours IR service for children.

- The NCH requires an 08:00–18:00 Paediatric IR service 5 days per week for elective and emergency in-hours procedures.
- The service will require dedicated anaesthesia service delivery, which will have to be developed.
- Paediatric IR outpatient department (OPD) clinics should initially commence on a two half-days per week basis to maximise efficiency on procedural days, ensure the efficient use of resources and minimise patient delays.
- Paediatric interventional radiologists should attend all relevant MDT meetings with a view to adding value to the MDT, assisting in adding relevant treatment options where physicians and surgeons may not have considered IR options, and preventing unnecessary IR referrals where other procedure options are preferable.

- SLAs and/or co-appointments of adult interventional radiologists and neurointerventional radiologists should ideally be progressed before the opening of the NCH to support complex body embolisation and neurointerventional procedures. The requirement for these outside services may alter with recruitment of body and possibly neurointerventional trained paediatric interventional radiologists in NCH. Emergency paediatric Neuro IR services should also continue in Cork University Hospital and should be formalised with SLAs.

#### 4.2.2.3 Out of hours

When the NCH opens, there will be no resourced out-of-hours Paediatric IR service. A Paediatric IR implementation committee liaising with CHI management should be set up to develop the Paediatric IR service to provide a sustainable 24/7 rota to manage the critical risk associated with trauma and sepsis in children.

## *Key Recommendations* for the PAEDIATRIC INTERVENTIONAL RADIOLOGY SERVICE MODEL

**14.** Because there is no current out-of-hours Paediatric IR service, there is an urgent need to organise a Paediatric IR implementation committee liaising with the new National Children's Hospital (NCH) management to provide a sustainable 24/7 rota to manage the critical risk associated with trauma and sepsis in children. The NCH should be designated a major trauma centre for paediatric patients, as indicated in the National Trauma Strategy, and paediatric trauma care should be guided by the National Trauma Office and publications by relevant National Clinical Programmes.

**15.** The NCH requires a new 08:00–18:00 Paediatric IR service 5 days per week for elective and emergency in-hours procedures with a dedicated anaesthesia service

**16.** Spoke hospitals (Model 3 hospitals) and paediatric services in Model 4 hospitals should continue to provide IR services to children within their competence and training.

**17.** Multidisciplinary team attendance by paediatric interventional radiologists, Paediatric IR outpatient department clinics and clinical integration must be included 1 day per week in the work plans of new paediatric interventional radiologists.

**18.** Service Level Agreements (SLAs) and/or co-appointments of adult interventional radiologists and neurointerventional radiologists should ideally be progressed before the opening of the NCH to support complex body embolisation and neurointerventional procedures. The requirement for these outside services may alter in the future with recruitment of body and possibly trained paediatric interventional radiologists in NCH.

## *Body interventional radiology 'condition-specific' recommendations (adults and paediatrics)*

*Table 15* BODY INTERVENTIONAL RADIOLOGY 'CONDITION-SPECIFIC' RECOMMENDATIONS (ADULTS AND PAEDIATRICS)

| Condition Treated | Recommendations |
|---|---|
| **EMERGENCY CONDITIONS TREATED BY BODY IR** | |
| Postoperative and spontaneous life-threatening haemorrhage | • Emergency embolisation should be available 24/7 for conditions including post-pancreatic surgical bleeding, hepatic artery bleeding and iatrogenic haemorrhage in Model 4 hospitals designated as out of-hours IR hubs.*<br>• The National Life-threatening Haemorrhage Management Poster[6] should be prominently displayed in IR suites. |
| Acute Gastrointestinal Haemorrhage | • Hospitals accepting patients with GI bleeding should have access to IR services 24/7, either in house or via formal transfer policies to a hub hospital with a 24/7 IR service.<br>• Transjugular intrahepatic portosystemic shunt (TIPS) for variceal haemorrhage should be available 24/7 in Model 4 hospitals designated as out-of-hours IR hubs, with formal transfer policies in place from Model 3 hospitals.<br>• IR consultants should be part of hospital GI bleeding teams as they are developed. |
| Trauma | • IR services should be available 24/7/365 within 30–60 minutes in the major trauma centres.<br>• Trauma Units (TUs) in Model 4 hospitals should have a 24/7 IR service (the trauma recommendation is 09:00–17:00, but 24/7 is necessary for all other IR emergency procedures). TUs in Model 3 hospitals should have a 09:00–17:00 IR service with transfer protocols in place to a hospital offering 24/7 services outside these hours.<br>• The NCH should be designated a major trauma centre for paediatric trauma, as per the National Trauma Strategy,and a Paediatric IR team trained, employed and resourced to enable IR service delivery. |
| Sepsis | • Model 4 hospitals designated as out-of-hours IR hubs and the NCH should have a 24/7 IR service to provide sepsis control by drainage of infected foci.<br>• Radiologists in all Model 3 hospitals should be able to provide sepsis control in hours with clear transfer protocols to the regional Model 4 hospital out of hours.<br>• Sepsis control for paediatric patients can be provided in Model 4 hospitals within the scope of individual interventional radiologists' practice. |
| Venous thromboembolism | • Limb venous thrombolysis/thrombectomy should be performed in Model 4 hospitals with the appropriate input from vascular surgery and haematology.<br>• Out-of-hours IR services for limb venous thrombolysis/thrombectomy should be available in Model 4 hospitals designated as out-of-hours IR hubs if the limb is at risk.<br>• Interventional radiologists should be part of pulmonary embolus response teams (PERT) in Model 4 hospitals.<br>• Out-of-hours IR services for major and intermediate-grade pulmonary embolism should be available in Model 4 hospitals designated as out-of-hours IR hubs as required by pulmonary embolism response team (PERT) protocols. |

| Condition Treated | Recommendations |
|---|---|
| **EMERGENCY CONDITIONS TREATED BY BODY IR** | |
| Postpartum haemorrhage and placenta accreta disorder | • One Model 4 hospital with a 24/7 IR service in each health region should be designated as the referral hospital for postpartum haemorrhage (PPH) if IR services are not available on-site. IR attendance at placenta accreta spectrum MDTs should also be available<br>• Future co-location of obstetric units (particularly high-risk units) with adult hospitals should have the appropriate number of interventional radiologists and resources to deal with relevant obstetric emergencies. Networks of hospitals should agree pathways for transfer and acceptance of patients for urgent IR treatment as part of a PPH protocol.<br>• Maternity services should reduce the time to refer to IR units for definitive embolisation and integrate IR care into their major bleeding protocol and policy for PPH.<br>• IR consultants should attend placenta accreta spectrum MDT meetings. |
| | **Ideally, all Model 4 hospitals should offer 24/7 emergency IR services; at a minimum, at least one Model 4 hospital in each health region must act as a regional out-of-hours IR hub.* |
| **ELECTIVE CONDITIONS TREATED BY BODY IR** | |
| Arterial disease | • IR trainees must have adequate training to achieve competency in endovascular interventions and will require rotation while training to achieve this.<br>• Paediatric IR services need to be developed to deliver these services in the new NCH. |
| Arteriovenous malformations | • IR treatments for arteriovenous malformations (AVMs) should be provided in Model 4 hospitals that have the appropriate experience to treat AVMs.<br>• A multidisciplinary group of appropriate specialty doctors (including plastic surgeons; vascular surgeons; interventional radiologists; ear, nose and throat specialists; etc.) should be involved with, ideally, a dedicated AVM clinic.<br>• Appropriately trained paediatric interventional radiologists should be available to treat AVMs in the NCH.<br>• SLAs between the NCH and adult hospitals with the necessary Body and Neuro IR skills should be established for treating more complex body AVMs and head and neck AVMs, respectively. |
| Venous disease | • IR services to treat venous disease should be provided in all Model 4 hospitals that have the required expertise available.<br>• Paediatric IR services need to be developed to deliver these services in the NCH. |
| Cancer | • Oncology treatments should only be carried out in hospitals with appropriate oncological and surgical support by trained interventional radiologists with accreditation.<br>• Interventional oncology procedures should be incorporated into National Cancer Control Programme guidelines.<br>• Interventional oncology should be integrated into the National Cancer Control Programme's clinical governance structures.<br>• Paediatric IR services need to be developed to deliver these services in the NCH. |
| Kidney disease | • Central venous access to enable dialysis should be available in all Model 4 hospitals and in those Model 3 hospitals with trained IR doctors and an angiographic suite.<br>• IR treatments to deal with malfunctioning arteriovenous fistulas should be available 24/7 in Model 4 hospitals designated as out-of-hours IR hubs.<br>• Central venous access should be performed by paediatric interventional radiologists in the NCH with appropriate resources. |

| Condition Treated | Recommendations |
|---|---|
| **ELECTIVE CONDITIONS TREATED BY BODY IR** | |
| Musculoskeletal (MSK) and pain intervention | • Level 1 MSK procedures should be performed in all Model 3 and Model 4 hospitals.<br>• Paediatric IR services need to be developed to deliver these services in the NCH. |
| Gynaecological conditions | • Patients with abnormal uterine bleeding or pressure-related symptoms due to uterine fibroids or adenomyosis should be offered uterine artery embolisation (UAE) as an option by gynaecologists and should have access to consultation with an interventional radiologist regarding the suitability of UAE. Collaboration with Gynaecology colleagues and availability of IR beds will help increase access to uterine fibroid embolisation. |
| Gastrointestinal, hepatobiliary and pancreatic diseases | • Level 1 procedures for gastrointestinal (GI), hepatobiliary and pancreatic diseases should be available in all Model 3 hospitals, while Level 2 procedures should only be performed in Model 3 hospitals with trained interventional radiologists.<br>• Paediatric IR services need to be developed to deliver these services in the NCH. |
| Venous access | • All Model 4 hospitals should provide a venous access service.<br>• Model 3 hospitals designated as trauma units (TUs) with an angiographic suite should provide a venous access service.<br>• Model 3 hospitals that are not designated as TUs may provide a venous access service if there is a trained interventional radiologist and an angiographic suite on-site.<br>• All Model 4 and Model 3 hospitals designated as TUs should have a dedicated central venous catheter/peripherally inserted central catheter (PICC) service to ensure that high-level expertise is practiced within this interventional area.<br>• A formal Paediatric IR in-hours venous access service should be provided at the NCH. |
| Transplant interventions | • IR transplant interventions should ideally be performed at the Model 4 transplant centres where transplant teams are present.<br>• Paediatric IR services need to be developed to deliver these services in the NCH. |
| Renal and genitourinary disease | • Percutaneous nephrostomy should be available in all Model 4 hospitals and the NCH in hours. It should be available out of hours in Model 4 hospitals designated as out-of-hours IR hubs, as well as in the NCH.<br>• Percutaneous nephrostomy should be available in all Model 3 hospitals with trained interventional radiologists in hours and formal agreed transfer protocols should be in place for transfer to Model 4 hospitals designated as out-of-hours IR hubs.<br>• Percutaneous nephrostomy should be available in and out of hours at the NCH. |
| IR catheter problem prevention and intervention in the community | • Links to Community Healthcare Networks should be set up with local IR services to prevent and treat issues for patients with indwelling catheters to avoid emergency department visits and inpatient admission. |

## 4.2.3 NEUROINTERVENTIONAL RADIOLOGY (Adults and Paediatrics)

Neuro IR currently has a hub-and-spoke hospital model with two adult Neuro IR centres at Beaumont Hospital and Cork University Hospital. Adult neurointerventional procedures in Ireland (elective and emergency), including stroke thrombectomy, must continue to be performed at these two Neuro IR centres.

Maintaining high procedure volumes (e.g. a minimum of 100 thrombectomy procedures per year) is paramount for ensuring proficiency and optimal outcomes in Neuro IR. Development of these procedures at other centres will not be supported unless a compelling case can be made based on robust data demonstrating significant unmet need, geographic barriers to access, and the capacity to achieve and sustain the high procedure volumes necessary for quality and safety.

Service Level Agreements (SLAs) and/or co-appointments of adult interventional radiologists and neurointerventional radiologists should ideally be progressed before the opening of the NCH to support complex body embolisation and neurointerventional procedures. The requirement for these outside services may alter with recruitment of body and possibly neurointerventional trained paediatric interventional radiologists in NCH. Emergency paediatric Neuro IR services should also continue in Cork University Hospital and should be formalised with SLAs.

### 4.2.3.1 Overarching principles/recommendations

- Beaumont Hospital and Cork University Hospital will deliver adult Neuro IR procedures, including neuro-trauma procedures and stroke thrombectomy.
- Beaumont Hospital and Cork University Hospital will offer 24/7 emergency Neuro IR services with formal on-call rotas for IR consultants, IR nurses and radiographers.
- Model 4 hospitals with Neuro IR experience will perform Neuro IR procedures within their scope of practice (e.g. Level 1 procedures).
- Neuro IR referral arrangements must be in place between health regions.
- Paediatric Neuro IR services will be delivered in the NCH based on the skill mix that the interventional radiologists staffing the unit can provide according to their areas of competence and training. These services within the NCH will be supplemented by neurointerventional radiologists outside the NCH under an agreed SLA with appropriate Neuro IR centres.

### 4.2.3.2 In hours and out of hours

Adult Neuro IR will operate as a highly specialised service delivered through two comprehensively equipped national neuroscience centres at Beaumont Hospital and Cork University Hospital. This model ensures concentrated expertise, high procedure volumes, and optimal patient outcomes. These centres will provide 24/7 coverage for the full spectrum of neurointerventional procedures.

The well-established endovascular thrombectomy (EVT) model must be maintained. There are clearly documented referral pathways and standardised protocols for this model. As per the National Stroke Strategy, pre-hospital triage and bypass protocols may be instituted in the future where appropriate to minimise time to definitive treatment for stroke patients.

The complex needs of children requiring Neuro IR procedures necessitates the implementation of a collaborative model, underpinned by SLAs, appointment and co-appointments.

# *Key Recommendations* for the **Neurointerventional Radiology** SERVICE MODEL

**19.** Beaumont Hospital and Cork University Hospital must continue to deliver adult Neuro IR services including those for trauma (embolisation and covered stent placement), subarachnoid haemorrhage (endovascular coiling of cerebral aneurysm) and stroke (thrombectomy). Beaumont Hospital and Cork University Hospital must continue to offer 24/7 emergency Neuro IR services with formal on-call rotas for IR consultants, IR nurses and radiographers and appropriate resources.

## *Neurointerventional radiology 'condition-specific' recommendations (adults and paediatrics)*

*Table 16* NEUROINTERVENTIONAL RADIOLOGY 'CONDITION-SPECIFIC' RECOMMENDATIONS (ADULTS AND PAEDIATRICS)

| Condition Treated | Recommendations |
|---|---|
| **EMERGENCY CONDITIONS TREATED BY NEURO IR** | |
| Endovascular thrombectomy for acute ischaemic stroke | • Endovascular thrombectomy (EVT) should be performed in Ireland by neurointerventional radiologists in comprehensive neurointerventional centres at Beaumont Hospital and Cork University Hospital.<br>• All patients referred to the National Thrombectomy Service should be assessed and screened by a stroke physician to ensure patient suitability and minimise inappropriate referrals.<br>• A consultant neurointerventional radiologist will be available 24/7 at Beaumont Hospital and Cork University Hospital to accept referrals and perform EVT as required if the patient is deemed suitable for treatment.<br>• Target door-to-puncture times should be aligned with international best practice guidelines, aiming for patients to be treated as quickly as possible (time is brain). |
| Management of subarachnoid haemorrhage | • Continue the current system of referral to the two national Neuro IR centres. |
| Endovascular treatment of head and neck vascular trauma | • Continue the current system of referral to the two national Neuro IR centres. |
| **ELECTIVE CONDITIONS TREATED BY NEURO IR** | |
| Middle meningeal artery (MMA) embolisation for chronic subdural haematomas | • Continue adherence to the current pathway. |
| Dural arteriovenous fistula (dAVF) and arteriovenous malformation (AVM) embolisation | • Continue adherence to the current pathway. |
| Carotid artery stenting | • A formal national referral pathway for acute and subacute carotid stenting should be established. |

## 4.3 Interventional Radiology Organisation

### 4.3.1 Staffing

The complex nature of IR means that the successful delivery of care requires a team of healthcare professionals comprising IR consultants, IR nurses, dedicated IR radiographers, clerical staff, and healthcare assistants (HCAs) with specific training and knowledge. Additional members of the Paediatric IR team will include play therapists, dedicated paediatric vascular access nurses, Paediatric IR clinical nurse specialists (CNSs) and medical physicists.

Providing training and leadership in IR will require new leadership posts in the radiology department. New nursing and radiography positions should be developed with responsibilities in line with delivering the Model of Care for IR.

The future consultant IR needs are assessed in Chapter 5 on Workforce Planning.

#### *Consultants*

##### Hub hospitals (Model 4), National Children's Hospital and neuroscience centres

Services consisting of six or more interventional radiologists will usually be able to provide an effective and sustainable service, and networks or units should aim for a rota with a minimum frequency of 1:6. Some on-call rotas will require more consultants (depending on the acuity and frequency of call-outs) in order to be sustainable.

IR consultants should be released from DR on-call rotas so that they can provide a robust and sustainable 24/7 IR on-call rota.

Overall, there is a shortage of suitably trained interventional radiologists. Sustaining current services and expanding services to provide 24/7 on-call service will require an uplift in the number of IR consultants and trainees, and local agreement on the staffing of other diagnostic services. In some regions, joint appointments of interventional radiologists to Model 4 and Model 3 hospitals (where geographic distances permit) may be a useful method to boost IR services in Model 3 hospitals. In addition, where feasible, Model 3 hospital IR consultants could also join the IR on-call rota in the regional Model 4 hospital.

##### Spoke hospitals (Model 3)

The number of IR consultants required in Model 3 hospitals will vary depending on the scope of services offered. Overall, there is a shortage of suitably trained interventional radiologists in Ireland. In some Model 3 hospitals, there are experienced IR consultants with variable amounts of IR training performing Level 2 procedures within their skill set, and this should continue. In the future, any Model 3 hospital providing advanced Level 2 IR procedures will require a fellowship-trained interventional radiologist with a minimum of 2 years of dedicated IR training.

The provision of Level 2 IR procedures in Model 3 hospitals in hours will require an uplift in the number of IR consultants and trainees, and local agreement on the staffing of other diagnostic services.

### *Nursing*

Notes:

- International evidence on optimal IR nursing team requirements is limited at present, and the *Framework for Safe Nurse Staffing and Skill Mix in General and Specialist Medical and Surgical Care Settings in Ireland 2018*[75] does not currently cover IR settings. Most of the relevant nursing workforce models in the literature describe safe staffing levels for the operating theatre, and because there are similarities between these and IR requirements for staffing IR suites, IR staffing documents follow the same staffing principles. There are three documents that detail nursing staffing levels for IR specifically:
  - ~ Guide*lines for nursing care in interventional radiology: Third edition*, from the Royal College of Radiologists (RCR) in the United Kingdom;[76]
  - ~ Safe Staffing in the Perioperative Setting, from the New Zealand Nurses Organisation[68] which details nursing requirements for operating theatres and IR units; and
  - ~ Society of Interventional Radiology Position Statement: Staffing Guidelines for the Interventional Radiology Suite, from the Society of Interventional Radiology (SIR) in the United States.[77]

  The SIR Position Statement is intended for the private healthcare system in the United States and is not transferable to the public health system in Ireland. Therefore, the workforce plan in this section is informed by the first two documents listed.
- Guidance on nursing requirements may evolve as evidence and associated frameworks (e.g. safe staffing) are expanded to cover IR in the future. In the meantime, it is recommended that a detailed workforce plan is developed collectively at national and health region level to ensure that IR units have the right IR nursing capacity, capability and skill mix to enable the implementation of this Model of Care.
- Given the precarious nature of nurse recruitment and retention, it may be necessary in some hospitals to explore a shared skill model between IR nurses and operating theatre nurses with formalised competencies, and the sharing of knowledge, skills and expertise to ensure the efficient use of resources.

#### Interventional radiology nursing team composition

**Body IR:** IR nurses are required to safely staff all IR units in hours and provide a sustainable on-call service in Model 4 hospitals out of hours.

##### *Specialist and managerial nursing roles*

In hours, IR units in Model 4 hospitals require senior clinical and managerial nursing roles, including clinical nurse specialists (CNS), clinical nurse managers (CNMs) and clinical skills facilitators (education coordinators); see Section 2.3.2 for full details of these roles. For high-volume Model 4 hospitals (such as national centres with significant in- and out-of-hours work), a CNS may be required to provide clinical support, integration and outreach care. Nursing requirements in Model 3 hospitals will vary depending on the level of IR service.

##### *Staff nurses and healthcare assistants*

All IR procedures require an appropriate complement of IR nurses. Nursing numbers are informed by the New Zealand Nurses Organisation's statement, Safe Staffing in the Perioperative Setting[68], and the RCR *Guidelines for nursing care in interventional radiology: Third edition.*[76]

- Biopsies or drainages performed via ultrasound (US) or computed tomography (CT) guidance are generally performed in non-IR suites and require an IR doctor and one circulating trained staff member (who is experienced in the procedure and equipment) to adjust and provide equipment and to monitor and maintain the safety of the sterile

environment. With appropriate training, this role could be undertaken by a qualified HCA (Quality and Qualifications Ireland (QQI) Level 5) with IR training, subject to expansion of the HCA role within policy and role guidelines.

- Vascular procedures and complex Level 2 procedures are performed in dedicated IR suites that resemble operating theatres, with the majority of patients receiving conscious sedation. This type of procedure requires a scrub nurse and a nurse who is trained in the administration of conscious sedation. A trained scrub nurse is responsible for maintaining the sterile field during the surgery. The scrub nurse and the interventional radiologist work together as a team, handling sterile instruments, sutures and supplies. Scrub nurses are knowledgeable about specialised IR equipment such as catheters, wires, stents, embolic material and angioplasty balloons. They maintain a vigilant eye on the patient's safety during the procedure, maintaining good communication with both the operating interventional radiologist and the other nursing staff in the IR suite. The conscious sedation nurse has a sole duty to administer sedation and provide monitoring and observation of the patient as needed.[68] There will often be a third nurse in the IR suite to circulate and assist with getting equipment and assisting both the scrub nurse and the conscious sedation nurse.
- For patients undergoing general anaesthesia, a trained nurse whose sole duty is to provide monitoring and observation of the patient is needed.[68] In Ireland this is the responsibility of the anesthesiologist with assistance from anaesthesia nurses. For IR procedures requiring general anaesthesia, the anaesthesia nurse is present in addition to the scrub nurse and circulating staff member.

Appropriate numbers of staff nurses and HCAs are also required to safely care for radiology patients in IR reception bays both pre- and post-procedure.

A clinical coordinator (usually a CNM or designate) is needed to coordinate the list of patients, ensure appropriate patient preparation, manage communications with the wider team and keep the IR suites running smoothly.

**On call**

Notes:

- The two available workforce papers[68,76] that inform this workforce plan do not provide a specific number of nursing staff to cover out-of-hours services. The number of nursing staff required to deliver an on-call service in Model 4 hospitals is therefore based on professional judgement after wide consultation with various nursing bodies, including the HSE Office of the Nursing and Midwifery Services Director.
- It is not anticipated at this time that Model 3 hospitals will provide an out-of-hours IR service, and therefore this section applies to Model 4 hospitals only.

IR units in Model 4 hospitals should have a minimum of one IR-educated/trained staff nurse on call per night, 7 days per week. A minimum of 10 competent IR nurses are needed on the on-call rota in Model 4 hospitals in order to provide a safe and sustainable on-call IR nursing service. These nurses will also be included in the day-to-day rota of the radiology department, inclusive of the on-call service. In Model 4 hospitals with high volumes of out-of-hours call-outs, the number of nurses required will be higher (e.g. hospitals with dual Neuro IR and Body IR on-call rotas and a requirement for two on-call nurses per night).

**Paediatric IR:** The NCH will have its IR suite based in the theatre complex and staffed by theatre nurses.

**Neuro IR:** On-call intensity, on-call frequency, and maintaining in-hours service and the sustainability of the on-call service will require significant investment in nurse staffing

complements to sustain the National Stroke Thrombectomy Service both in and out of hours. Continued growth in Neuro IR procedures impacts on the elective operation of the Neuro IR units the day after a late call. A formalised sustainable agreement is required to balance sustainable on-call staffing (unscheduled) and maintain elective (scheduled) safe staffing levels for Neuro IR centres.

### Expanded nursing role

The role of staff nurses in Model 4 and Model 3 hospitals can be expanded to optimise their specialist knowledge and skill set. In particular, the management of IR drains should be nurse led in core hours.

To enable the expanding role of IR nurses, there is a need for the development of HCA roles to support registered nursing staff in the delivery of care. With education and training, the role of HCAs could be expanded in IR to include assistance with procedures, preparation and handling of sterile equipment, and taking observations, among other duties.

The development of CNS and registered advanced nurse practitioner (RANP) roles in IR services enables career progression and the delivery of high-quality, safe patient care.

For CNSs, there are opportunities for experienced clinical nurses to apply specialist knowledge and competencies to enhance patients' preparedness and post-procedure care, and to integrate with community care structures to allow early discharge for many IR patients.

For RANPs, there are opportunities for nurses to practice at a higher level of capability as independent, autonomous and expert advanced practitioners by providing advanced nurse-led care to patients across the IR pathway, providing clinical leadership, and contributing to research and continuous quality improvement.

### Recognition and education for interventional radiology nurses

IR nursing practice is a unique field of expertise that incorporates procedure-specific knowledge, skills and competencies, and it should be recognised as a distinct specialist area. The role of the nurse in Ireland has evolved over the decades, and there is huge potential for the development of a career pathway in IR to include the roles of CNSs and RANPs. A clear career progression in IR nursing teams is needed in hub (Model 4) and spoke (Model 3) hospitals to enhance the quality, safety and continuity of patient care, along with improving recruitment and retention.

As of 2025, there is a lack of further education for IR nursing staff. A Graduate Diploma in Nursing (Radiology) with substantial IR content was offered by University College Dublin in conjunction with St Vincent's University Hospital, pre-COVID-19 but has not been re-established. This gap could be addressed by putting in place an educational pathway for IR nurses that would be supported by clinical facilitators who are members of the on-site IR nursing team in Model 4 hospitals.

The recommended career structure is as follows:

- **National foundation programme (QQI Level 8):** A foundation course should be available for all registered nurses working in IR in Ireland. Current national foundation programmes in anaesthesia and post-anaesthesia care and in pre-admission unit care do have area of relevance to IR nursing, but they do not cover the fundamentals of IR nursing. Therefore, there is a requirement for an education needs assessment to underpin the design of an educational pathway commencing with a foundation programme for nurses who are new to IR nursing. This could potentially be developed within a national foundation programme for perioperative nursing or radiology nursing.

- **Postgraduate diploma (QQI Level 9):** For IR nurses who hold a QQI Level 8 qualification, a postgraduate IR nursing course should be re-established to develop specialist IR clinical expertise within an IR nursing career pathway.
- **Pathway to advanced practice**: The Department of Health's 2019 publication *A Policy on the Development of Graduate to Advanced Nursing and Midwifery Practice* sets out the strategic vision for the development of advanced practice services in the context of Sláintecare.[78] The HSE's Office of the Nursing and Midwifery Services Director has produced guidance on how advanced nurse practitioner (ANP) roles can be developed.[79] It is recommended that the development of ANP roles within radiology departments to meet population health needs and organisational requirements (as identified through local and national planning processes) should be fully explored at national and regional level.

A professional development plan will enable IR nurses to manage their continuing professional development (CPD) and identify and realise their professional goals for the benefit of themselves, their service users and their workplace. The Office of the Nursing and Midwifery Services Directorate has developed a digital professional development planning framework to support IR nurses in this area.[80] In addition to the mandatory HSE modules, other relevant courses available via the HSeLanD online learning portal (for example, the national training programme to promote radiation safety awareness) should be undertaken as part of CPD.

### Summary of interventional radiology nursing recommendations

- A detailed workforce plan should be developed collectively at national and health regio level to ensure that IR units have the right IR nursing capacity, capability and skill mix to enable the implementation of this Model of Care both in hours and via a sustainable on all service.
- A national foundation programme for all registered nurses working in IR should be developed, potentially within a foundation programme for perioperative nursing, with IR specific modules.
- The clinical career pathway for specialist (CNS) roles in IR should be supported in line with Sláintecare. Specifically, a postgraduate programme for IR nurses with a QQI Level 8 qualification should be developed to enable progression to CNS level.
- The development of ANP roles within radiology departments to meet population health needs and organisational requirements (as identified through local and national planning processes) should be fully explored at national and regional level.

## *Radiography*

Notes:

- There is currently no framework for safe staffing and skill mix for radiography in Ireland. Accordingly, guidance on radiography requirements in this section is deliberately high level and may evolve as evidence and associated frameworks (e.g. safe staffing) are developed in the future. In the meantime, it is recommended that a detailed workforce plan is developed collectively at national and health region level to ensure that IR units have the right numbers and skill mix of radiographers trained in IR to enable the implementation of this Model of Care.
- Radiography will require analysis and staffing during the implementation process and engagement with nursing through national radiography bodies to develop sustainable safe staffing levels for networked care.

## Radiography team composition

**Body and Paediatric IR:** Radiographers trained in IR are needed to safely staff all IR units in hours and provide a sustainable on-call service in Model 4 hospitals out of hours.

In hours, IR units in Model 4 hospitals require clinical specialist radiographers (CSRs) and a complement of senior- and basic-grade radiographers. Radiography service managers (RSMs) work across the wider radiology service. In high-volume Model 4 hospitals, one CSR is required across the entire IR service, with an additional CSR required in units with access to a hybrid theatre.

Each IR suite requires two WTE radiographers per day to ensure maximum room utilisation and to maintain training and retraining for the on-call IR pool.

In IR units in Model 4 hospitals, a minimum of 12 radiographers trained in IR are required to cover a 24/7 on-call IR service. This figure may be increased depending on the total number of radiographers in the department and the number of other on-call commitments they have.

**Neuro IR:** For Neuro IR, on-call intensity and working arrangements will require a significant increase in the number of radiography staff to sustain the stroke thrombectomy service both in and out of hours. Continued growth in the number of Neuro IR procedures being performed can have an impact on the elective operation functioning of Neuro IR units the day after a late call. A formalised sustainable agreement is required to balance sustainable on-call staffing and maintain elective safe staffing levels for Neuro IR centres.

## Recognition and education/training for radiographers

IR radiography practice is a unique field of expertise incorporating procedure-specific knowledge, skills and competencies that should be recognised as a distinct specialist area. The role of the radiographer has evolved over the years, and there is now potential for the development of training and a career pathway in IR. A clear career progression for IR radiographers is needed in hub (Model 4) and spoke (Model 3) hospitals to enhance the quality, safety and continuity of patient care, along with improving recruitment and retention.

At present, there is a lack of further education for IR radiography staff. This deficit is partly satisfied by the graduate certificate in Interventional Imaging and Practice that is offered by University College Dublin. The deficit could be further addressed by putting in place an educational pathway for IR radiographers that would be supported by radiography clinical facilitators who are members of the on-site IR teams in Model 4 hospitals, and through the development of supported academic programmes.

In-house postgraduate education moderated by clinical facilitators is important to ensure that appropriate skills and knowledge are obtained by those training in IR radiography. Irish postgraduate programmes and CPD for IR radiographers should be supported. A clinical services manager grade for the IR radiography area should be established to help increase the training, retention and motivation of IR radiographers. The new role would build radiography training and management structures and coordinate audit, quality initiatives and specialist training.

## Expanded radiography roles within interventional radiology services

The development of radiography roles in IR services enables career progression, aids staff recruitment and retention, and improves the delivery of high-quality, safe patient care. Development should align with the HSE's *HSCP Advanced Practice Framework*.[81] One example of the development of clinical pathways with extended radiography roles is IR radiographers undertaking PICC insertion for venous access under supervision in University Hospital Waterford and St Vincent's University Hospital.

### Summary of interventional radiology radiography recommendations

- A detailed workforce plan should be developed collectively at national and health regio level to ensure that IR units have the right IR radiography capacity, capability and skill mix to enable the implementation of this Model of Care, both in hours and via a sustainable on-call service.
- A national educational pathway for IR radiographers supported by local radiography clinical facilitators who are members of the on-site IR teams in Model 4 hospitals should be established and supported academic programmes should be developed.
  The clinical career pathway for expanded radiography roles in IR should be supported in line with Sláintecare and the *HSCP Advanced Practice Framework*.

## *Anaesthesiology*

Although most adult Body IR procedures are performed with conscious sedation and local anaesthesia administered by the IR team, many Neuro IR and Paediatric IR cases require general anaesthesia or monitored anaesthetic care delivered by consultant anaesthesiologists, anaesthetic nurses and post anaesthesia care nurses.

Anaesthesiologist service development planning will need to be worked out on a regional level in each Model 4 hospital with appropriate WTE anaesthesiology personnel allocated to service local patient need.

## *Clerical staff*

Under this new Model of Care for IR, all IR units should have at least one WTE Grade 5 clerical officer. This administrative role should have responsibility for:

- registering new patients on the radiology system;
- reviewing IR requests; and
- running IR clinics e.g. providing appointments, scheduling IR lists, providing patient information, scheduling support to efficiently coordinate IR admission and ongoing care and communication, and managing and validating waiting list cases.

An additional clerical resource with adequate training and experience would be required to collect and enter data to comply with key performance indicators and audit reporting, as specified in Chapter 6.

## *Key Recommendations* for INTERVENTIONAL RADIOLOGY STAFFING

**5.** Appropriate equipment, trained radiographers, nursing staff and anaesthesiology teams must be available to staff expanded IR services.

**11.** A detailed workforce plan should be developed collectively at national and health region level to ensure that IR units have the right IR nursing and radiography capacity, capability and skill mix to enable the implementation of this Model of Care, both in hours and via a sustainable on-call service.

**12.** An educational and training needs assessment for IR nursing (including HCAs) and radiography should be undertaken in collaboration with relevant stakeholders to inform the development of an educational and training pathway that incorporates foundation and postgraduate education provision.

### 4.3.2 Interventional Radiology Clinical Integration

**BODY INTERVENTIONAL RADIOLOGY, PAEDIATRIC INTERVENTIONAL RADIOLOGY AND NEUROINTERVENTIONAL RADIOLOGY**

Taking clinical responsibility for patients is the best way to ensure that patients are rigorously evaluated, informed, consented and managed throughout the patient journey in IR. It also allows interventional radiologists to better integrate into the broader hospital/healthcare structure and ensures more seamless patient care.

Best practice dictates that interventional radiologists should have effective clinical skills, such as appropriate patient evaluation for a particular procedure, management planning and longitudinal care.

Under this Model of Care, IR staffing roles will continue to evolve to incorporate clinical duties, including outpatient consultation, ward consultation, admission of patients, discharge of patients, patient follow-up, education, and quality and management roles.

#### *Formal arrangements for clinical practice*

In the future, consultant radiologist work plans should reflect the clinical service requirements of the specialty (see *Figure 13*). Work plans should incorporate all aspects of IR activity (0.8 WTE of the work plan should be devoted to IR), including IR procedures, inpatient clinical support, time for quality and audit roles, and teaching. In addition, 0.2 WTE of the 0.8 WTE portion of the work plan should be protected for OPD clinics and patient consultation, MDT meeting attendance, and practice management. The remaining 0.2 WTE of an interventional radiologist's work plan should be to perform diagnostic radiology reporting sessions with a case mix appropriate to support their clinical practice.

The proposed expansion of IR is based on current consultants expanding their IR practice to at least 50% of their work plan. The current arrangement, where 0.5 WTE or more is dedicated to diagnostic radiology services delivered by an interventional radiologist, is unusual by international standards. It is envisaged that increases in demand for IR would largely be met through a reduction in the diagnostic workload of interventional radiologists and an appropriate level of clinical practice integration into individual work plans. Future diagnostic radiology appointments will mitigate any losses to current diagnostic radiology services.

### *Interventional radiology clinics*

A direct doctor–patient relationship between interventional radiologists and patients is a fundamental change recommended in this Model of Care for IR. The monitoring of efficacy, complications and the patient's expectations necessitates the development of an IR outpatient clinic in all hospitals that provide Level 2 IR services.

### *Patient consent*

Patient consent should be obtained by the interventional radiologist in a clinic or outpatient setting. In keeping with Irish Medical Council guidance, best practice and patient expectations, this will ensure that the procedure and treatment is fully explained by the responsible clinician, and that patients have sufficient time and information to give their fully informed consent.

### *Multidisciplinary team meetings*

MDT meetings of specialties that make regular referral and treatment decisions should be attended by interventional radiologists. There should be flexibility within interventional radiologists' job plans to allow their attendance at such meetings.

These MDT meetings should follow the guidelines set out by the Faculty of Radiologists and Radiation Oncologists. As an example, the Vascular Society of Great Britain and Ireland states that no patient with critical limb ischaemia should ever undergo amputation without discussion at an MDT meeting that is attended by an expert in infrapopliteal endovascular intervention.

### *Morbidity and mortality meetings*

Morbidity and mortality meetings must be attended by all consultant interventional radiologists, fellows and trainees at least every 3 months.

### *Interventional radiology ward rounds and conferences*

IR ward rounds should become routine in all IR units.

*Figure 13* SUMMARY OF CLINICAL PRACTICE RECOMMENDATIONS OF THE MODEL OF CARE FOR INTERVENTIONAL RADIOLOGY

| Pre-procedure care | Periprocedural care | Post-procedure care |
|---|---|---|
| • Pre-procedure care should take place in an outpatient setting.<br>• Operating interventional radiologist should meet the patient and/or family and develop a relationship built on trust.<br>• Interventional radiologists should:<br>~ verify the indication;<br>~ identify any contraindications;<br>~ discuss the procedure in depth;<br>~ provide reading or graphic material;<br>~ give detail with regard to potential complications;<br>~ assess the patient's capacity to consent;<br>~ answer questions;<br>~ set realistic expectations; and<br>~ ensure the patient is involved in decision-making.<br>• Sufficient time should be allowed for voluntary consent. | • Interventional radiologists should use structured patient safety checklists to reduce human error by verifying:<br>~ the procedure and marking side and site;<br>~ fasting status;<br>~ antibiotic prophylaxis requirement and coagulation status;<br>~ allergy status; and renal function.<br>• Interventional radiologists should engage in accurate scrutiny of imaging studies to help choose the safest approach.<br>• IR team members should use the 'time-out' method to ensure that they are all fully informed and understand what procedure is taking place. | • Ward rounds should take place to allow interventional radiologists to discuss results with patients, answer questions and deliver aftercare instructions.<br>• Outpatient follow-up visits (as required) are important for continued patient care to:<br>~ help manage expectations;<br>~ address any concerns;<br>~ identify complications and outcomes; and<br>~ encourage patients to actively engage in their recovery. |

## ***Key Recommendations*** for **INTERVENTIONAL RADIOLOGY** CLINICAL INTEGRATION

**8.** Clinical integration of IR requires the development of a consultant led IR inpatient consultation service, multidisciplinary team (MDT) meeting attendance, IR same-day admission, and the development of outpatient radiology clinics. In hospitals providing complex (Level 2) IR services. IR clinical time should be recognised in consultant work plans and adequately resourced.

## 4.3.3 Interventional Radiology Infrastructure

### *Interventional radiology suite*

**Body IR:** Any hospital performing Level 2 IR procedures requires access to optimally sized IR procedure rooms with fixed high-quality angiographic X-ray systems, portable ultrasound (US) systems, anaesthetic facilities, IR clinic space, IR recovery beds, and radiology day care beds, and must meet CT/US procedure area requirements, with appropriate ventilation and storage for IR devices.

Model 4 hospitals ideally require IR units with two or more IR angiographic suites to provide a full IR service in hours and an emergency IR service out of hours. One IR suite is required for every two WTE IR consultants appointed.

Both major trauma centres will contain an IR suite in the emergency department, which will include a dedicated multislice CT on a rail and a fixed C-arm for endovascular treatment of haemorrhage. Consumables employed for IR treatments (embolisation materials, sheaths, catheters, microcatheters, guide-wires, stent grafts, occlusion balloons, etc.) should be kept in the trauma suite.

Model 3 hospitals that perform Level 1 procedures do not require all of the above.

**Neuro IR:** The two Neuro IR centres (at Beaumont Hospital and Cork University Hospital) require two appropriately sized Neuro IR suites containing biplane neuroangiography units, portable US systems and anaesthetic facilities, with appropriate ventilation and storage for Neuro IR devices. Access to postoperative recovery beds, a Neuro IR admissions unit, day care beds and a CT/US procedure area is also required.

A third Neuro IR suite will be required in Beaumont Hospital in the future with the expected increase in the volume of the Neuro IR workload.

**Paediatric IR:** Two Paediatric IR suites and a radiology day ward are required in the new NCH. A biplane unit is being procured for the new Paediatric IR suite in the NCH which will allow both Neuro IR and Paediatric IR procedures.

Opportunities to refurbish or replace IR infrastructure in line with the National Equipment Replacement Programme should be pursued. The lifespan of an IR fluoroscopy unit is approximately 10 years, after which it should be replaced. If the fluoroscopy unit shows signs of decreased image quality and performance before 10 years, replacement parts are not available or repair costs are close to or exceed replacement costs, the unit should be replaced.

### *Access to day case (radiology day care) and inpatient beds*

Suitable patients who require Body or Neuro IR procedures should be admitted, managed and discharged by the IR/Neuro IR service through a radiology day care facility. Efficient and safe management of patients requiring radiology procedures should be carried out by interventional radiologists, radiology nurses and IR interns in the radiology department. The latter recommendations will allow the optimum utilisation of day beds and increase day case and inpatient capacity in the hospital for other services.

There is the potential to move a significant cohort of routine outpatient Body IR procedures from Model 3 and Model 4 sites to the new standalone elective-only facilities in Dublin (Connolly Hospital and CHI at Crumlin), Cork (St Stephen's Hospital, Sarsfield Court) and Galway (Merlin Park University Hospital). Many IR procedures are now managed as inpatient admissions under other clinical services. Some of these procedures can be moved to outpatient procedures or same-day IR admissions.

In hospitals where IR day care beds are in place, nurse-led admission and discharge policies, procedures and guidelines (PPPGs) should be developed and appropriate nurse staffing available to safely manage day ward patients. A system of follow-up care should be developed to allow an IR nurse lead, IR fellow or consultant IR to conduct clinical follow-up in the days following a procedure.

**Neuro IR:** At present, most inpatients treated by neurointerventional radiologists are admitted under another clinical team (neurosurgery, stroke medicine or neurology). In the future, a cohort of these patients may be suitable for direct inpatient admission under the Neuro IR consultant. This would require dedicated Neuro IR non-consultant hospital doctors (NCHDs) or NCHDs shared between Neuro IR and the other clinical specialties. The development of such Neuro IR-led inpatient admission pathways will require discussion and agreement with all relevant stakeholders, including neurosurgery. Such discussions should be undertaken locally at Beaumont Hospital and Cork University Hospital.

### *Inpatient admitting rights*

Every interventional radiologist (both Body and Neuro) should have admitting rights to both day care and inpatient facilities. Inpatient/day case admitting rights allow interventional radiologists to have responsibility for all patient hospital episodes and improves access to and continuity of care.

### *Access to anaesthesia*

**Body IR:** The delivery of safe and comfortable IR care in and out of hours requires the support of an anaesthetic nurse and anaesthesiologist. Adequate anaesthetic and monitoring equipment should be provided for the practice of safe anaesthesia, as well as the supply of appropriate medical gases (oxygen, medical air and nitrous oxide). Ideally, oxygen and medical air should have a piped supply with back-up cylinders on the anaesthetic machine, whereas nitrous oxide can be supplied by a cylinder on the anaesthetic machine. Airway equipment, a resuscitation trolley and equipment, an anaesthesia trolley, and anaesthesia consumables will be required and will need to be stored within the radiology department. Access to a fully equipped recovery area will also be required. Piped scavenging (for removal of anaesthetic inhalational agents from the working environment) and piped suction should also be installed. Suitable facilities/pathways need to be in place for preoperative assessment as well as for recovery from anaesthesia.

As IR services are developed within Model 4 hospitals, it is essential that the anaesthesia service has the capacity to provide the service on an elective and emergency basis. In order to deliver a 24-hour, year-round emergency IR service, the anaesthesia providers need to be free of other duties that require an immediate response.

Anaesthesiology service development planning will need to be worked out on a regional level in each Model 4 hospital with appropriate WTE anaesthesiology personnel allocated to service local patient needs.

**Paediatric IR**: Many Paediatric IR cases require general anaesthesia or monitored anaesthetic care delivered by consultant anaesthesiologists and anaesthetic nurses. Therefore, 08:00–17:00, Monday to Friday anaesthesia cover for the Paediatric IR service in NCH (and access to emergency cover out of hours) will need to be developed and resourced. This includes access to anaesthetic consultants, anaesthetic nurses and NCHDs, as well as appropriate access to recovery bays and recovery nursing staff.

**Neuro IR:** Many Neuro IR cases require general anaesthesia or monitored anaesthetic care delivered by consultant anaesthesiologists and anaesthetic nurses. Recent developments in Neuro IR will further significantly increase demand for anaesthetic cover. In the case of

endovascular thrombectomy (EVT), recent studies have demonstrated the benefit of EVT in patients with larger core strokes. These patients tend to be very unwell and may have a reduced Glasgow Coma Scale score, necessitating anaesthetic input. EVT is also likely to demonstrate benefit in more distal medium vessel occlusion strokes. Many of these patients will require anaesthesia, as negotiating catheters and stent retrievers into smaller, more distal arterial branches is challenging and potentially more dangerous with the patient awake. In addition, the first trials assessing middle meningeal artery (MMA) embolisation in cases of chronic subdural haematoma have recently been published, with many more to follow. The evidence will likely strongly favour MMA embolisation as an adjunct to surgery and as a standalone treatment. Most patients undergoing MMA embolisation will require general anaesthesia, potentially resulting in an additional 300–400 general anaesthesia cases per year across Beaumont Hospital and Cork University Hospital.

Therefore, 08:00–17:00, Monday to Friday anaesthesia cover for the Neuro IR services in Beaumont Hospital and Cork University Hospital (and access to emergency cover out of hours) will need to be developed and resourced. This includes access to anaesthetic consultants, anaesthetic nurses and NCHDs, as well as appropriate access to recovery bays and recovery nursing staff.

Anaesthesia arrangements will require focused review, engagement with anaesthesia, and service planning for Body IR, Neuro IR and Paediatric IR in the implementation phase of this Model of Care. .

### *Access to hyper-acute stroke unit beds*

**Neuro IR:** Both Neuro IR hospitals will need extra hyper-acute stroke unit beds with multidisciplinary team staffing to allow for the transfer of stroke patients and short-stay accommodation where required before repatriation to the referring stroke unit. This is the ‘drip, ship and return’ pathway to and from the EVT stroke centre. Adequate space and staffing are required in the post-anaesthesia care unit to allow for the recovery of Neuro IR patients returning from procedures. There must also be suitable high-dependency beds with neurological care and monitoring for patients who are not suitable for repatriation to the referring hospital.

### *Closer links to community services*

Community Healthcare Networks are being developed in each health region, and these offer a good opportunity to enhance IR links to community services. Ireland has an ageing population, with an increasing life expectancy and an increasing incidence of chronic disease. These factors are placing increasing stress on health services, including IR. Community Healthcare Networks are being developed in line with the Sláintecare vision to provide the right care, in the right place, at the right time.

Body IR services should be directly available to community care services and GPs.

A clinical nurse specialist should act as a liaison with community care services to facilitate access for patients from the community requiring IR management of indwelling IR-placed catheters. The CNS should also educate healthcare workers, as well as patients and their carers, regarding appropriate care; deal with outpatient queries; and manage patients’ ongoing IR care. Adequate resources in terms of equipment and administrative support will be required to develop this service.

Direct access to IR clinics for GPs will need to be established, with adequate nursing and administrative support.

### *Interventional radiology clinics*

A consulting space with clerical support and a waiting area for patients is required to allow pre- and post-procedure outpatient consultation with IR patients.

### *Information technology*

In the procedure area, planning and triage of cases is facilitated by network access to CT imaging, magnetic resonance imaging and US imaging on a workstation. Mobile picture archiving and communication system (PACS) viewers (on mobile phones and tablet devices) and networked mobile patient record systems are needed to facilitate the triage of cases.

An IR device stock management system and a quality and registry platform for recording complications and procedure numbers are needed. A modified Hospital In-Patient Enquiry (HIPE) system needs to be developed to reflect the services provided by interventional radiologists (the NCP IR is actively engaging with HIPE to address this issue).

## *Key Recommendations* for INTERVENTIONAL RADIOLOGY INFRASTRUCTURE

**9.** There must be investment in moving inpatient procedures to same-day IR admissions. All IR services in Model 4 hospitals should have governance over and scheduled access to radiology day care beds, preferably close to the IR work area. IR should be included in the new National Elective Hospital Programme for day case IR procedures.

**10.** Hospital clinical services, community services and GPs must be able to access patient consultation and treatment through IR clinics.

## 4.4 Interventional Radiology Service Size: Future Service Demands for Interventional Radiology

The future service demands for IR have been informed by a review of historic IR demand; changes in the scope of IR procedures; demographics of the Irish IR patient population; population size and age statistics for Ireland; Central Statistics Office (CSO) models of population growth and ageing in Ireland; and available international IR procedure numbers per capita.

IR procedure demand in Ireland is increasing: 46,548 IR procedures were performed in public hospitals in 2018, and 50,488 IR procedures were performed in 2023. IR procedure activity in the National Integrated Medical Imaging System (NIMIS) recorded a 2% year-on-year increase in demand between 2017 and 2023.

The scope of practice of IR procedures in Ireland is also increasing. There has been a progressive development of the clinical practice and enlarging scope of IR procedures available in Ireland, supported by scientific research and advancements in materials and imaging: there were 18 IR procedure types available in 1998, 43 procedure types in 2008 and 68 procedure types in 2018.

IR patients of a broad range of ages were treated in 2023 (see *Figure 14*). The ages ranged from the paediatric population to the oldest patient, who was aged over 100 years (see *Figures 9, 10 and 11*). IR procedures are most frequently performed on individuals aged 50–80 years.

*Figure 14* INTERVENTIONAL RADIOLOGY PROCEDURES BY PATIENT AGE IN 2023.

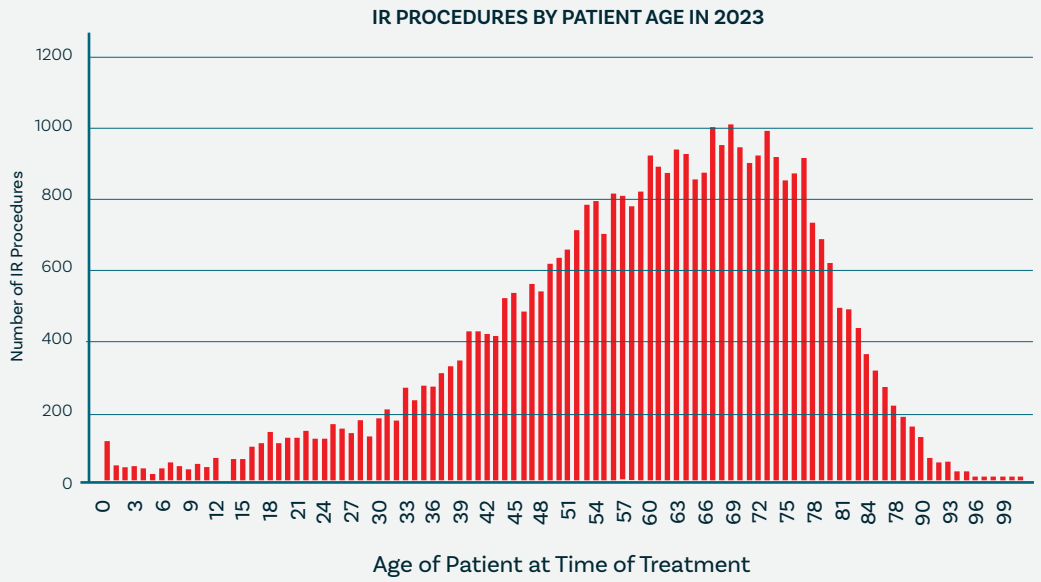
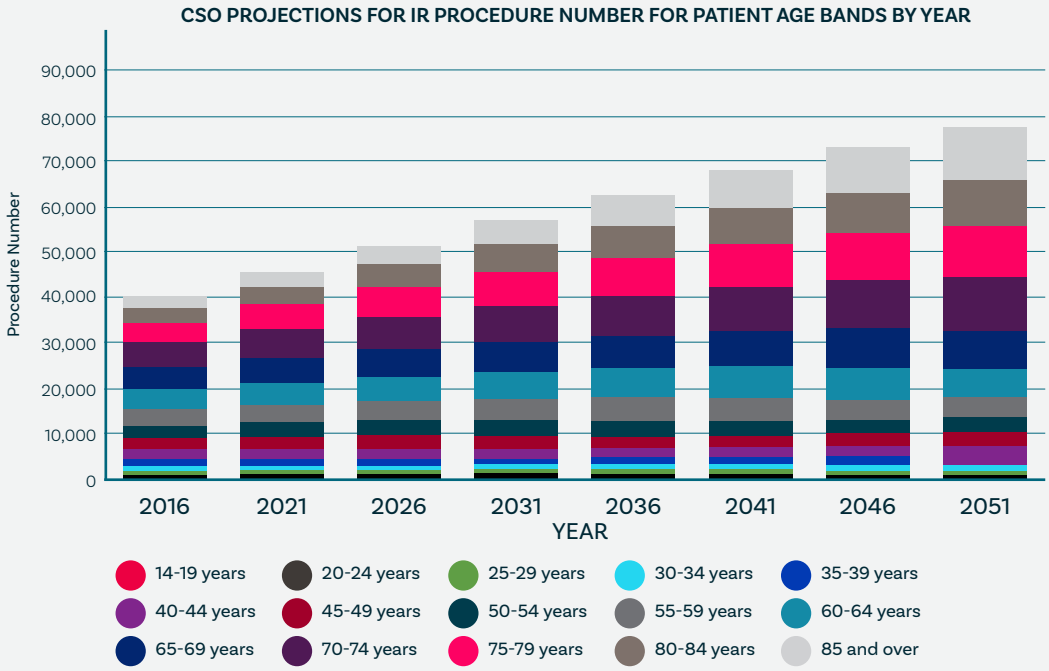



*Figure 15* PROJECTED INTERVENTIONAL RADIOLOGY WORKLOAD USING CENTRAL STATISTICS OFFICE MODEL M2F2 (M2; NET INWARD MIGRATION +20,000 PERSONS A YEAR TO 2051, F2; DECLINING FERTILITY)



The population of Ireland is increasing, as per CSO modelling and census data. According to population models, IR demand will grow due to:

1. Irish population growth, which is assumed to be 10,000–20,000 people per year; and
2. An ageing patient population profile; the absolute population aged 50–80 years is increasing over time.

The CSO model of population and age profile changes from 2016 to 2051 suggests that the number of IR procedures should increase by 2.4–2.6% per annum over that time, or 1,069–1,172 procedures per year (see *Figure 15*).

International benchmarking of the number of IR procedures suggests that Ireland delivers fewer IR procedures per capita than the G7 average in 2010. In 2023, 50,488 IR procedures were performed in Irish public hospitals. The per capita number of IR procedures performed in Ireland in 2023 was 9,728 per 1 million inhabitants. Compared with other G7 countries in 2010, this is half the average number of per capita IR procedures performed.

Based on available CSO population projections and the number of IR procedures performed in 2016, projections of future IR procedure numbers in adults have been generated by the NDTP. These models are based on the following assumptions:

1. Projected migration, survival and birth models generated by the CSO;
2. The number of IR procedures performed in adults in 2016, grouped by patient age at the time of the IR procedure;
3. No growth in existing IR procedure use/demand; and
4. No new IR procedures delivered.

Limitations of this modelling include the following:

1. New IR procedures will emerge that will improve patient outcomes.
2. IR procedure volume will increase based on increased public awareness and demand.
3. The model assumes that the incidence of underlying diseases treated by IR will remain the same over the estimation period.

# 5. Training and Workforce Planning

# 5. Training and Workforce Planning



To deliver the recommendations of the Model of Care for Interventional Radiology, there needs to be clinical service restructuring, radiology service restructuring, an increase in training of interventional radiology (IR) staff and an increase in IR staffing.

## 5.1 Interventional Radiology Medical Workforce Planning

There is a substantial shortage of interventional radiologists in Ireland when compared with the United Kingdom (UK). Interventional radiologists in Ireland make up a smaller proportion of the radiology workforce compared with the UK (9% versus 17%). There are no OECD figures for interventional radiologists per capita. However, there are currently an estimated 6.5 clinical radiologists (public and private, WTE) per 100,000 in Ireland, the median number of radiologists per 100,000 across Europe is 11.5. In Ireland, there are 53 radiology consultants practising Body IR delivering 25.6 whole-time equivalent (WTE) IR services (4.8 WTE per 1 million population). *Table 17* shows that the estimated current demand for Body IR consultants is 54.6 WTE (based on the UK ratio of 10.2 WTE consultants in Body IR per 1 million population).[72] Geographic inequalities emerge when the distribution of IR expertise is mapped against the population demand for the service across the health regions in Ireland (*Table 17*).

The National Doctors Training and Planning (NDTP) report The Radiology Workforce in Ireland 2024-2040: Preliminary Stakeholder Informed Review quantifies the deficit in IR consultant numbers in Body IR, Neuro IR and Paediatric IR, and models the growth in demand and in the population of Ireland. It proposes an increase in interventional radiologist training, changes in current and new interventional radiologist work plans, and new posts in diagnostic radiology to meet the increasing demand in health regions and to correct geographic inequalities in available Body IR services, provide 24/7 regional on-call services, and align with other models of care.[82]

*Table 17* BODY INTERVENTIONAL RADIOLOGY CONSULTANT STAFFING BY HEALTH REGION, AND FUTURE INTERVENTIONAL RADIOLOGY CONSULTANT STAFFING DEFICIT BASED ON POPULATION

| Body IR | | | |
|---|---|---|---|
| **Health region** (population, in millions) | IR consultant WTEs in post | WTE IR consultant demand per 1 million population | Regional deficit in WTE IR consultants per 1 million population |
| HSE Dublin and North East (1.23) | 8.5 | 12.5 | 4.0 |
| HSE Dublin and Midlands (1.15) | 4.5 | 11.7 | 7.2 |
| HSE Dublin and South East (1.00) | 4.0 | 10.3 | 6.3 |
| HSE South West (0.77) | 3.7 | 7.8 | 4.1 |
| HSE Mid West (0.43) | 1.5 | 4.3 | 2.8 |
| HSE West and North West (0.77) | 3.4 | 7.9 | 4.5 |
| **TOTAL** | **25.6** | **54.6** | **29.0** |

In addition, as shown in *Table 18*, there is a current demand for 6.6 WTE neurointerventional radiologists (the current workforce is 4.8 WTEs) and 6.0 paediatric interventional radiologists (the current workforce is 0.25 WTEs). The population of Ireland is both increasing and ageing, and these demographic shifts will increase demand for IR. Hence, the recommended consultant interventional radiologist workforce will need to increase to 80.3 WTEs for Body IR and 10.9 WTEs for Neuro IR by 2040.

*Table 18* NATIONAL DOCTORS TRAINING AND PLANNING WORKFORCE ANALYSIS OF CURRENT ACTUAL, CURRENT RECOMMENDED AND 2040 TARGET WORKFORCE (PUBLIC AND PRIVATE) FOR BODY IR, NEURO IR AND PAEDIATRIC IR

| Specialty | Current actual workforce | Vacant posts | Additional current unmet demand | Current recommended workforce | Demand growth to 2040 | Recommended workforce by 2040 |
|---|---|---|---|---|---|---|
| Body IR | 25.6 | 0 | 29 | 54.6 | 25.7 | 80.3 |
| Paediatric IR | 0.25 | 0 | 5.8 | 6 | 0 | 6 |
| Neuro IR | 4.8 | 1 | 0.9 | 6.6 | 4.3 | 10.9 |

There is currently limited capacity to hire radiology consultants from outside the Irish radiology training programme.[83] The key constraint in expanding the consultant radiology workforce (interventional and diagnostic) is the training programme's capacity to expand.

In 2024, the National Clinical Programme for Interventional Radiology (NCP IR) collaborated with the HSE NDTP and the Faculty of Radiologists and Radiation Oncologists to develop a workforce model to assess training intake requirements for IR and the broader radiology medical workforce.[82] This analysis indicated that a major expansion of the Irish radiology training programme is required to meet the rapid expansion in demand for IR. This expansion will facilitate the expansion in the number of IR trainees.

To meet the demand for consultant interventional radiologists, Body IR training structures need to recruit six trainees every year from 2024 to 2026 and then seven trainees every year from 2027 to 2030. A separate, curriculum-based IR training programme with competency assessment will be required to train the necessary number of IR consultants outlined in the workforce plan. Currently, most trainees in Body IR go abroad to complete a fellowship. There are potentially substantial advantages to providing fellowship training places for some trainees in Ireland, including increased retention and defined training skills. Paediatric IR training structures need to recruit and train on average 0-1 per year from the domestic training programme. Neuro IR will require an intermittent training intake to supply a small number of additional proposed posts and projected retirements in the 2030s.

This analysis indicates that three to six new consultant hires per year are required in Body IR from 2026 to 2030 to achieve the national target for WTE interventional radiologists. This is projected to increase the Body IR workforce to 51 WTEs in 2033 (see *Table 19*) and 73 WTEs by 2040. The proposed expansion of IR is also based on consultants currently practising IR continuing to contribute at least 50% of their time to IR. The current arrangement of diagnostic radiology being delivered by interventional radiologists is unusual by international standards. It is envisaged that increases in demand for IR would largely be met through a reduction in the diagnostic workload of interventional radiologists and an appropriate level of clinical practice integration into individual work plans. The proposed expansion in Neuro IR will be achieved through two additional posts and an expansion in the proportion of time Neuro IR consultants dedicate to Neuro IR. The proposed expansion in Paediatric IR indicates six new paediatric interventional radiologist hires through a combination of hiring paediatric interventional radiologists and backfilling current paediatric radiology commitments as suitable candidates become available.

*Table 19* NATIONAL DOCTORS TRAINING AND PLANNING WORKFORCE ANALYSIS OF PROJECTED SUPPLY (WHOLE-TIME EQUIVALENT ATTRIBUTED TO ACTIVITY AREA)

| Specialty | YE 2024 | YE 2025 | YE 2026 | YE 2027 | YE 2028 | YE 2029 | YE 2030 | YE 2031 | YE 2032 | YE 2033 | YE 2034 | YE 2035 | YE 2036 | YE 2037 | YE 2038 | YE 2039 | YE 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Body IR | 26 | 27 | 30 | 32 | 35 | 38 | 40 | 44 | 47 | 51 | 54 | 57 | 60 | 64 | 67 | 70 | 73 |
| Neuro IR | 5 | 6 | 7 | 9 | 9 | 11 | 11 | 11 | 10 | 11 | 10 | 11 | 10 | 11 | 11 | 11 | 11 |
| Paediatric IR | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

*YE = year ending*

These increases in the number of consultants will not be achieved without the development of a robust, curriculum-based training programme with competency assessment.

## 5.2 Consultant Interventional Radiologist Work Plan

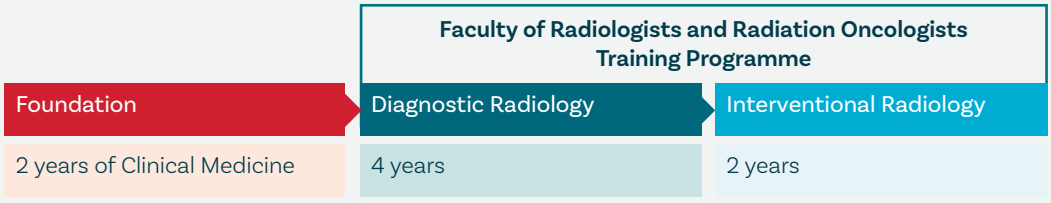
The delivery of the necessary number of WTE consultant interventional radiologists is challenged by the current work plan framework. Central to planning and achieving the necessary increase in IR services and clinical integration of IR services is the framework of practice changes in work plans for consultant interventional radiologists, which are as follows:

- Twenty-two in-post consultant radiologists who are practicing IR but on a general radiologist contract should be offered contract descriptions that specify a special interest (SI) in IR (only 30 of 53 current interventional radiologists have 'consultant radiologist with SI in IR' specified in their contracts) to identify these staff to their employers for workforce planning.
- Planned diagnostic radiology consultant posts should be filled to accommodate the change in the practice of in-post consultant radiologists with an SI in IR. This will mitigate the reporting time lost when 0.2 WTE clinical time is added to the work plan of each interventional radiologist and the impact of IR service expansion and on-call IR services.
- All new interventional radiologists should have 0.8 WTE IR service and 0.2 WTE diagnostic responsibilities in their work plan.

## 5.3 Interventional Radiology Training

The NDTP workforce analysis has demonstrated a need to increase the number of radiology trainees. All trainees require diagnostic radiology training with body interventional radiologists requiring at least 2 years of IR training and neurointerventional radiologists requiring 3 years of Neuro IR training in an IR pathway (*Figure 16*). Training of paediatric interventional radiologists should be a high priority, facilitated outside of Ireland until a critical mass of paediatric interventional radiologists is available to provide training domestically.

*Figure 16* FACULTY OF RADIOLOGISTS AND RADIATION ONCOLOGISTS INTEGRATED TRAINING PROGRAMME FOR DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY



Applicants for the Diagnostic Radiology training programme must have completed two years of clinical medicine (intern year and at least one other year) to be eligible to apply for the Faculty of Radiologists and Radiation Oncologists radiology training programme. Diagnostic Radiology and IR training occurs over six years (see *Figure 16*) with the conferring of the Fellowship of the Faculty of Radiologists and Radiation Oncologists (FFRRO) in year 4 to successful examination candidates. The FFRRO is a national test of knowledge as laid out in the Faculty of Radiologists and Radiation Oncologists syllabus agreed with the Medical Council of Ireland. It is embedded in the Diagnostic Radiology curriculum and radiologists-in-training may not progress to IR training without obtaining the FFRRO.

The NDTP and Faculty of Radiologists and Radiation Oncologists will require an appropriate number of funded specialist registrar (SPR) posts for the 2 year IR training programmes for Body IR, Neuro IR and Paediatric IR to fulfil the mission of the NDTP workforce plan for IR. These IR training programmes will involve rotations to accredited training hospitals under approved IR consultant trainers, with a pre-planned two-year schedule of curriculum-based IR training and under the direction of a national lead for IR training.

Competency assessment of IR training will be composed of a written examination (European Board of Radiology (EBIR) or equivalent) and clinical and formative assessments, both of which cover the theory and practical aspects of modern IR. Satisfactory IR training assessment will lead to a Certificate of Eligibility for Specialist Registration (CESR) in Interventional Radiology and Certificate of Satisfactory Completion of Specialist Training (CSCST) in Diagnostic Radiology.

Paediatric IR will require at least one year of approved Paediatric IR training out of programme.

Neuro IR will require an additional one year of approved diagnostic neuroradiology training out of programme.

## 5.4 Intern in Interventional Radiology/Radiology

The development of intern/junior house doctor roles in radiology and IR reflects the increasingly significant role played by interventional radiologists in patient care and treatment. This change in how modern medicine is delivered necessitates that medical practitioners get exposure to the capabilities and limitations of a modern imaging and IR department. This Model of Care strongly advocates that interns should rotate through IR in all Model 4 hospitals.

## 5.5 Interventional Radiology Leadership and Training Structures

To deliver the current and future system change in the Model of Care for IR, new leadership positions are required in the NCP IR, or a combined programme for radiology needs to be set up in a national radiology office with a national IR consultant clinical lead to deal with IR matters. A funded Body IR fellowship pathway director in the Faculty of Radiologists and Radiation Oncologists and clerical support will require approval and funding from the NDTP and the HSE.

## 5.6 Workforce Planning for Interventional Radiology Service Multidisciplinary Teams

The National Radiology Strategy 2025-2029 will expand on the broader diagnostic radiology service workforce needs. The nursing, radiography, radiographer assistant, administrative support, anaesthesiologist support and medical physicist workforce should be guided by this Model of Care for IR and any current or future IR workforce documents developed by the Faculty of Radiologists and Radiation Oncologists or international institutions.

A detailed workforce plan should be developed collectively at national and health region level to ensure that IR units have the right IR nursing and radiography capacity, capability and skill mix to enable the implementation of this Model of Care both in hours and via a sustainable on-call service.

### *Key Recommendations* for INTERVENTIONAL RADIOLOGY WORKFORCE PLANNING

**6.** Expanding IR services to provide 24/7 on-call services, projected increases in elective IR service activity, increased provision of IR procedures in Model 3 hospitals designated as trauma units, and clinical integration will require an increase in the number of consultant interventional radiologists and increased IR training. Service needs require the training and appointment of consultant interventional radiologists in line with the NDTP workforce plan. All new IR consultant job plans should have an 80% IR component that is adequately resourced. Existing IR consultants should move to at least a 50% IR job plan.

**7.** A robust, curriculum-based IR training programme with competency assessment must be established to deliver the required number of consultants set out in the Workforce Planning section of this Model of Care.

**11.** A detailed workforce plan should be developed collectively at national and health region level to ensure that IR units have the right IR nursing and radiography capacity, capability and skill mix to enable the implementation of this Model of Care, both in hours and via a sustainable on-call service.

# 6. Governance, Quality Assurance and Patient Safety

# 6. Governance, Quality Assurance and Patient Safety

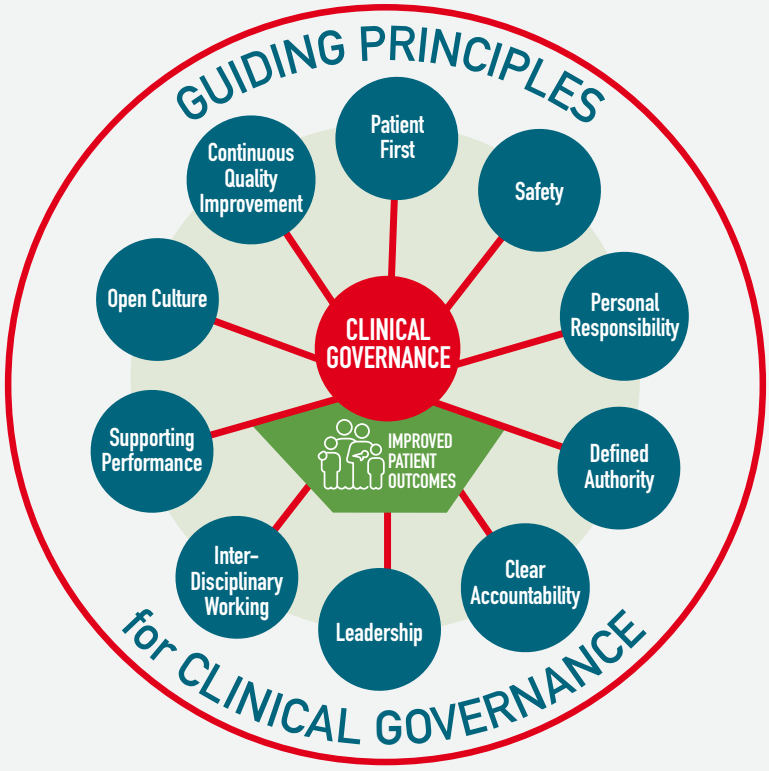


## 6.1 Clinical Governance

Clinical governance is a system or framework (see *Figure 17*) through which healthcare teams and organisations are accountable for continuously improving the quality of their services and safeguarding exacting standards of care by creating an environment in which excellence in clinical care will flourish.

Effective clinical governance ensures that risks are mitigated, adverse events are rapidly detected and investigated openly, and lessons are learned.[84]

*Figure 17* ESTABLISHED GUIDING PRINCIPLES FOR CLINICAL GOVERNANCE




*Adapted from HSE Clinical Governance Information Leaflet*

### 6.1.1 Clinical Governance Roles

Regional Executive Officers (REOs) in each health region assume a legal responsibility for quality of care that is equal in measure to their other statutory duties. The hospital/health region will define the clinical governance structure for clinical services, including the interventional radiology (IR) service.

It is imperative that an appropriate framework for leadership and management is established to support the delivery of an equitable IR service throughout the country, as well as supporting safe practice, quality improvement and innovation.

As part of this Model of Care (MOC), the governance structures and roles outlined below are recommended.

A national radiology office should be established with a national IR consultant clinical lead to deal with IR matters, and appropriate staffing. The national clinical lead for IR should:

- provide distinct national leadership;
- make recommendations in relation to the implementation of the MOC;
- take the lead in driving progress and innovation in IR;
- support regional- and hospital-level IR leads;
- promote shared culture, collaboration and collegiality across the specialty;
- promote a culture of open reporting on clinical incidents, near misses, and other workplace health and safety incidents to improve patient safety and outcomes;
- develop and maintain strong relationships across other related national clinical programmes and clinical specialties;
- develop systems, in conjunction with other stakeholders, to continuously monitor the quality of care provided and patient outcomes;
- develop systems to benchmark patient outcomes against national and international best practice standards; and
- develop a national registry to record IR data so that key performance indicators (KPIs) can be developed and benchmarked with national and international standards.

Each health region should have a designated IR regional lead in order to ensure that the principles of the IR network (hub-and-spoke model) are safely and consistently operationalised. For example, the IR regional lead should work with all hospitals in the region to ensure that there are:

- written agreements regarding the scope of services (type and level of IR procedures) provided in Model 4 and Model 3 hospitals both in and out of hours;
- protocols regarding referral pathways and processes;
- clearly defined roles and responsibilities;
- structured meetings (e.g. joint multidisciplinary team (MDT) meetings for complex cases involving all relevant clinicians) in Model 4 and Model 3 hospitals; and
- promotion of and active engagement in the open reporting policy of clinical incidents and near misses.

An IR lead should be identified in each hospital, and should have the following responsibilities:

- engaging with the health region and the proposed national radiology office in relation to IR unit performance and accountability;
- ensuring IR attendance at joint MDT meetings in relation to complex cases;
- ensuring compliance with quality improvement recommendations (e.g. participation in national/international registries);
- monitoring IR unit performance against KPIs and driving improvements;
- driving the implementation of MOC recommendations at hospital level;
- liaising with hospital risk management to promote the open reporting of clinical incidents and near misses; and
- ensuring IR unit responses to service users' complaints, feedback or compliments are reviewed as part of the unit's routine clinical governance function.

Opportunities to involve patient representatives within the national, regional and hospital level governance structure should be embraced during the implementation phase.

## 6.2 Quality Assurance

The philosophy of the National Clinical Programme for Interventional Radiology (NCP IR) and the Irish Society of Interventional Radiology is that interventional management of IR patients will be practised in accordance with the international guidelines laid down by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE), the British Society of Interventional Radiology (BSIR), the Royal College of Radiologists (RCR), the Society of Interventional Radiology (SIR), and the International Accreditation System for Interventional Oncology Services.

To maintain IR expertise in specific areas (e.g. endovascular procedures/interventional oncology), the Irish Society of Interventional Radiology recommends adopting international governance protocols that state the following:

- IR case volume (determined by the National Quality Assurance and Improvement System) must be sufficient to ensure optimal patient outcomes and clinician competence.
- Interventional radiologists should have established expertise and training in all IR procedures and in particular emergency IR procedures.
- IR procedure outcomes are subject to audit/KPIs.
- Morbidity and mortality should be assessed regionally, locally and nationally, and outcome analysis provided with input from all services.

The Irish Society of Interventional Radiology, the Faculty of Radiologists and Radiation Oncologists, and the NCP IR will contribute to National Clinical Effectiveness Committee national clinical guidelines relevant to clinical effectiveness involving IR. National clinical audit suggestions will be submitted to the National Clinical Effectiveness Committee for consideration if they are relevant to IR practice.

It is critical for healthcare delivery and patients that a robust system of quality improvement and audit, with relevant KPIs, is in place to identify risk and monitor the safety of service delivery. Clinical audit will be used as a tool in IR departments and nationally to monitor clinical effectiveness, patient radiation dose and quality assurance.

IR practitioners will follow the guidance of the Faculty of Radiologists and Radiation Oncologists, as well as national and regional IR leads, in relation to participation in quality assurance programmes, and will ensure adherence to local hospital governance structures and relevant HSE policies.

### 6.2.1. Clinical Audit and Quality Improvement

Unfortunately, to date, IR has not been involved to any significant level in a formal quality improvement programme with relevant KPIs. The current National Radiology Quality Improvement (NRQI) Programme is heavily focused on diagnostic radiology, with no quality improvement reporting to date on IR.

Clinical audit needs to be performed at national, health region and local hospital level. Robust reporting of audit outcomes can identify potential risks to be corrected and enables comparison with national and international standards.

An IR quality improvement governance committee should be established to define and oversee quality improvement initiatives. Membership should include the national IR lead, representatives from the Faculty of Radiologists and Radiation Oncologists and the NRQI Programme, and other relevant stakeholders.

The NRQI Programme should be expanded to include IR. A series of KPIs relevant to IR should be drawn up by the IR quality improvement governance committee. All interventional radiologists should participate fully in the expanded NRQI Programme. IR data should

be entered/uploaded to the National Quality Assurance and Improvement System for Radiology (NQAIS-Radiology), the central repository for data associated with the NRQI Programme, in line with agreed protocols.

A national registry for IR should be established under the remit of the IR quality improvement governance committee. The routine collection of high-quality, robust data, along with the full and complete participation of all IR units, will drive IR service improvements, ensure that best practice is followed, inform further audit, and facilitate the early identification of outliers. The registry dataset should collect data on out-of-hours procedures, new procedures, and some selected scheduled procedures and complications. National- and hospital-level reports should be generated at defined intervals to provide insights into IR service delivery, with data benchmarked against regional and national averages, international best practice standards, and over time. The information should guide resourcing and practice development in hub hospitals.

In addition, the IR registry governance committee will define a structured programme of annual audits and re-audits necessary to comply with best practice in IR and Health Information and Quality Authority (HIQA) guidance, and should be informed by the performance of prior audits.

Participation in IR quality improvement initiatives (clinical audit and registry) will be the responsibility of the hospital IR lead and will comply with national and health region audit policies. Quality improvement initiatives based on service-user feedback should be scoped and successfully completed. Local clinical audits performed annually by clinical and non-clinical staff in the IR unit will be reported to the IR lead, the hospital clinical audit and risk committee, and the radiology audit committee. The hospital will define the reporting relationship between the IR audit lead, radiology audit committee, radiation protection committee, hospital clinical audit and risk committee, and hospital board. Radiation-related audits will be subject to external inspection by the Health Information and Quality Authority. Risk assessment, recommendations and the monitoring of compliance with recommendations arising from audits will be the responsibility of the health region governance structure and the hospital clinical audit and risk committee.

Roles related to audit and quality improvement will include the following:

- The designated clinical lead interventional radiologist in each unit will be responsible for administrative roles, including audit.
- The regional IR leads in each health region will oversee and use quality and audit reports to drive improvement.
- The national IR lead will work with regional IR leads to ensure that quality and audit protocols are in place and that reporting structures are followed.
- A central team will manage the IR registry, analyse data, and generate benchmarked reports at hospital, regional and national level.

### 6.2.2 Risk and Patient Safety

Risk management of the IR group will be the responsibility of the health region and hospital risk structures. IR risk management reports will be provided by the IR lead in each hospital, who will report to the quality and risk advisory committee in the hospital and health region as well as to the regional and national IR leads. The risk advisory committee is responsible and accountable to provide assurance that there are appropriate and effective systems in place to cover and manage all aspects of risk, quality and safety in the health region and its hospitals.

All IR units will participate in and cooperate with internal and external evaluations of hospital structures, services and processes as required, including, but not limited to:

- legislation and guidelines related to radiation safety;
- open disclosure guidelines;
- national standards for safer, better healthcare;
- national standards for the prevention and control of healthcare-associated infections particularly, related to intravascular access devices and enteral feeding tubes increasingly placed by IR[29];
- HSE standards and recommended practices for healthcare record management;
- HSE standards and recommended practices for decontamination of reusable invasive medical devices;
- safety audits and other audits specified by the HSE or other regulatory authorities; and
- initiating, supporting and implementing quality improvement initiatives in their area that are in keeping with the health region's/hospital's continuous quality improvement programme.

## 6.3 Education, Training and Research

The Faculty of Radiologists and Radiation Oncologists is the professional body for training interventional radiologists and, along with the NCP IR, it has a role in advising the National Cancer Control Programme, the national clinical programmes and the HSE regarding best practice for IR.

Education and training in IR is the joint responsibility of the Faculty of Radiologists and Radiation Oncologists and the NDTP. Continuing professional development in IR would be jointly administered by the Faculty of Radiologists and Radiation Oncologists and the proposed new IR specialty, with Medical Council approval.

Primary research and development in IR will be the responsibility of the IR practitioner. IR units will use critical appraisal of the literature to develop guidelines and protocols and to implement change in line with best practice and national guidance through departmental meetings.

## 6.4 Recommendations

In relation to clinical governance, audit and quality improvement, patient safety, and education and training, the MOC recommends the following:

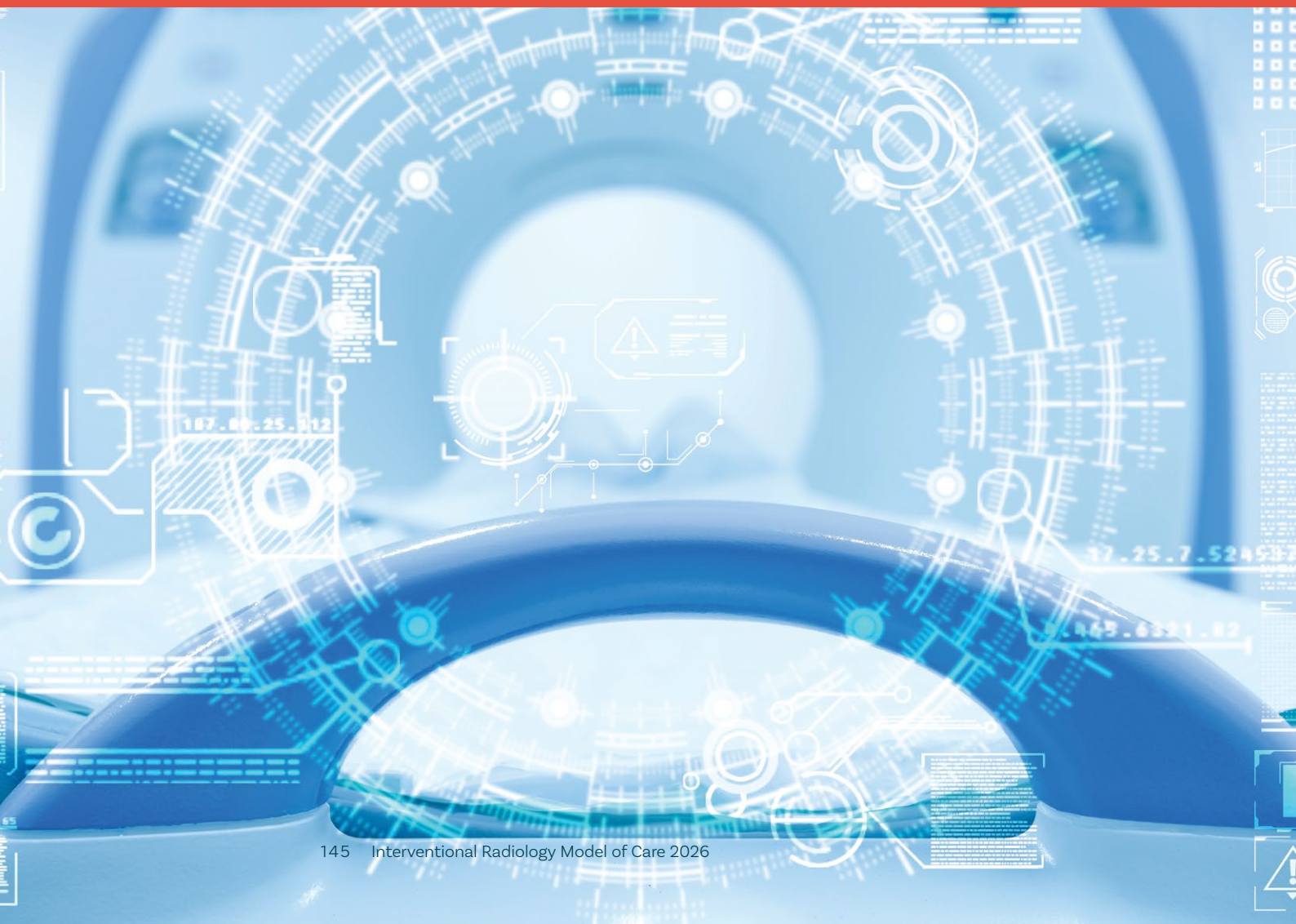
- A national radiology office should be established with a national IR consultant clinical lead to deal with IR matters. Together with other stakeholders and the NRQI Programme, the IR lead should devise a relevant plan for quality and audit in IR.
- The national IR lead should work with regional IR leads to ensure that quality and audit protocols are in place and that reporting structures are followed.
- A national IR registry should be established for unscheduled procedures, new IR procedures and selected scheduled procedures for the purposes of national benchmarking against peers and international benchmarking.
- A structured programme of annual clinical audit should be established. Some of he audits should be focused on patient dose from IR procedures, procedure success, complication rate, patient experience and patient outcomes.
- Regular (at least quarterly) morbidity and mortality conferences should take place to review patient outcomes.

- Irish IR standards should be aligned with the quality standards published by Cardiovascular and Interventional Radiological Society of Europe (CIRSE), the British Society of Interventional Radiology (BSIR), the Royal College of Radiologists (RCR), the Society of Interventional Radiology (SIR).
- The use of a safety checklist in IR should be mandatory in all IR units.
- Interventional radiologists should attend clinical radiology conferences.
- IR should participate in a radiology alert system for the communication of critical, urgent and unexpected, and clinically significant radiological findings.
- Ideally, once there is a robust IR registry, audit (with relevant IR KPIs) and reporting processes established, an anonymised annual report should be produced by a central team to report on performance at hospital, regional and national level. This would enable department- and health region-wide IR errors and areas for improvement to be identified and action plans put in place. In addition, each health region should have a regional IR lead to oversee and use quality and audit reports to drive change.
- Hospitals should engage with service users in a structured and regular manner and ensure that quality improvement initiatives based on service-user feedback are successfully completed. The NCP IR recommends that IR unit responses to service users' complaints, feedback or compliments be reviewed as part of the unit's routine clinical governance function.

## *Key Recommendations* for INTERVENTIONAL RADIOLOGY CLINICAL GOVERNANCE, QUALITY ASSURANCE AND PATIENT SAFETY

**13.** A national radiology office should be established with a national IR consultant clinical lead to deal with IR matters. The IR lead, together with other stakeholders and the National Radiology Quality Improvement Programme, should devise a relevant plan for quality assurance and audit in IR.

# 7. Technology and Innovation



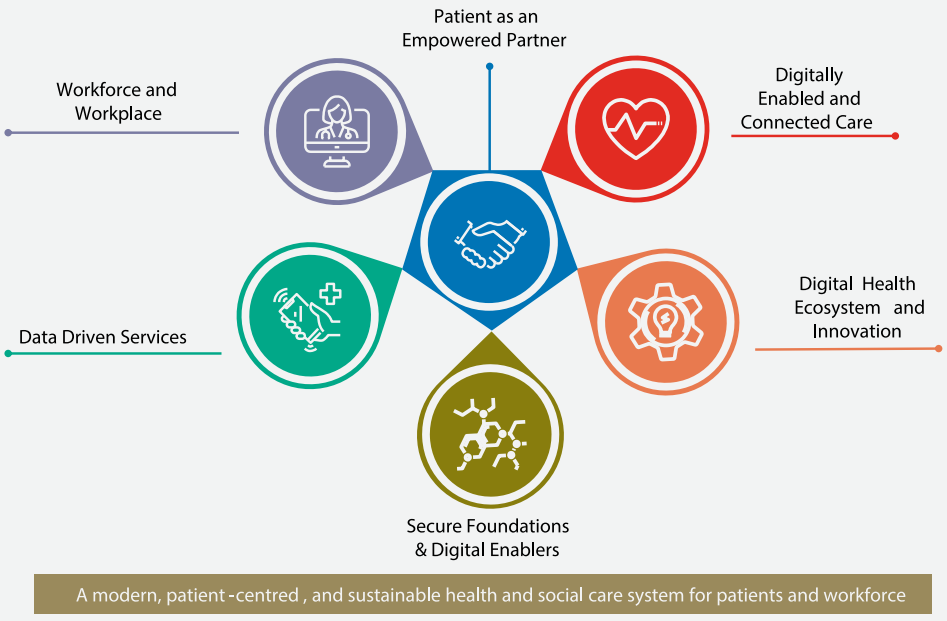
# 7. Technology and Innovation



Digital health is fundamental to supporting the health service in delivering universal healthcare; planning for the population's health needs; building integrated care models; and ensuring safety, quality and sustainability in delivering health services. Digital health is also key to transforming the delivery of improved health outcomes for all our population and the care experience of our patients. *Digital for Care - A Digital Health Framework for Ireland 2024-2030* [85] sets out a clear ambition for the future of digital health in Ireland. Such a future harnesses the power of data, digital technology and innovation in order to expand access to health and social care services, provide improved affordable and equitable care, allow better patient safety, and achieve greater productivity.

Digital solutions are key to increasing efficiency and controlling expenditure to derive the very best value from limited resources and ensure that healthcare staff are equipped with modern digital tools to deliver better, safer care for the benefit of both staff and patients. The six principles that underpin the vision for Digital for Care in Ireland are depicted in *Figure 18*.

*Figure 18* THE SIX PRINCIPLES THAT UNDERPIN THE VISION FOR DIGITAL HEALTH IN IRELAND




*Source: Digital for Care - A Digital Health Framework for Ireland 2024-2030*

Sharing the collective vision of the Department of Health and the Health Service Executive (HSE) in relation to the digital health agenda, the recommendations in this chapter of the Model of Care aim to coordinate, streamline and integrate digital technologies in order to ensure that data and information flow to support the provision of comprehensive care to interventional radiology (IR) patients across all settings.

In addition to the Digital Health Framework, this Model of Care aligns with the priority areas and principles of national health strategies, including Sláintecare, the Health Information Bill 2024, *Connecting Government 2030: A Digital and ICT Strategy for Ireland's Public Service*, and the European Union's commitment to transform and deliver digital health services by 2030 in line with the Digital Decade policy.

## 7.1 Information System for Interventional Radiology

A robust information system is a necessity for IR, as with any other clinical specialty, and will help to increase the quality and efficiency of IR healthcare delivery. Components of such a system will include:

- a full national digital imaging platform (currently, the National Integrated Medical Imaging System (NIMIS) is used by 85% of Model 3 and Model 4 hospitals);
- interfaces with existing hospital management systems and, in future, the recommended national registry for IR;
- full integration with national digital health initiatives (both completed and in progress), including the Electronic Health Record (EHR), eReferrals and ePrescribing;
- a real-time electronic IR stock management system; and
- robust local information technology support.

The benefits of implementing an information system for IR will include the following:

- Having a single source of patient clinical data, lab results and imaging data will reduce errors from poor communication arising from either verbal or written referrals.
- Second opinions on IR cases nationally will be more easily and efficiently provided with access to all patient data.
- Seamless continuity of care will be feasible within health regions and nationally
- Distribution of IR patient care pathways will be facilitated quickly and efficiently
- Coding for IR procedures will be more easily accomplished (IR procedures are currently not recorded).
- ePrescribing will allow interventional radiologists to write and send prescriptions to the patient's designated pharmacy.
- Patient information (pre- and post-procedure) can be digitally provided to patients in different languages.
- Electronic referral pathways can be created from general practices, community services and Model 2 or 3 hospitals.
- The ability to seamlessly upload data to the recommended national IR registry will ease the burden of data collection.
- An electronic solution for the stock management of devices across IR services will reduce costs, eliminate stock duplication and facilitate critical device access across hub hospitals.

## 7.2 Innovation and Communication

IR units need a device stock management system that allows local and national review of stock management and emergent devices.

IR planning and triage of cases is facilitated by access to computed tomography (CT) imaging, magnetic resonance imaging (MRI) and ultrasound imaging. Across the proposed hub and spoke networks, there should be universal access to imaging and a picture archiving and communication system (PACS). All network organisations should use compatible systems through the national PACS (i.e. (NIMIS)) or mobile PACS viewers (on mobile phones and tablet devices) and networked mobile patient record systems in order to facilitate the triage of cases.

A quality platform and a registry platform for recording complications and procedure numbers is needed. IR registries form part of the quality assurance system and require

development. National Quality Assurance and Improvement System (NQAIS-Radiology) data need to be entered for IR departments. Data collection and entry must be resourced by the health region in which the IR unit is sited. The collection and entry of data will be the responsibility of specific data managers assigned to the IR department.

In discussion with the HSE, a modified Hospital In-Patient Enquiry (HIPE) system needs to be developed to reflect the services provided by IR. Health regions that provide IR services should be acknowledged by activity-based funding. The NCP IR is actively engaging with the HSE HIPE team to progress this.



## 7.3 Artificial Intelligence and Interventional Radiology

The artificial intelligence (AI) landscape is rapidly evolving and changing, and many AI tools are commercially available, with few guidelines as to whether they are appropriate or will provide value to healthcare services. However, there is no doubt that the ways in which all procedure-based specialties deliver care to patients will be profoundly changed by AI developments that are rigorously tested and clinically validated. It is also imperative that Irish consultants collaborate with industry to develop AI programmes that will be of benefit to patients and the health service.

The potential benefits of AI in the field of IR include:

- appropriate patient selection based on patient imaging, eChart and literature review;
- the generation of procedure-specific consent forms;
- automatic patient preparation, with alerts only if all labs or other safety checklist parameters are not complete;
- procedure planning and augmented treatment simulation;
- the prediction of treatment response for each patient based on trial data and patient suitability;
- the prediction of complications in real time so that the technique can be adjusted;
- the potential to provide CT or MRI image fusion during procedures;
- the optimisation of IR fluoroscopy units in order to limit radiation exposure to patients and staff;
- AI-generated automatic, procedure-specific imaging follow-up;
- patient follow-up by chatbots for some standard procedures;
- remote smart monitoring of post-procedure patients with an alert triggering when the operator is required
- stock tracking with automatic ordering when stocks are low; and
- the potential to control remote robotic equipment to perform procedures in remote areas.

While some of these AI technologies have been developed and are undergoing validation, many are still in development, but there is no doubt that the landscape of invasive medicine will change dramatically in the next 30–50 years. IR involvement in AI solutions is imperative in designing clinically relevant tools that can replace or augment the administrative tasks of interventional radiologists so that they can spend more time with patients. AI can significantly enhance evidence-based approaches to treatment and improve safety and efficiency. Engagement with this new and powerful technology is key for IR trainees and consultant interventional radiologists.

# 8. Implementation Plan

# 8. Implementation Plan

This chapter proposes a high-level roadmap to enable the recommendations of this Model of Care (MOC) to be implemented in a phased and integrated way, noting that the responsibility and accountability for the implementation of this MOC lies with the new health regions.

## 8.1 Overarching Principles

This MOC has highlighted several significant risks with the current interventional radiology (IR) service and proposes a way forward to deliver a robust IR service, taking into consideration the six new health regions and the Sláintecare principles of delivering a patient-centred service across community and hospital services and as close to patients' homes as possible. The MOC also prioritises several population health principles, making recommendations on how:

- IR services should be organised and delivered, prioritising equity of access across the country;
- IR workforce requirements for the next 15 years can be achieved to address the looming IR consultant crisis and ensure the long-term sustainability of IR; and
- IR services should be integrated across the health spectrum, including direct referrals from the community, joined-up pathways and formal links with a wide range of acute specialties.
- IR services should be resourced to meet the relative needs of the population of each health region to ensure equity and efficiency.

Key principles underpinning the proposed implementation plan are outlined below.

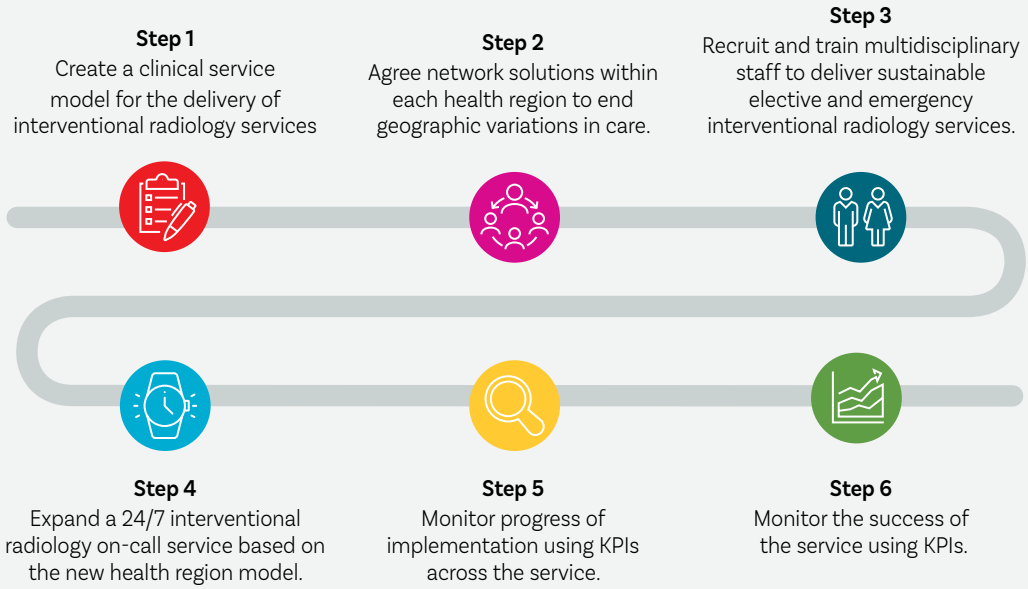
- Patient care pathways and service models should be designed so that all patients requiring IR services have access to timely, expert IR care.
- Regional executive officers (REOs) in each health region should have sufficient authority to ensure that all relevant stakeholders engage in the planning process to deliver the proposed IR service.
- Operational capacity throughout each health region must be sufficiently funded to deliver the necessary care.
- A clear strategy to evaluate the proposed implementation plan will help determine whether the planned objectives are being met.

## 8.2 Critical Success Factors

The implementation of the recommendations of this MOC will not be achieved without buy-in from the Department of Health, HSE and REOs in each region, and sufficient funding to achieve the goals of the MOC. It is recognised that the changes proposed will take some time to implement, but some short-term actions can be taken immediately with committed funding that will have a significant impact and contribute to the long-term vision for IR. The National Clinical Programme for Interventional Radiology or the proposed National Radiology Office is the most appropriate body to provide leadership advice and management of the

implementation strategy at a national level, including the development of both short- and long-term goals. Some of the items in the proposed plan are listed in *Figure 19*.

*Figure 19* PROPOSED ROADMAP FOR IMPLEMENTATION TO DELIVER THE MODEL OF CARE FOR INTERVENTIONAL RADIOLOGY




## 8.3 Measuring Progress

Monitoring the progress of the implementation of the MOC for IR should include:

- monitoring progress made in each health region against the stated goals of the MOC;
- identifying barriers encountered that require action;
- identifying progress on an annual basis to achieve the goals of the MOC; and
- monitoring progress and success against agreed KPIs.

The following are suggested annual KPIs with which to evaluate the impact of the MOC for IR:Disinvestment: number of patients where an IR treatment avoided a theatre event.

1. Disinvestment: inpatient and day-care bed days avoided by IR services.
2. Disinvestment: number of cases directly admitted and discharged from radiology reducing clinical team role in admission and discharge.
3. Time from referral to consultation with IR OPD
4. Consult to procedure time (median days)
5. Waiting time for inpatient and outpatient IR procedures (median days)
6. Technical success rate per procedure type (%)
7. Clinical success rate at 30 days (%)
8. Unplanned return to IR within 30 days (%)
9. Unplanned hospital admission within 30 days post IR procedure
10. 30 days mortality (all cause and procedure related
11. Procedural timeouts/safety checklist compliance (%)
12. Same day discharge rate for day-case patients (%)
13. Number of complications overall and by procedure type (%)
14. Number of complications discussed at morbidity and mortality meetings (%)

The above metrics cannot be measured without significant improvements, in the context of data collection for interventional radiology, to both the Hospital-Inpatient Enquiry (HIPE) system and the National Imaging Management Information System (NIMIS). As outlined in Section 3.2.1, IR activity is not recorded in the HIPE system for national inpatient or day care IR admitting consultants while the NIMIS codes available for IR procedures are limited and do not reflect the nature or complexity of some procedures, or do not cover the scope of IR practice. The NCP is actively working with the HSE HIPE and NIMIS teams to address these issues and this will form an important body of work during the implementation phase.

## 8.4 An Accelerated Implementation Plan for Paediatric Interventional Radiology

Paediatric IR services require an accelerated implementation plan, as follows:

- Paediatric IR needs an implementation committee with representatives from across the National Children's Hospital (NCH) services to deliver an appropriately staffed and structured IR facility and service with the opening of the NCH.
- Making the commitment to provide Paediatric IR procedures at the new NCH will require that the institution provide appropriate infrastructure and resources, including the following:
  - Dedicated consultant paediatric interventional radiologists must be appointed.
  - The work plans of consultant radiologists with a special interest in IR should be amended by agreement to support clinical practice and Paediatric IR provision. Diagnostic paediatric consultant radiologists should be appointed to support this workforce plan.
  - There must be dedicated out-of-theatre elective and emergency anaesthesiology resources to support Paediatric IR.
- Once in place, the Paediatric IR service needs to:
  - define anaesthesiology resources to support Paediatric IR;
  - develop a nurse-led Paediatric IR sedation protocol so that IR procedures can occur out of a theatre environment under the governance of the radiology department;
  - develop a hub-and-spoke framework for access to IR services in cases of paediatric trauma;
  - develop the vascular anomaly service and a multidisciplinary service that includes Paediatric IR; plastic surgery; dermatology; ear, nose and throat (ENT) expertise; and ophthalmology;
  - introduce ablative treatments for the treatment of cancer;
  - deliver the neurointerventional service at the NCH;
  - deliver IR management of renal hypertensive disease in children and obviate the need for children to have to travel to the United Kingdom for management;
  - develop a programme for the multidisciplinary management of head and neck lymphatic malformations (cystic hygroma) with paediatric, fetal medicine, neonatology and ENT teams;
  - develop a strategy to deal with out-of-hours emergencies requiring Paediatric IR; and
  - develop an IR-led nurse vascular access service.

## 8.5 Patient Involvement

During the Implementation phase, the NCP IR recommends that patients be encouraged to become partners in the delivery of high-quality IR care through patient representation at national, regional and hospital level. The NCP IR recommends that hospitals engage with service users in a structured and regular manner and that quality improvement initiatives based on service-user feedback are successfully completed. The NCP IR recommends that IR unit responses to service users' complaints, feedback or compliments be reviewed as part of the unit's routine clinical governance function. Clinical guidelines and protocols will enhance the provision of equitable standards of care for patients in all IR care settings, while patient representatives enhance their development.

## 8.6 Promoting Sustainability and Climate Action

In 2023, the HSE launched its Climate Action Strategy 2023-2050[86], which aims to achieve net-zero emissions by 2050 and provide healthcare that is environmentally and socially sustainable. The NCP IR supports specific consideration of the role that IR can play in achieving this target.

The HSE document provides support, guidance, tools and measures to track improvement.

These are divided into things that can be done:

- When at work;
- When on the move;
- When ordering materials or services;
- In management of water and waste.

It also provides guidance on:

- Healthcare models;
- Adaptation and resilience.

The strategy contains a programme of work to develop a delivery framework for greener healthcare models and to support implementation of the plan to reduce the environmental impact of the models of care deployed, the pharmaceutical products used and the services delivered, while continuing to prioritise patient safety, disease prevention and population health.

To tackle the climate crisis and its far-reaching consequences, there is an environmental imperative to transition all healthcare practice, including IR, to a model that minimises its negative impact on climate change while maintaining the highest standards of care.

The NCP IR strongly supports the strategic objectives of the HSE Climate Action Strategy and the adoption of green initiatives in all IR units.

# ACKNOWLEDGEMENTS

The Model of Care in Interventional Radiology was written by a group of interventional radiologists with a wide geographic representation, and that included board members of the Faculty of Radiologists and Radiation Oncologists, the National Clinical Programme for Interventional Radiology (NCP IR) and the Irish Society of Interventional Radiology. It also included representation from paediatric interventional radiology and neurointerventional radiology.

## Working Group

The Model of Care for Interventional Radiology Working Group was led by Professor Colin Cantwell and was supported by the wider NCP IR Working Group. *Table 20* lists the Working Group membership.

*Table 20* MEMBERSHIP OF THE NATIONAL CLINICAL PROGRAMME FOR INTERVENTIONAL RADIOLOGY WORKING GROUP

| Member | Job Title | Representing |
|---|---|---|
| Prof. Colin Cantwell | Consultant Interventional Radiologist | Faculty of Radiologists and Radiation Oncologists and St Vincent's University Hospital |
| Prof. Michael Lee | Clinical Lead, NCP IR | NCP Interventional Radiology |
| Dr Michael Brassil | Consultant Radiologist | Tallaght University Hospital |
| Dr Matt Crockett | Consultant Neuroradiologist | Neurointerventional Radiology (Beaumont Hospital) |
| Dr Stephen Davitt | Consultant Radiologist | Sligo University Hospital |
| Dr Tony Geoghegan | Consultant Radiologist | Mater Misericordiae University Hospital |
| Dr Siobhan Hoare | Consultant Paediatric Radiologist | Paediatric Interventional Radiology |
| Dr Niall McEniff | Consultant Interventional Radiologist | St James's Hospital |
| Dr Doug Mulholland | Consultant Radiologist | Beaumont Hospital |
| Dr Damien O'Neill | Consultant Interventional Radiologist | Mercy University Hospital |
| Dr Michael O'Reilly | Consultant Radiologist | University Hospital Limerick |
| Prof. Gerry O'Sullivan | Consultant Interventional Radiologist | Galway University Hospital |
| Dr Kevin Pennycooke | Consultant Interventional Radiologist | Connolly Hospital |
| Dr David Rea | Consultant Paediatric Radiologist | Paediatric Interventional Radiology |
| Prof. Anthony Ryan | Consultant Radiologist | University Hospital Waterford |
| Dr Tim Scanlon | Consultant Radiologist | University Hospital Limerick |
| Dr Michael Slattery | Consultant Radiologist | Our Lady of Lourdes Hospital Drogheda |
| Prof. William Torreggiani | Consultant Radiologist | Tallaght University Hospital |
| Dr David Tuite | President, Irish Society of Interventional Radiology and Consultant Interventional Radiologist | Irish Society of Interventional Radiology and Cork University Hospital |

| Member | Job Title | Representing |
|---|---|---|
| Dr Gerry Wyse | Consultant Neuroradiologist | Neurointerventional Radiology (Cork University Hospital) |
| Dr Maureen Flynn | Director of Nursing | Office of the Nursing and Midwifery Services Director, HSE |
| Ms Rosalind Farrell/ Ms Orla Dunlevy | Clinical Nurse Specialist Interventional Radiology | IR Nursing |
| Ms Ann Dolan | Radiology Directorate Manager | Health and Social Care Professionals (Radiography) |
| Ms Eimear Boylan | Clinical Specialist Radiographer | Radiography |
| Prof. Garry Courtney | Clinical Lead, National Acute Medicine Programme | National Acute Medicine Programme |
| Mr Peter Dawson | Consultant Orthopaedic Surgeon | National Clinical Programme for Trauma and Orthopaedic Surgery |
| Dr Michael Dockery | Clinical Lead, National Clinical Programme for Anaesthesia | National Clinical Programme for Anaesthesia |
| Prof. Jennifer Donnelly | Consultant Obstetrician and Gynaecologist | Institute of Obstetricians and Gynaecologists |
| Dr Martina Healy | Clinical Lead, National Clinical Programme for Critical Care | National Clinical Programme for Critical Care |
| Dr Rosa McNamara (previously Dr Gerry McCarthy) | Clinical Lead, Emergency Medicine Programme | Emergency Medicine Programme |
| Ms Bridget Egan (previously Mr Ken Mealy) | Joint Clinical Lead, National Clinical Programme for Surgery | National Clinical Programme for Surgery |
| Mr Keith Synnott | National Clinical Lead for Trauma Services | National Office for Trauma Services |
| **Neuro IR subgroup** | | |
| Dr Matt Crockett | Consultant Neuroradiologist | Neurointerventional Radiology |
| Dr Aidan Hegarty | Consultant Neuroradiologist | Neurointerventional Radiology |
| Dr Patrick Nicholson | Consultant Neuroradiologist | Neurointerventional Radiology |
| Prof. Mohsen Javadpour | Consultant Neurosurgeon | Neurosurgery |
| Prof. Karl Boyle | Consultant Stroke Physician | Stroke Medicine |

The Model of Care was guided by the overarching National Clinical Programme Clinical Advisory Group, the members of which are listed in *Table 21*. which includes the following members:

*Table 21* MEMBERSHIP OF THE NATIONAL CLINICAL PROGRAMME FOR INTERVENTIONAL RADIOLOGY CLINICAL ADVISORY GROUP

| Member | Job Title | Representing |
|---|---|---|
| **Prof. Jerome Coffey (Chair)** | Dean, Faculty of Radiologists and Radiation Oncologists | Faculty of Radiologists and Radiation Oncologists |
| **Prof. Colin Cantwell** | Vice-Dean, Faculty of Radiologists and Radiation Oncologists | Faculty of Radiologists and Radiation Oncologists and St Vincent's University Hospital |
| **Dr Rónán Collins** | National Clinical Lead for Stroke | National Clinical Programme for Stroke |
| **Dr Matt Crockett** | Consultant Neuroradiologist | Neurointerventional Radiology |
| **Ms Ann Dolan** | Radiology Directorate Manager | Health and Social Care Professionals (Radiography) |
| **Ms Bridget Egan** | Joint Clinical Lead, National Clinical Programme for Surgery | National Clinical Programme for Surgery |
| **Dr Maureen Flynn** | Director of Nursing | Office of the Nursing and Midwifery Services Director, HSE |
| **Dr Tony Geoghegan** | Consultant Radiologist | Mater Misericordiae University Hospital |
| **Dr Siobhan Hoare** | Consultant Paediatric Radiologist | Paediatric Interventional Radiology |
| **Mr John Hoey** | Patient Representative | Patients and the Public |
| **Prof. Michael Lee** | Clinical Lead, NCP IR | NCP IR |
| **Dr Aisling Lyons** | Site Lead for Galway University Hospital Paediatrics | Paediatrics |
| **Dr Niall McEniff** | Consultant Interventional Radiologist | St James's Hospital |
| **Dr Doug Mulholland** | Consultant Interventional Radiologist | Beaumont Hospital |
| **Prof. Risteárd Ó Laoide** | National Director, National Cancer Control Programme | National Cancer Control Programme |
| **Dr Michael O'Reilly/ Dr Tim Scanlon** | Consultant Radiologist | University Hospital Limerick |
| **Prof. Gerry O'Sullivan** | Consultant Radiologist | Galway University Hospital |
| **Ms Niamh Shields** | Directorate Nurse Manager | Operational Nursing Management |
| **Mr Keith Synnott** | National Clinical Lead for Trauma Services | National Office for Trauma Services |
| **Ms Sunitha Thomas** | Clinical Nurse Manager (IR) | Operational Nursing Management (IR) |
| **Dr David Tuite** | President, Irish Society of Interventional Radiology and Consultant Interventional Radiologist | Irish Society of Interventional Radiology and Cork University Hospital |

We wish to specially acknowledge the assistance of **Ms Sara Kavanagh**, Programme Manager, NCP for Interventional Radiology.

We would like to express our gratitude to the two patients who shared their powerful IR testimonials for this Model of Care: **Ms Majella Cassidy** and **Mr Danny Kelly**.

We would also like to thank **Mr John Hoey**, patient representative on the NCP IR Clinical Advisory Group, for his time and support.

We would like to thank the following for their support and collaboration: **Dr Deirdre Mulligan**, Office of the Nursing and Midwifery Services Director Workforce Planning Lead; **Ms Sinead Lardner**, National Lead for Safe Nurse Staffing and Skill Mix; **Dr David Mullane**, Co-Chair of the Paediatrics Clinical Advisory Group within the Faculty of Paediatrics; **Dr Fionnuala Ní Aínle**, Clinical Lead for the National Clinical Programme for Venous Thromboembolism; and the Endoscopy Programme team.

We would also like to thank **Dr Tom Pierse** of National Doctors Training and Planning for his expertise and input into the Training and Workforce Planning sections of this document.

Finally, we would like to acknowledge the time and effort of all those involved in collecting and submitting the data used in this Model of Care. This includes IR consultants in Model 4 and Model 3 hospitals; the team in the National Integrated Medical Imaging System; the National Thrombectomy Service; and staff working in hospital data departments.

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# APPENDICES

## 1. Scope of Body and Neuro Interventional Radiology practice and examples of indications in adults (A) and paediatric population (P) and complexity level rating (L).

*Table A* SCOPE OF BODY INTERVENTIONAL RADIOLOGY PRACTICE AND EXAMPLES OF INDICATIONS IN ADULTS (A) AND PAEDIATRIC POPULATION (P) AND COMPLEXITY LEVEL RATING (L).

| Body IR: Adult (A) and Paediatric (P) | |
|---|---|
| **Elective** | **L** |
| Facet joint injection for back pain (A) | 1 |
| Fallopian tube recanalization in infertility (A) | 1 |
| Image guided biopsy of chest, GI, biliary and bone lesions (A,P) | 1 |
| Joint aspiration or injection (A,P) | 1 |
| Airway Interventions (Bronchography and Stenting) (P) | 2 |
| Sclerotherapy and embolisation of vascular malformations (A,P) | 2 |
| Tunnelled pleural and ascites drains for recurrent collections (A) | 2 |
| Tunnelled peritoneal dialysis catheter insertion for renal failure (A,P) | 2 |
| Urologic Interventions (Ureteric stent, PCNL, PUJ/UVJ dilatation) (A,P) | 2 |
| Oesophageal/gastric/duodenal stents for benign or malignant strictures (A,P) | 2 |
| Vascular diagnosis and intervention (A,P) | 2 |
| Balloon retrograde transvenous obliteration of gastric varices (A,P) | 2 |
| Below Knee pedal angioplasty for critical limb ischaemia/diabetic Foot (A) | 2 |
| Biliary stent or drainage for benign or malignant jaundice (A,P) | 2 |
| Chemoembolisation and radioembolisation for liver cancer (A,P) | 2 |
| Endoleak treatments after aortic aneurysm stent graft (A) | 2 |
| Fistuloplasty and stenting for failing AF fistulas needed for dialysis (A,P) | 2 |
| Haemodialysis fistula creation, maintenance and care (A) | 2 |
| Iliac/SFA angioplasty for peripheral arterial disease/critical limb ischaemia (A) | 2 |
| Lymphangiography and thoracic duct embolisation for chyle leaks (A,P) | 2 |
| Percutaneous gastrostomy or de novo gastro jejunostomy placement (A,P) | 2 |
| Preoperative embolisation of tumours to prevent operative haemorrhage (A.P) | 2 |
| Prostate embolisation for benign prostatic hyperplasia (A) | 2 |
| Pulmonary, cerebral, visceral and cutaneous arterio-venous malformation embolisation (A,P) | 2 |
| Radiofrequency/microwave/ cryoablation for cancers of lung, liver, kidney or bone (A,P) | 2 |
| Renal and mesenteric artery stenting (A) | 2 |
| Subclavian artery stenting for arterial occlusion (A) | 2 |
| Uterine artery embolisation for symptomatic fibroids to avoid hysterectomy (A) | 2 |
| Varicocoele embolisation (A,P) | 2 |

| Body IR: Adult (A) and Paediatric (P) | |
|---|---|
| **Elective** | **L** |
| Pelvic vein embolisation in women with pelvic congestion syndrome (A) | 2 |
| Venous interventions for IVC obstruction, Budd Chiari Syndrome (A,P) | 2 |
| Vertebroplasty* for vertebral fracture and pain (A) | 2 |
| Visceral aneurysm repair (A) | 2 |
| **Elective or Emergency** | **L** |
| Gastro-jejunal and gastrostomy feeding tube replacement (A,P) | 1 |
| Fluid collection Drainage procedures (A,P) | 1 |
| Joint aspiration in septic arthritis (A,P) | 1 |
| Large bowel stent for intestinal obstruction (A) | 2 |
| Superior vena cava stent or angioplasty for acute obstructions (A,P) | 2 |
| Abdominal aortic aneurysm endovascular repair (A) | 2 |
| Antegrade ureteric stenting (A,P) | 2 |
| Arterial angioplasty and/or stent Including thrombolysis (A,P) | 2 |
| Arterial-venous fistula thrombolysis (A,P) | 2 |
| Balloon occlusion of uterine arteries or abdominal aorta for placenta accreta spectrum (A) | 2 |
| Biliary drainage/stenting (A,P) | 2 |
| Cerebral angiography as an adjunct test for the diagnosis of brain death. | 2 |
| Coeliac axis block for abdominal pain (A) | 2 |
| Embolisation for epistaxis (A,P) | 2 |
| Iatrogenic pseudoaneurysm thrombosis (A,P) | 2 |
| IVC filter insertion for pulmonary embolus protection (A) | 2 |
| Liver transplant arterial, venous or biliary intervention (A,P) | 2 |
| Nephrostomy insertion (A,P) | 2 |
| Renal transplant ureteric, arterial or venous intervention (A,P) | 2 |
| Thoracic aortic aneurysm endovascular repair (A) | 2 |
| Thrombolysis and thrombectomy for iliofemoral DVT (A,P) | 2 |
| Transjugular intrahepatic portosystemic shunt (TIPS) and variceal embolisation (A,P) | 2 |
| Treatment of complicated type B aortic dissection (A) | 2 |
| Visceral artery stent (A) | 2 |
| **Emergency** | **L** |
| Covered stent for ruptured major artery or vein (A,P) | 2 |
| Embolisation for high flow priapism (A) | 2 |
| Embolisation for iatrogenic haemorrhage (A,P) | 2 |
| Embolisation for massive haemoptysis (A,P) | 2 |
| Embolisation for post-partum haemorrhage (A) | 2 |
| Embolisation for trauma (A,P) | 2 |

| Body IR: Adult (A) and Paediatric (P) | |
|---|---|
| **Elective** | **L** |
| Embolisation for upper and lower gastrointestinal haemorrhage (A,P) | 2 |
| Embolisation of postoperative bleeding (A,P) | 2 |
| Embolisation of severe intra-operative bleeding (A,P) | 2 |
| Stent grafting for aortic transection (A) | 2 |
| Stent grafting of traumatic partial thickness tears of the aorta or dissection (A,P) | 2 |
| Thrombolysis or thrombectomy for acute limb ischemia (A,P) | 2 |
| Thrombolysis or thrombectomy for pulmonary embolus (A,P) | 2 |
| Foreign body retrieval from arteries and veins and body cavity (A,P) | 2 |

**Neuro IR or Body IR procedure*

*Table B* SCOPE OF NEUROINTERVENTIONAL RADIOLOGY PRACTICE IN ADULTS (A) AND PAEDIATRIC POPULATION (P) AND COMPLEXITY LEVEL RATING (L).

| Neuro IR: Adult (A) and Paediatric (P) | |
|---|---|
| **Elective** | **L** |
| Vein of Galen Malformation (VOGMs) (P) | 2 |
| Image guided Lumbar Puncture* | 1 |
| Spinal pain injections* (A,P) | 1 |
| Cerebrospinal fluid (CSF) interventions, therapeutic infusion, diversion, drain insertion*, and treatment of leakage and fistula (A,P) | 2 |
| Dural venous sinus stenting for intracranial hypertension (A,P) | 2 |
| Skull/neck/spine biopsy* (A,P) | 2 |
| Vertebroplasty* (A,P) | 2 |
| **Elective or Emergency** | **L** |
| Cerebral angiography (A) | 2 |
| Carotid stenting for steno-occlusive disease* (A,P) | 2 |
| Endovascular intracranial arteriovenous shunt embolisation (A,P) | 2 |
| Endovascular intracranial aneurysm treatment (A,P) | 2 |
| Epistaxis embolisation* (A,P) | 2 |
| Head and neck tumour embolisation* (A,P) | 2 |
| Middle meningeal artery embolisation for chronic subdural haematoma (A) | 2 |
| **Emergency** | **L** |
| Embolisation/stenting for head and neck vascular trauma* (A,P) | 2 |
| EVT for stroke (arterial) (A,P) | 2 |
| EVT for dural venous sinus thrombosis (A,P) | 2 |

**Neuro IR or Body IR procedure*

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