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# Model of Care for Paediatric Critical Care



**July 2019**

**National Clinical Programme For Critical Care**

## Contents

## 1. FOREWORD

The National Clinical Programme for Critical Care (NCPCC) is part of a National Clinical Programmes initiative that has a mandate to produce Models of Care for Paediatric Critical Care; Adult Anaesthesia; Paediatric Anaesthesia; and Adult Critical Care. This Model of Care for Paediatric Critical Care sets out the care of critically ill and/or critically injured neonates, infants and children presenting to hospitals in the Republic of Ireland (ROI), including the regional (Model 4R), major (Model 3) and local (Model 2) hospitals. Critically ill children may present in emergency departments (EDs), children's assessment units (CAUs) or become critically ill while an inpatient.

Paediatric Critical Care services care for infants and children whose conditions are life-threatening and who need constant, close monitoring and support from equipment and medication to restore and maintain normal body function. Care is provided in specialist Critical Care Units (CCUs) or Paediatric High Dependency Units (PHDUs) that have high levels of trained staff, monitoring capability and equipment in line with national and international standards, such as those produced by the Joint Faculty of Intensive Care Medicine of Ireland (JFICMI) in 2018.

This model of care clearly sets out the surgical and medical services that must be available locally for an adult hospital to care for children who are or have the potential to become critically ill. It also sets out the minimum standards required for critically ill children in the supra-regional (Model 4S) hospitals, including staffing.

We have also agreed, in conjunction with Paediatric Medicine, Adult Critical Care, and Anaesthesia, the recommendations for safe and effective care of children in Model 4R, Model 3 and Model 2 hospitals. This includes agreed local policies on training, staffing and treatment criteria in children requiring HDU care treated locally.

Currently, approximately 1500 children in ROI are admitted each year requiring critical care, according to data produced by PICANet in 2018. There are two Paediatric CCUs in the two supra-regional children's hospitals in the Republic. However, up to 30% of all surgery carried out on children in Ireland takes place in designated adult Model 4R, Model 3 and Model 2 hospitals. A recent audit carried out to estimate the number of children requiring basic or urgent medical critical care management outside of the two children's hospitals clearly outlines the large numbers of children treated at ward and HDU level by paediatricians in the adult hospital setting.

Using agreed current adult hospital classification, we set out to produce a guide to the service and standards required to deliver acceptable levels of care throughout any hospital in Ireland. To date, there had been no clear national agreed classification of Model 4R, Model 3 or Model 2 hospital services with regard to paediatrics. This model of care has a number of key components:

- National agreement on a basic level of critical care (adult and paediatric) Levels 1–3S (JFICMI, 2018).
- Agreement on regional hospital level (Model 4R) regarding regional high dependency care.
- Agreement on a Paediatric Critical Care Medicine (PCCM) delivery framework document for ROI.
- Agreement on a local model of care for ill children at local and regional level with all professional groups involved in the care of children, including Anaesthesia, Adult Critical Care Medicine, Paediatrics, Transport Medicine and PCCM.
- Outline of current and future staffing requirements for doctors, nurses, health and social care professionals in the short, medium and long term with reference to national and international standards.
- Paediatric Critical Care Minimum Data Set (PCCMDS) data submitted to the Paediatric Intensive Care Audit Network (PICANet) from all paediatric critical care providers in Ireland and the United Kingdom (UK). These data are presented each year in the PICANet annual report, which is available online and published annually in the National Audit Report by the National Office of Clinical Audit (NOCA).

The development of a Model of Care for Paediatric Critical Care has taken time, effort and much discussion between all professionals involved in the care of critically ill children. This includes collaboration between Paediatrics, Paediatric Anaesthesia, Adult Anaesthesia and Adult Critical Care, Paediatric Critical Care Nursing and allied health professionals (AHP). I would like to thank all the contributors to this model of care and my colleagues in Paediatric Critical Care, and acknowledge the time and effort involved in producing the document.

Dr Martina Healy

National Clinical Lead for Paediatric Critical Care

# 2. EXECUTIVE SUMMARY

## Introduction

The aim of the Model of Care for Paediatric Critical Care is to set out what is required to establish safe, effective care for all critically ill children requiring Paediatric Critical Care Medicine (PCCM) in the Republic of Ireland. It complements the national Model of Care for Paediatric Anaesthesia;[1] the Model of Care for Paediatrics;[2] the Model of Care for Adult Critical Care;[3] and the Model of Care for Anaesthesiology (Adult).[4]

Guidance on categorisation of hospitals with respect to Paediatrics has been set out based on current provision of services in these hospitals (Paediatric Critical Care Hospital Models Delivery Framework). This model of care provides a clear delivery framework for the care of critically ill children presenting to all hospital settings.

Care of the critically ill child can start at numerous points, e.g. emergency departments, at ward level both within the supra-regional (Model 4S) hospitals and at regional (Model 4R), major (Model 3) or local (Model 2) level. Any hospital receiving or admitting children should adhere to the minimum standards outlined in the national standards documents produced by the Joint Faculty of Intensive Care Medicine of Ireland in 2018.[5]

The National Model of Care for Paediatrics proposes a networked model of care with the new National Children's Hospital (NCH) linked into 3–4 regional centres, which are in turn linked to local Hospital Groups.

## Alignment

This model of care aligns with the published models of care of other National Clinical Programmes, specifically National Clinical Programmes for Paediatrics, Adult and Paediatric Anaesthesia, and Adult Critical Care. The Model of Care for Paediatric Critical Care includes children requiring continuous nursing supervision because of advanced respiratory support, or because of two or more organ systems requiring support, or because of one acute organ failure receiving support, plus one chronic organ failure.

## Governance of Model of Care of Paediatric Critical Care

As part of the Critical Care model, Paediatric Critical Care stands alongside Adult Critical Care under the umbrella of the National Critical Care Programme. This structure has been endorsed by the Joint Faculty of Intensive Care Medicine of Ireland (JFICMI) and the Intensive Care Society of Ireland (ICSI). The models of care for these respective programmes set out the configuration of service delivery and organisational models for the respective services.

## Capacity planning

Part of the remit of the model of care for PCCM is capacity planning for the short and medium term, including the NCH, but also major surge planning in the event of an epidemic or catastrophic event, including a mass casualty event. Major surge capacity planning is outlined by the HSE National Emergency Management Office.

## Planning for the future

The Strategic Plan for Paediatric Critical Care proposes the following:

- Recognition by the Irish Medical Council of PCCM as a standalone specialty
- Creation of a National Paediatric Training Scheme for PCCM
- Expansion of PCCM research capacity
- Delivery of an Advanced Nurse Practitioner Training Programme for PCCM
- Provision of 24/7 critical care outreach – initially within the hospital with a view to expansion (within the NCH)
- Creation of a Respiratory Extracorporeal Life Support (ECLS) Service
- Creation of a Cardiac Ventricular Assist Device (VAD) Programme
- Development of a Cardiac Transplantation Programme in conjunction with CT and Cardiology colleagues
- Enhanced services (including clinics) for long-term follow-up of patients when discharged from Paediatric Critical Care.

## Summary

The Paediatric component of the National Clinical Programme for Critical Care describes the Paediatric Critical Care Hospital Model Delivery Framework, which follows the 2018 National Standards for Paediatric Critical Care Services from the JFICMI. Its sets out agreed national standards for critically ill children in all settings in ROI. Work has taken place at local level with paediatricians, adult

anaesthetists and adult critical care physicians who receive critically ill children at regional and local level, and a strategy agreement reached, whereby children are stabilised locally and transferred on either by the Irish Paediatric Acute Transport Service (IPATS) or local transfer or treated locally in centres that achieve national standards in HDU.[5]

# 3. STRUCTURES AND GOVERNANCE OF PAEDIATRIC CRITICAL CARE SERVICES

## 3.1 Governance of patients admitted to PCCUs in ROI

Patients requiring critical care and high dependency care are admitted into the care of two consultants following admission to the Paediatric Critical Care Unit (PCCU). Specifically, these are a primary consultant in critical care who is responsible for the overall multidisciplinary management of the patient and a primary hospital consultant into whose care this patient will be delivered post-treatment in PCCU. Responsibility and management of care of the acutely ill child will lie with the primary consultant in critical care. This should be reflected in the admission documentation of these patients. Furthermore, these patients should be admitted under a named consultant in critical care, according to international practice. The primary hospital consultant could be a consultant with a subspecialty interest or in general paediatrics.

## 3.2 Consultants with lead responsibility

There should be a nominated clinical lead for PCCM in each unit (currently a nominated medical director) and an overall clinical lead to take responsibility for overall planning and performance of PCC. Both these positions should be for a defined period (e.g. 4 years) and the person should be appointed following nomination and a vote by colleagues. The lead consultant should be supported by consultants with lead responsibility for the following areas:

- Clinical governance
- Audit and data collection
- Research
- Medical education and training
- Organ donation.

## 3.3 National Clinical Programme for Critical Care

The National Clinical Programme for Critical Care (NCPCC) is a key component of the Clinical Strategy and Programmes Division in the Health Service Executive (HSE). Figure 3.1 outlines a model for governance as a network for PCC services in Hospital Groups, while Figure 3.2 outlines the proposed model for governance of the Children's Hospital Group.

Figure 3.1: A model for governance of PCC services in the Hospital Groups Children's Health Ireland

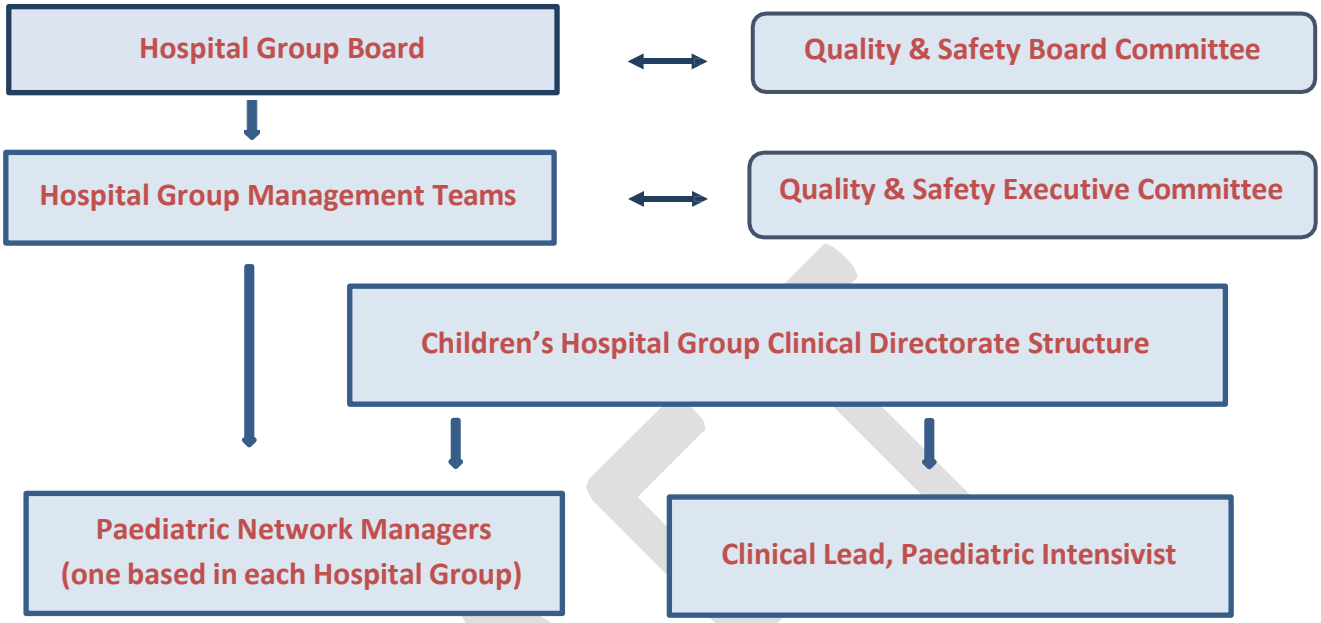
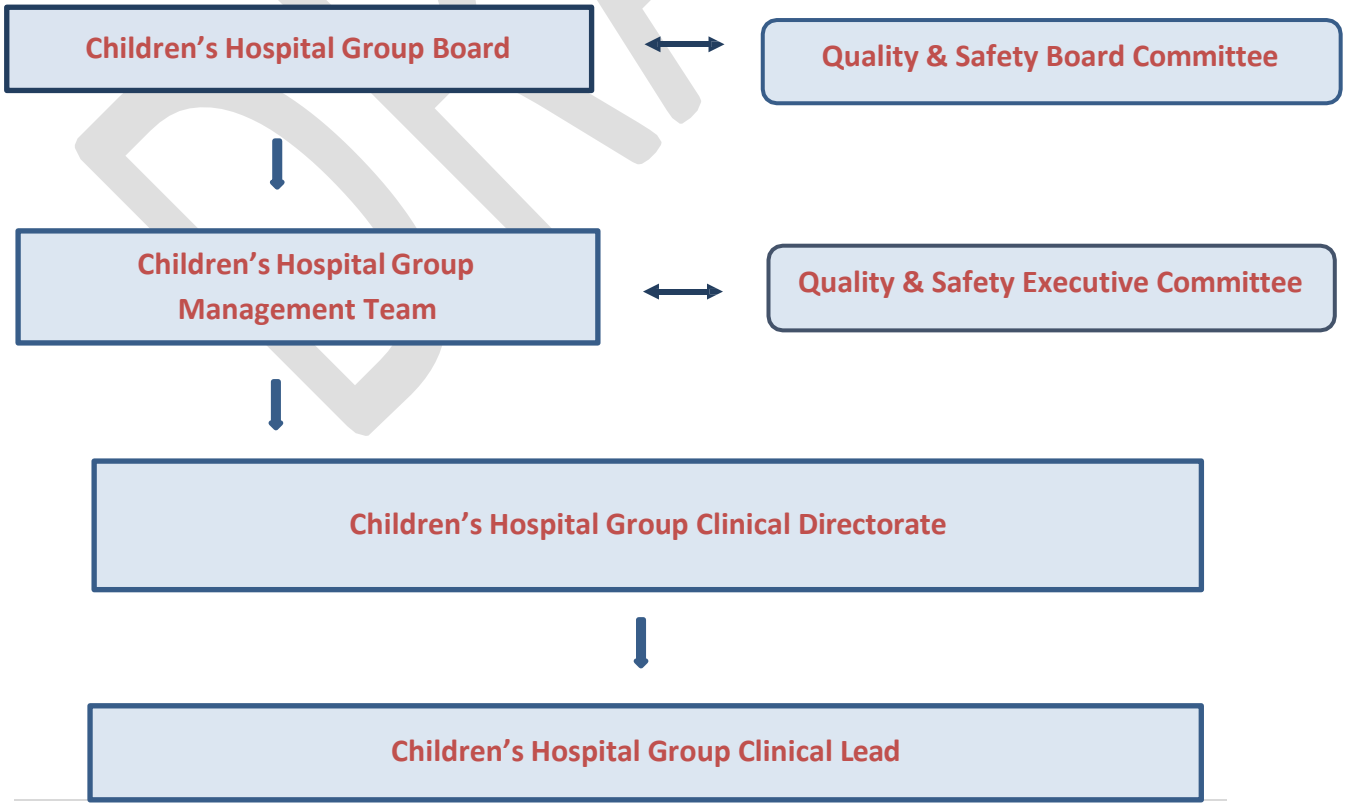



Figure 3.2: Proposed model for governance of the Children's Hospital Group



# 4. PAEDIATRIC CRITICAL CARE

## 4.1 Definition of PCCU

The Paediatric Critical Care Unit (PCCU) is a specialised facility within a children's hospital charged with the care of infants and children, staffed by a specialist team of intensivists, critical care nursing and allied health staff with specialty training in PCCM. The PCCU is designated to provide an increased level of detailed clinical observation, invasive monitoring, focused interventions and technical support to facilitate the care of critically ill paediatric patients over an indefinite period of time.

A PCCU will care for patients that are typically aged between birth and their 16th birthday, diagnosed with life-threatening potentially recoverable conditions; postoperative patients who may benefit from close nursing or technical support; and children with chronic complex medical comorbidities that exceed the capabilities of other clinical care areas within the hospital.

Between the ages of 16 and 18, new patients may be admitted to a paediatric service where there is a clinical indication that they should be treated in a paediatric setting. It is also widely recognised that end-of-life care, including potential organ donation and family bereavement counselling, are skills integral to the care of the critically ill child and are facilitated within the PCCU.

The PCCU team comprises paediatric intensivists, nurses, pharmacists, and allied professions (such as clinical engineering, physiotherapists, dietitians, speech and language therapists, occupational therapists, medical social workers and psychologists) who are certified in and/or have received recognised specialised training particular to their profession in the care of critically ill infants and children. These individuals should deliver care within a PCCU that conforms to agreed guidelines and standards particular to their professional regulatory bodies.

## 4.2 Levels of critical care according to national and international standards

National levels of critical care have been accepted and agreed – from the 2011 National Standards for Adult Critical Care Services.[6] The Joint Faculty of Intensive Care Medicine of Ireland (JFICMI) was established in 2009 and subsequently developed the National Standards for Adult Critical Care. In 2013, National Standards for Paediatric Critical Care were developed by the Paediatric Critical Care Group (PCCG) and endorsed by JFICMI and the Intensive Care Society of Ireland (ICSI),[7] and later updated in 2018.[5]

The term Critical Care Unit (CCU) refers to an HDU or an ICU. The National Standards for Paediatric Critical Care Services 2018 define minimum requirements for an ICU in terms of resourcing, staffing, delivery and governance requirements. The national standards also define minimal facility requirements for critical care delivery.

## 4.3 Definitions of agreed model of levels of PCC

Definitions of the agreed model of levels of PCC, according to National Standards for Paediatric Critical Care Services 2018, are as follows.

### Level 0: Ward-based care

Hospital ward clinical management.

### Level 1: High dependency care requiring a nurse-to-patient ratio of 0.5:1

A discrete area or unit where Level 1 PCC care is delivered. Close monitoring and observation are required but not acute mechanical ventilation.

Patients who require basic respiratory/circulatory/ neurological or renal support whose needs cannot be met on the acute ward and require the input of the critical care team, or in the case of a regional High Dependency Unit (RHDU), the agreed paediatric cover according to the standards.

### Level 1: HDU: RHDU care

In addition to providing enhanced observation and basic system supports, Level 1 RHDUs, due to the availability of subspecialty expertise, may continue to care for those requiring more complex care, such as a continuation of long-term ventilation via tracheostomy or non-invasively. A consensus to care for such patients locally should be reached on a case-by-case basis following early communication with the lead centre.

### Level 2: Critical care requiring a nurse-to-patient ratio of 1:1

A child requiring continuous nursing supervision who is receiving advanced respiratory support (complex non-invasive ventilation or invasive ventilation), according to the 2018 national standards. Level 2 also pertains to the unstable non-intubated child, e.g. the haemodynamically unstable patient requiring invasive cardiovascular monitoring, frequent fluid challenges and vasoactive drug infusions. A child meeting Level 2 criteria should be treated within a PCCM lead centre, except in a case where

it is agreed between the regional and lead centre consultants that the child can be safely cared for locally.

### Level 3: Critical care requiring a nurse-to-patient ratio of 1:1

The critically ill child with two or more organ failures, requiring intensive supervision, who needs additional complex therapeutic procedures. For example, patients requiring respiratory support, patients with multiple organ failure requiring vasoactive and inotropic medications, and postoperative patients requiring ventilation and vasoactive medications, such as major abdominal surgery or paediatric scoliosis surgery.

### Level 3S: Critical care requiring a nurse-to-patient ratio of 2:1

The critically ill child requiring the most intensive therapeutic interventions, e.g. paediatric cardiac critical care, including ECLS, and/or paediatric renal replacement therapy (RRT) and paediatric neurosurgical critical care. These criteria may change with advances in technology.

### Levels 1–3S in supra-regional hospitals – National Children's Hospital

The minimal facility requirements for critical care delivery are:

- 1:1 nurse/patient ratio for Level 3 critically ill patients
- Desirable that consultant sessions be provided by a specialist who is a fellow of JFICMI or is trained to a level that allows accreditation, according to National Standards for Paediatric Critical Care Services 2018
- Direct access to continuous renal replacement therapy (CVVH)
- Clinical Microbiology, Radiology, with direct sessional support
- National Critical Care Audit
- Direct sessional support from dietitian, pharmacist and physiotherapist
- Radiology, Laboratory, arterial blood gases and blood bank on call 24/7
- Level 2 Critical Care or greater is only provided at Model 3, Model 4 and Model 4S and not at Model 2 hospitals,[8] in accordance with Adult Critical Care services
- Daily PICM (Paediatric Intensive Care Medicine) consultant sessions committed to PCCU alone.

## 4.4 Current situation of PCC in ROI

Currently, there are two PCCUs in Ireland – Our Lady's Children's Hospital, Crumlin (OLCHC) and Temple Street Children's University Hospital (TSCUH). The total number of beds is 32 between the two sites at present (with 34 PCCU beds at full capacity when staffed) with over 1500 admissions per year. Both units are capable of delivering Level 3 and Level 3S care.

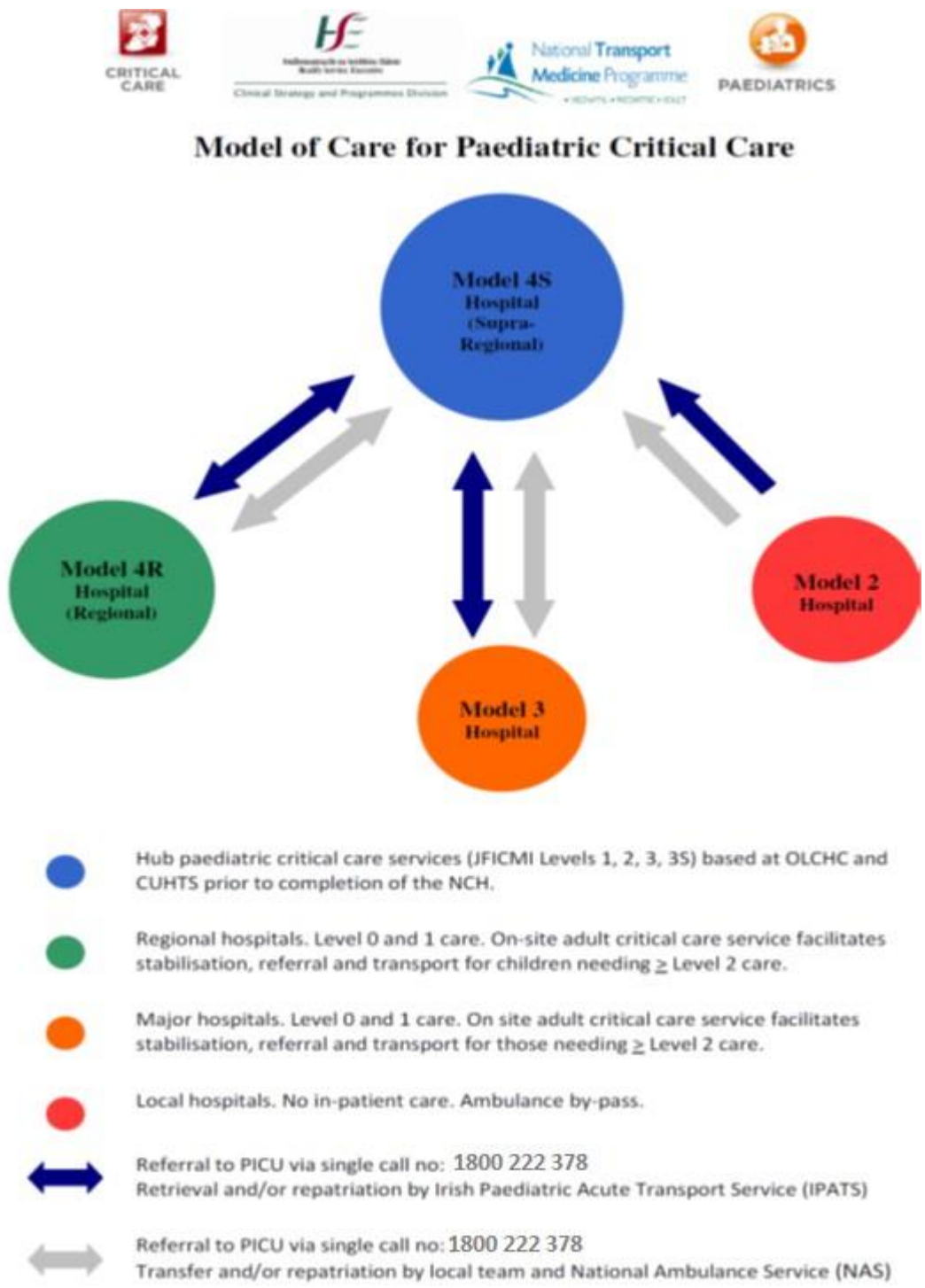
The PCCU can be accessed via the National Paediatric Critical Care Network telephone number 1800 222 378 (1800 ACCEPT) and the website **www.PICU.ie**. Any neonate, infant or child who is critically unwell or has the potential to become critically ill can get access to the PCCU via this number. This will in turn lead to locating an appropriate PCCU bed and advice in resuscitation, stabilisation and transfer of the critically ill child to that appropriate facility. This phone line and advice are available 24/7. Transfer of critically ill neonates up to 6 weeks of age is also available in ROI. This is a 24/7 service carried out by the National Neonatal Transport Programme (NNTP), where greater than 50% of neonatal transports are to PCCU. See Figure 4.1 and Figure 4.2 for the transport pathways in the Model of Care for Paediatric Critical Care.

There is also a cohort of children who are cared for in regional hospitals classified as Level 1 Regional High Dependency – Level 1 RHDU (PRHDUs) (see chapter 6) or in Adult Critical Care Units (ACCUs). We do not currently have concise data on numbers of critically ill children cared for in either ACCU or Level 1 RHDU outside of Dublin. With the investment and rolling out of the Intensive Care National Audit and Research Centre (ICNARC) in Adult Critical Care Medicine (ACCM) and the creation of a national register, we intend to capture all data of children in ACCM.

Validated data from both PCCUs have been collected and submitted annually since 2009 to the Paediatric Intensive Care Audit Network (PICANet). This has allowed both PCCUs to benchmark treatment and outcome data against international PCCUs in the UK and Northern Ireland (NI) (see chapter 7).

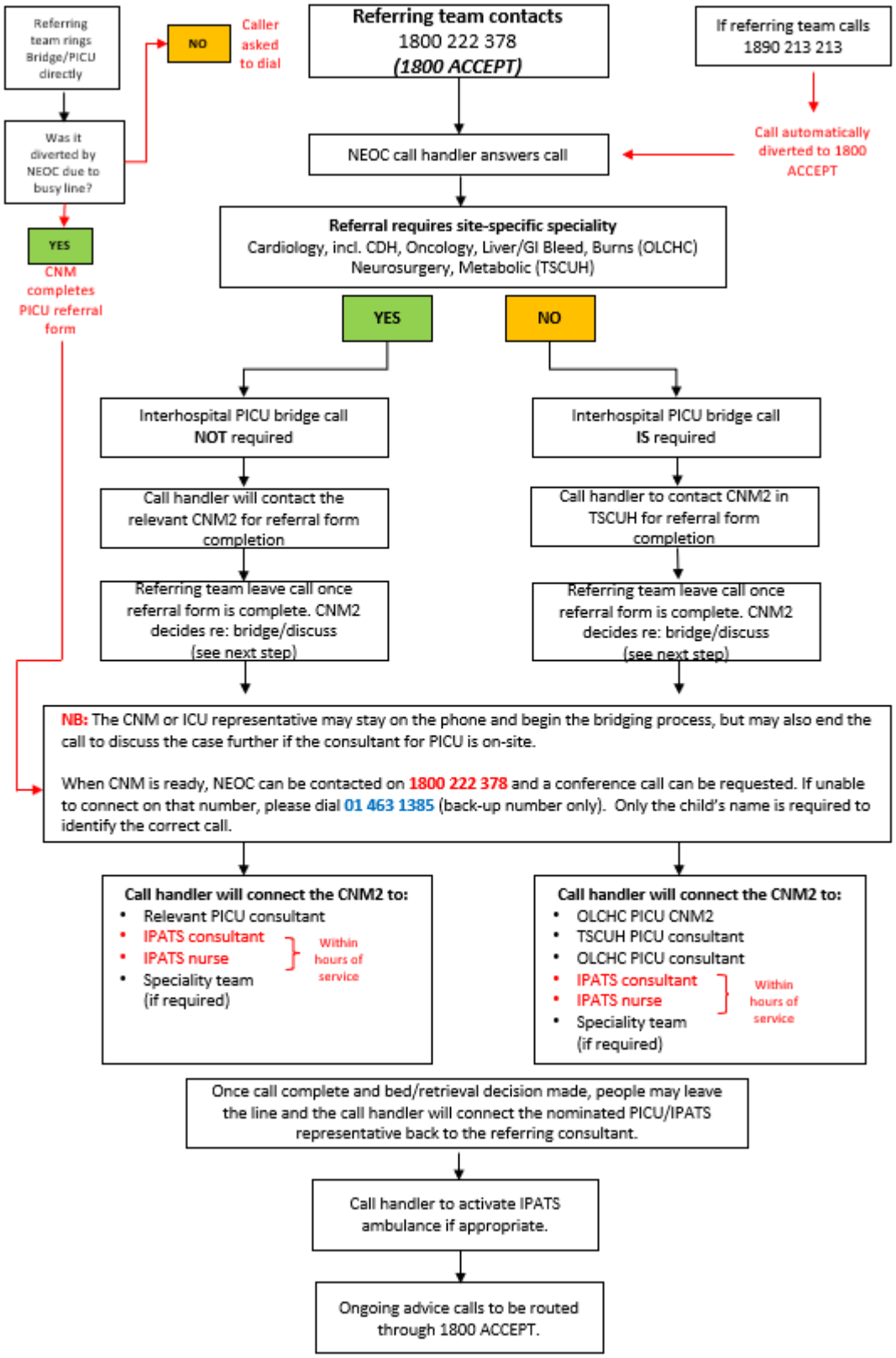
Following consultation with the Irish Paediatric Acute Transport Service (IPATS), Paediatrics and Paediatric and Adult Anaesthesia programmes, recommendations are made in this model of care for the procurement of a bed in supra-regional (Model 4S) PCCU and agreement with local minimum standards for stabilisation and transport of the critically ill child.

**Figure 4.1: Model of Care for Paediatric Critical Care**




Source: *National Standards for Paediatric Critical Care Services, 2018*, p. 4

**Figure 4.2: Model of Care for Paediatric Critical Care transport pathway**



### Alignment of paediatrics with reference to PCCM to Local and Regional hospitals

The framework table in Table 4.1 outlines the categorisation of hospitals in ROI receiving and admitting children at major, regional and supra-regional level. It sets out the minimum level of paediatric services that should be available for a hospital to achieve each of the respective hospital model designations. The framework complies with the JFICMI and ICSI National Standards for Paediatric Critical Care Services.[5]

**Table 4.1: Paediatric Critical Care Hospital Models Delivery Framework**

| **Hospital Model**<br>*Report of the National Acute Medicine Programme* 2010[9] | **Model 2 Hospital** | **Model 3 Hospital** | **Model 4R Hospital (Regional)** | **Model 4S Hospital (Supra-Regional)** |
|---|---|---|---|---|
| **Hanly Report**[10]<br>*Report of the National Task Force on Medical Staffing* 2003 | Local hospital | Major hospital | Regional or university hospital | Children's hospitals |
| **Emergency Department** | x | ✓ | ✓ | ✓ |
| **Paediatric Inpatient Ward Level 0*** | x | ✓ | ✓ | ✓ |
| **Paediatric Inpatient Observation Unit Level 1*** | x | ✓ | ✓ | ✓ |
| **Adult Anaesthesia ICM Level 2 (HDU) / Level 3 (ICU)** | x | ✓ | ✓ | ✓ |
| **Specialised:** Paediatric Anaesthesia / Paediatric Medicine / Paediatric Surgery | x | x | ✓ R | ✓ S |
| **Paediatric HDU Level 1* / Level 1 (RHDU)‡** | x | ✓ Level 1 | ✓ Level 1 RHDU‡ | ✓ S |
| **Paediatric CCU Level 2*/ Level 3*/ Level 3s* (PCCU)** | x | x | x | ✓ |
| **Paediatric Retrieval / PICU.ie† / Referral** | x | x | x | ✓ |

* JFICMI levels of critical care:
**Level 0:** Hospital ward clinical management. **Level 1:** Higher level of observation. **Level 1 HDU:** Active management up to and including continuation of non-invasive ventilation where established. **Regional High Dependency Unit (RHDU):** Requirement for close observation, monitoring or any intervention that cannot be delivered at ward level but does not require treatment or admission to PCCU. **Level 2:** Active management by critical care team to treat and support critically ill patients with primarily single organ failure (e.g. those requiring acute non-invasive ventilation or greater). **Level 3:** Active management by the critical care team to treat and support those with two or more organ failures. **Level 3S:** Level 3 with regional/national service.

† www.PICU.ie; bridge phone: 1800 222 378.

‡ See chapter 7 on Level 1 RHDU.

The local anaesthesia/ICM consultant makes the clinical decision to transfer, as appropriate.

# 5. MANAGEMENT OF CRITICAL CARE IN CHILDREN IN HEALTHCARE FACILITIES WITHOUT DEDICATED PAEDIATRIC FACILITIES

## 5.1 Model 2, Model 3 and Model 4R hospitals

There are clear recommendations in the Model of Care for Paediatric Anaesthesia for hospitals who manage children for anaesthesia and surgery.[1] It is recommended that a policy should be developed and documented jointly by representatives of anaesthesia, surgical and nursing staff and that this document should be reviewed at intervals of five years or less. In the event of a child becoming critically ill, it must be recognised that the initial treatment of paediatric emergencies may be necessary in facilities and under circumstances where paediatric care is not normally provided. In this situation, the child should be transferred to a specialist paediatric centre at the earliest opportunity. A 24/7 bridge phone line – 1800 222 378 – exists for central referral to Model 4S hospitals (www.PICU.ie).

## 5.2 Main recommendations for children undergoing surgery who may require PCC in healthcare facilities without dedicated PCC

In Model 3 and Model 4R hospitals, infants and children may require admission to critical care facilities as a planned part of their care. This can occur, for example, after surgery, due to trauma, an acute illness or extreme prematurity. Paediatric and neonatal intensive care should only be provided in designated units staffed by doctors and nurses with specialised paediatric critical care training.[12,13]

- **Recommendation 1:** Babies, infants and children who are likely to need critical care after surgery should undergo their surgery in a hospital/unit with a designated PCCU/HDU or NICU.[14,15]
- **Recommendation 2:** In the event of a critically ill child presenting to Model 3 or Model 4R hospitals either to ED or as an inpatient, the generalist consultant anaesthetist may be requested to assist in the resuscitation and implementation of critical care. The decision by the anaesthetist to admit to Adult Critical Care (see recommendation below) for a short time or alternatively to transfer out as an emergency should be made in good faith and on good clinical grounds. These decisions are based on the general competency skills of the consultant anaesthetist in the front-line and as such should be respected as the right decision. The competence and skill of the adult generalist anaesthetist in Model 3 and Model 4R hospitals

is recognised and supported by the Model of Care for Paediatric Anaesthesia,[1] the Model of Care for Anaesthesiology,[4] and Model of Care for Adult Critical Care.[3]

- **Recommendation 3:** In all Model 3 and 4R hospitals receiving or admitting infants and children, hospital protocols for the management of critically ill children should be agreed and drawn up. Clinical management of these children in both specialist and non-specialist units will require close cooperation and multidisciplinary teamwork between nurses, paediatricians, surgeons, anaesthetists, intensivists and other relevant clinicians.[16]
- **Recommendation 4:** Local guidelines should be clear on the roles and responsibilities of the multidisciplinary team, including anaesthetic services, as it is important that further stabilisation and management are not left in the sole remit of the anaesthetist.[17,4] In the event of a child becoming unexpectedly ill, there may also be occasions where only a very short period of intensive care is required that does not necessitate transfer to PCCU. This will be based on the clinical judgement of the team caring for the child, possibly in conjunction with input from the PCCU. This is acceptable on the condition that there is a suitable facility within the hospital, such as Adult Critical Care; there are staff with appropriate competencies; and the episode will only last a few hours. If, on subsequent review, the child has not improved or has deteriorated, the initial decision should be re-evaluated and a plan to transfer should be activated (see chapter 12).
- **Recommendation 5:** There should be a nominated lead consultant and nurse within general CCUs who are responsible for the policies and procedures for babies, infants and children when admitted.[18,1]
- **Recommendation 6:** In each hospital providing paediatric services, there should be a nominated clinician responsible for the organisation of paediatric transport. Paediatric emergency transfer teams generally undertake the transfer of critically ill children to specialist centres.[19] However, in some circumstances, such as neurosurgical emergencies, it may be necessary for the referring hospital to provide emergency transfer of a sick child who is intubated and ventilated. In these circumstances, it may be that the most appropriate anaesthetist to accompany the child is a consultant.[20]
- **Recommendation 7:** In Model 3 and Model 4R hospitals, a rota should be in place for senior cover where a senior anaesthetist needs to accompany a critically ill child to a Model 4S hospital.[4] At present, in most Model 3 and Model 4R hospitals, the out-of-hours emergency on-call anaesthesia cover consists of one consultant plus one or two non-consultant hospital

doctors (NCHDs). In these circumstances, the choice of who should accompany a sick child for transfer to a PCCU is particularly difficult. The NCHDs may not be sufficiently experienced or competent in the transfer of a sick child. The consultant is also responsible for all other emergencies in the hospital, which may include an obstetric unit.

The Model of Care for Anaesthesiology recommends that the basic building block of on-call anaesthesia service in Model 3 and Model 4R hospitals is two consultants and two NCHDs out of hours. This flexible unit should allow for the most appropriate member of the team to accompany the sick child without a major detrimental impact on the emergency anaesthesia care available to other patients and areas in the referring hospital.

According to the Model of Care for Paediatric Anaesthesia, the following factors should be taken into account when developing a policy:

- **Age:** Assessment of any borderline cases for suitability for surgery should occur preoperatively through a multidisciplinary preoperative assessment, including surgeons, anaesthetists and paediatricians.
- **Staff training and experience:** In Model 3 hospitals accepting children for surgery, at least one member of the team should have current APLS training. All team members should have up-to-date basic skills for paediatric resuscitation.[11] Each centre, whether ED, ward or theatre, must have a nominated consultant who is responsible for policies and procedures related to emergency care.[15,1]

If children undergo surgery and anaesthesia in a facility that does not have paediatric inpatient facilities, they should have access at all times to a named paediatric consultant with acute care responsibilities.[1,21]

While it is recognised that critical care facilities for children are not available in all hospitals that receive and admit children, facilities for initiating critical care prior to transfer/retrieval to a designated PCCU should be available. This may involve the short-term use of adult critical care intensivists, anaesthetists and local paediatrician expertise. Paediatric resuscitation equipment must be available and maintained wherever children are treated, and staff locally must maintain their skills in a team approach for resuscitation and stabilisation of the critically ill child.[18,1]

An attempt is currently being made by IPATS and Pharmacy to standardise equipment used in resuscitation and stabilisation of critically ill children. For example, recommended ventilators and ET tube sizes according to age, etc.

It is also recommended and currently being agreed that all paediatric infusions be run at standardised concentrations, facilitated by the use of smart-pumps and dosages agreed in advance with the supra-regional centres and paediatric pharmacy (see chapter 17).

# 6. REGIONAL DELIVERY OF PAEDIATRIC HIGH DEPENDENCY CARE – PHDU/LEVEL 1 RHDU IN MODEL 4R HOSPITALS

## 6.1 Background

Considerable progress has been made in delivering intensive care for children in Ireland, including the provision of state-of-the-art PCCUs in Dublin. The previous provision of critical care to a child in an adult CCU in a Model 4R hospital is no longer considered best practice. Once a child is stabilised, there are clear pathways established for the transfer of the child to PCCU. However, ongoing care of the critically ill child outside of PCCU has not progressed to the same degree, with considerable inequity across Ireland in how a child who requires high dependency care (HDC) is managed.

High dependency care is described as a requirement for close observation, monitoring or intervention that cannot be delivered in a normal ward environment, but at the same time does not require admission to CCU.

Currently in ROI, an unknown volume of HDC is being delivered across a wide variety of settings and locations, often with poor information about activity levels and patient outcomes. The same child may be cared for locally within a Model 4R hospital in one part of the country but require transfer to PCCU in another. This may in turn require the child to be transferred out, adding complexity, risk and cost, which is potentially avoidable, and may not be in the best interests of the child.

A key priority is to establish robust collection and reporting of HDC activity data and, through the service specification, achieve standardisation of HDU provision nationally. The introduction of Adult ICU data collection (ICNARC) will include a section on the child in adult CCU and such data will then be shared with PICANet. A similar system of data collection on children in RHDU would be of value and will be included in the list of recommendations for RHDU.

A specific group of children on long-term ventilation (LTV) creates challenges in the current system. The number of patients requiring LTV are increasing, and include infants with severe chronic lung disease associated with prematurity; children with neuromuscular disorders, e.g. spinal muscular atrophy or Duchenne muscular dystrophy; spinal cord injury; severe airway abnormalities; and children with disorders of respiratory drive. Currently, some of these children can remain in PCCU or Transitional Care Unit (TCU) in the supra-regional hospital for months, or even years, awaiting the establishment of a homecare team, housing adaptations and other requirements. During much of this time, they will be stable and could have their care delivered outside of PCCU/TCU (closer to home), if

only Model 4R hospitals had the necessary resources and staff training to care for a child with a tracheostomy on a ventilator. This is rarely possible within the current system.

Furthermore, once home, if a child on LTV becomes unwell and requires hospital admission for antibiotics and physiotherapy, they will frequently require readmission to the national PCCU in Dublin, as there are seldom staff with the correct training and competencies to care for them at a hospital closer to home.

The combination of reducing demand on PCCU/TCU beds by caring for children requiring acute non-invasive ventilation (including CPAP) and children requiring LTV within a HDU environment closer to their home would have a profound impact on PCCU/TCU bed capacity at a national level and at the same time would keep the child and family closer to home.

Currently, there is no ring-fenced additional funding for RHDU activity delivered outside PCCU/TCU, thus providing a disincentive for hospitals and clinicians (both doctors and nurses) to undertake HDU activity.

It is also important to highlight that within a ward environment with limited staff resources, such as a general paediatric ward, diversion of staff resources to deliver HDU level of care can result in a diversion of care away from other patients and may lead to a closure of ward beds, thereby affecting ward capacity.

Without investment in staff and equipment in Model 4R hospitals and significant upskilling of staff to enable them to feel confident to look after these patient groups, it is currently difficult to achieve regional delivery of PHDC. With the provision of staff and resources in line with national and international standards for provision of HDU and the concentration of these sites to a limited number in designated Model 4R hospitals, we could achieve regional delivery of PHDC.

## 6.2 RHDU definitions

Recent guidelines from JFICMI[5,7] have agreed on the following model to describe levels of PCC.

### Level 1: High dependency care requiring a nurse-to-patient ratio of 0.5:1

A discrete area or unit where Level 1 PCC care is delivered. Close monitoring and observation are required but not acute mechanical ventilation. Patients who require basic respiratory/circulatory/ neurological or renal support whose needs cannot be met on the acute ward and require the input of the critical care team.

### Level 1: Regional HDU

In addition to providing enhanced observation and basic system supports, Level 1 RHDUs, due to the availability of subspecialty expertise, may continue to care for those requiring more complex care, such as a continuation of long-term ventilation via tracheostomy or non-invasively. A consensus to care for such patients locally should be reached on a case-by-case basis following early communication with the lead centre.

Examples of Level 1 RHDU would include the child requiring acute non-invasive ventilator support for respiratory failure; the child with diabetic ketoacidosis requiring frequent monitoring of acid base and blood glucose; the child who is ventilated at home via a tracheostomy who requires admission for intravenous antibiotics for an infection; or the child who has undergone complex elective surgery and requires advanced monitoring and pain relief postoperatively. It is anticipated that Level 1 RHDU will not be delivered in every hospital that admits children but will be concentrated in a smaller number of centres.

While the goal should be to deliver Level 1 care outside of PCCUs, it is recognised that there will be situations when it is deemed clinically appropriate for a child requiring Level 1 care to be looked after within a PCCU, rather than in a Level 1 RHDU.

As a minimum, every Level 1 RHDU situated within a Model 4R hospital should be able to deliver acute (and chronic) non-invasive ventilation (both CPAP and bilevel support) and to care for a child with a tracheostomy on LTV.

## 6.3 Conditions appropriate for treatment in Level 1 RHDU in Model 4R hospitals

Broadly, any child requiring close observation, monitoring or intervention that cannot be delivered in a normal ward environment, but at the same time does not require admission to an intensive care unit, should be admitted to the Level 1 RHDU. This could include but is not limited to:

- Upper airway obstruction requiring nebulised adrenaline on two occasions within a six-hour period
- Apnoea – recurrent
- Respiratory distress requiring nasal high flow oxygen therapy
- Respiratory distress requiring non-invasive ventilation, such as CPAP, if available locally
- Severe asthma requiring continuous nebulisers and/or IV bronchodilators
- Diabetic ketoacidosis requiring continuous insulin infusion

- Supraventricular tachycardia responding to medical treatment, such as IV adenosine
- Reduced conscious level (GCS 8–12) requiring hourly (or more frequent) GCS monitoring
- Upper airway obstruction requiring a nasopharyngeal airway
- Long-term ventilation via a tracheostomy presenting with an acute illness but not requiring significant escalation in respiratory support
- Poor perfusion requiring >40 ml/kg volume boluses
- Significant derangement of fluid or electrolytes (e.g. severe hypernatremia) requiring frequent monitoring and adjustment of fluid therapy
- Status epilepticus requiring treatment with two or more anticonvulsants to stop the seizure
- Postoperative care of a child deemed to require close observation and more intensive nursing care and/or pain management
- Postoperative observation of a child after elective tonsillectomy/adenotonsillectomy stratified as severe obstructive sleep apnoea on preoperative oximetry and/or sleep study.

### 6.4 Indications for transfer to Level 3S PCCU

Broadly, any child requiring treatment beyond what can be provided safely in the Level 1 RHDU should be transferred urgently to PCCU. This could include but is not limited to:

- Requirement for intubation and ventilation
- Reduced conscious level (GCS ≤ 8)
- Long-term ventilation via tracheostomy requiring an escalation in ventilator support
- Circulatory failure not improving, despite ≥60 ml/kg volume bolus resuscitation
- Circulatory failure requiring vasoactive infusion
- Temporary external pacing
- Cardiac arrhythmia with cardiovascular instability, unresponsive to medical intervention, such as SVT unresponsive to repeated doses of IV adenosine
- Cardiopulmonary resuscitation within the previous 24 hours
- Failure of two or more systems requiring support
- Acute renal failure requiring dialysis or haemofiltration
- Requirement for invasive arterial monitoring
- Requirement for central venous pressure (CVP) monitoring
- Requirement for intracranial pressure monitoring or external ventricular drain
- Requirement for exchange transfusion

- Requirement for intravenous thrombolysis
- Fulminant liver failure
- Requirement for plasma filtration.

## 6.5 Recommended staffing in Level 1 RHDU in Model 4R hospitals

### Consultants

All children in Level 1 RHDU will be under the care of a named consultant paediatrician. A unit running a Level 1 RHDU must have 24/7 access to a consultant paediatrician on call who can attend the unit within 20 minutes.

While the day-to-day management of children within Level 1 RHDU will be led by paediatricians, a vital role will continue to be played by anaesthetists and general/adult intensivists in multidisciplinary teams, if deterioration occurs. Their experience and knowledge are critical to the overall management of the critically ill child, including assessment, resuscitation, stabilisation and safe transfer. They will continue to provide expert acute airway management, including intubation and invasive ventilation, as part of acute stabilisation should a child require transfer to PCCU. Together with the PCCU receiving team and the transport team, they can provide advice and support to paediatricians in optimising care of the critically ill child within the Model 4R hospital Level 1 RHDU.

Recognising their previous experience, existing consultants working within a centre with a Level 1 RHDU are not expected to undertake additional training but should aim to use CPD opportunities to maintain and enhance their knowledge and skills relevant to PCC, such as completing a recognised paediatric resuscitation course. For example, paediatric life support (PLS) or APLS[22] or have completed an in-house education and training programme covering similar learning outcomes.

### Nursing staff

In a Level 1 unit, there should be a minimum of one nurse on every shift who is directly involved with caring for the critically ill child and who has successfully completed a validated/accredited education and training programme of study addressing all the required PCC skills to Level 1.

All staff should have up-to-date paediatric basic life support (PBLS) training. There should be a minimum of one nurse on every shift who is directly involved with caring for the critically ill child, who has completed a recognised paediatric resuscitation course. For example, PBLS or APLS[22] or have completed an in-house education and training programme covering similar learning outcomes.

According to the current PCCM National Standards 2018, the recommended nurse-to-patient ratio for Level 1 PCCUs should be 0.5:1. In a Level 1 RHDU, this could be influenced by a number of factors, including patient diagnosis and complexity, severity of illness (PEWS score), and nursing skill mix and seniority.

### Continuing professional development for Level 1/RHDU staff

Continuing professional development (CPD) for nurses, trainees and consultants working in RHDU will need to include a focus on appropriate PCC updates and other learning opportunities with standards set and validated by the national PCCU.

### Non-consultant hospital doctor (NCHD)

A unit running a Level 1 PCCU/RHDU must have 24/7 paediatric NCHD in-house cover at registrar level. The registrar must have successfully completed their membership exams (MRCPI Paeds/MRCPCH),[23] or equivalent, or have gained adequate clinical experience while currently sitting their exams. The registrar must have up-to-date advanced resuscitation training (e.g. APLS).

## 6.6 Achieving and maintaining competence and skills/CPD

The proposed training and competency requirements for both nursing and medical staff are consistent with Level 1 RHDU. The requirements for Level 1 RHDUs may be a step up from the current position but are required in order to deliver safe, effective, high-quality care to this patient group. There is recognition that some of the proposed staff competency and training standards may prove challenging to achieve in the immediate term. Rather than dilute down the required standard, it is proposed that hospitals see these targets as developmental and agree on a timescale after which standards should be met.

It will be essential for all staff working in Level 1 RHDU to keep up to date and refresh their knowledge and skills relating to care of the critically ill child. This includes medical staff (paediatric and anaesthetic) supporting the PCCU as part of their on-call commitments. Suitable opportunities might include spending time in another PCC unit to observe practice, undertaking further courses, and attending relevant training events and conferences. Each member of staff should plan their CPD as part of their annual appraisal/personal development plan.

Clinical nurse managers (CNMs) will be responsible for ensuring that suitable educational and training opportunities are available for all staff, including the broader multidisciplinary team, working in the

Level 1 RHDU. This should include the appointment of a PCC nurse educator to support the network. In many instances, this may be linked to the network retrieval/transport service. Consideration should be given to the development of clinical nurse specialist (CNS) and advanced nurse practitioner (ANP) roles in Level 1 RHDUs. Care of the critically ill child in a Model 4R hospital relies on close working across a number of disciplines, including anaesthesia, general/adult CCU and emergency medicine. Specialists from these areas will also require support for their educational and training needs, and should plan relevant CPD as part of their annual appraisal/personal development plan.

### 6.7 Equipment

There should be an alignment of equipment used across all centres providing PCC to children. Particular emphasis should be put on using similar non-invasive ventilation devices and patient interfaces (nasal prongs, face masks, etc.). Guidance on equipment should be provided by the national PCCUs. In conjunction with the National Paediatric Transport Team (IPATS), a plan is currently being put in place that synchronises equipment locally with equipment used by the transport team; for example, an agreed model of ventilator for use in children in emergency situations in all hospitals receiving or admitting children.

### 6.8 Medications

All Model 3 and Model 4R hospitals should have access to the National Paediatric Drug Library on dedicated smart-pumps. This will facilitate the delivery of all IV medications as standard concentration infusions in Level 1 RHDU care as currently in use in both supra-regional paediatric hospitals. A list of medications suitable for use in Level 1 RHDUs should be drawn up by the supra-regional PCCUs, and their associated pharmacy support, in consultation with local clinicians and pharmacy services. Paediatric dosing and administration guidelines, including information on reconstituting and delivering of these medications, should be readily available.

### 6.9 Measurement of activity and outcomes

A robust audit process is needed to record Level 1 RHDU activity, namely to which patients, where it is happening (‘right child, right care, right place’). In addition, the outcome of RHDU episodes must be measured. In order to do this, a national minimum dataset is needed that can capture both activity and outcome, using a standardised tool. This should include indication for admission to the RHDU, pre-existing medical conditions, diagnosis, treatment received, and outcome (discharge, transfer or death).

### 6.10 Audit and governance arrangements

Each centre providing Level 1 RHDU should develop a robust governance structure and monitor performance. The governance structure must ensure that (a) delivery of care and access to treatment is in line with local and nationally agreed protocols, (b) training and audit requirements are met, and c) critical incident reporting occurs. Activity should be formally reviewed on a six-monthly basis, as part of an in-house clinical governance exercise.

Each centre providing Level 1 RHDU will be expected to produce an annual report that describes the activity of the unit and outcomes of all children meeting critical care criteria. This will be presented as part of an educational and training meeting hosted by national PCCUs and attended by all centres providing Level 1 PCCU.

### 6.11 Resources and funding

At present, a significant proportion of activity undertaken in PCCUs could potentially be provided in Level 1 RHDUs in Model 4R hospitals. Funding streams which take into account patient complexity could release important funds from current PCCU funding to support delivery of PCC activities outside of the PCCU. This would need to be agreed at a national level, with an accurate measure of activity and case complexity. Support of this initiative involves recognising that effective delivery of HDC would reduce the burden on PCCUs and at the same time allow delivery of care closer to the child's home.

### 6.12 Summary of key recommendations

1. Support for the initiative to deliver PCC activities outside of the PCCU should involve recognising that effective delivery of HDC to children in Model 4R hospitals in Ireland will reduce the burden on PCCUs in Dublin and at the same time allow delivery of care closer to the child's home. This is not achievable without investment in staff and equipment in Model 4R hospitals and significant upskilling of staff.
2. Staff and resources should be concentrated in a limited number of sites to achieve the initiative – it would not be deliverable across all inpatient sites.
3. A protected funding stream should be generated to align with activity levels, including a case-mix model to capture case complexity. Currently, there is no ring-fenced additional income for PHDU activity delivered outside the PCCU, providing a disincentive for hospitals and clinicians (doctors and nurses) to undertake HDU activity.

4. An agreed model of care should be developed to support the care of children with tracheostomy and long-term ventilation to be cared for in their homes, with input from the community services and supported by the geographically closest Model 4R hospital.
5. PHDU in Model 4R hospitals should be Level 1 RHDU, requiring a nurse-to-patient ratio of 0.5:1 in a discrete area or unit.
6. All children in the Level 1 RHDU should be under the care of a named consultant paediatrician. A unit running a Level 1 RHDU should have 24/7 access to a consultant paediatrician on call who can attend the unit within 20 minutes.
7. While the day-to-day management of children within Level 1 PCCU will be led by paediatricians, anaesthetists should play a vital role in managing the critically ill child by assisting in the assessment, resuscitation, stabilisation and safe transfer.
8. CPD for nurses, trainees and consultants working in PHDUs should include a focus on appropriate updates and other learning opportunities with standards set and validated by the national PCCUs. Rather than dilute down the required standard, hospitals should see these targets as developmental and agree on a timescale after which standards should be met. CNMs should be responsible for ensuring that suitable educational and training opportunities are available for all staff. This should include the appointment of a PCC nurse educator to support the network. Consideration should be given to the development of CNS and ANP roles in Level 1 RHDUs.
9. There should be an alignment of equipment used across all centres providing PCC to children. Particular emphasis should be put on using similar non-invasive ventilation devices and patient interfaces (nasal prongs, face masks, etc.). Guidance on equipment should be provided by the national PCCUs.
10. A list of medications suitable for use in Level 1 RHDUs should be drawn up by the supra-regional PCCUs, and their associated pharmacy support, in consultation with local clinicians and pharmacy services. Paediatric dosing and administration guidelines, including information on reconstituting and delivering of these the medications, should also be readily available.
11. All Model 3 and Model 4R hospitals should have access to the National Paediatric Drug Library on dedicated smart-pumps. This will facilitate the delivery of all IV medications as standard concentration infusions in Level 1 RHDU, as currently in use in both supra-regional paediatric hospitals.
12. A robust audit process should record how much activity is being delivered, to which patients, and where it is happening (‘right child, right care, right place’). This should involve robust

collection and reporting of PHDU activity data using standardised diagnostic and treatment definitions.

13. Each centre providing Level 1 RHDU should develop a governance structure and monitor performance.
14. Each centre providing Level 1 RHDU should produce an annual report that describes the activity of the unit and outcomes of all children meeting critical care criteria. This should be presented as part of an educational and training meeting hosted by national PCCUs and attended by all centres providing Level 1 RHDU.

# 7. CAPACITY PLANNING FOR PCCM IN ROI

## 7.1 Background

Care of critically ill children in ROI is currently in a state of change. In the short term, critically ill children are managed in two supra-regional units in Dublin. With the opening of the National Children's Hospital (NCH), there will be one large PCCU incorporating general and cardiac CCU and a separate neonatal ICU.[24] This model of care pertains to the current patient population that includes premature neonates, infants and children aged less than 16 years. The opening of a separate neonatal CCU in the NCH with separate staffing – both medical and nursing – may alter the patient population in the general PCCU. This has implications for staffing in all sections of PCCU.

Planning for the future includes planning for the short, medium and long term in terms of workforce and bed capacity planning for PCC. This needs to take into account the time period:

1. Up until the opening of the NCH.
2. Beyond the opening and the short to medium term before the opening happens (see chapter 9 on staffing). It is also important that planning is made for future expansion with population expansion taken into account.

Current data from PICANet show that up to 1500 children are cared for annually between both children's hospital CCUs in ROI[25] and an unestablished number in Adult Critical Care.

International data suggest that this number will increase with medical technology and advancement in critical care. We must therefore build into our planning the capacity to increase PCCM beds up to 50%, which is planned for with the opening of NCH beds.

Some children may spend a short period of time in Adult Critical Care while awaiting transport to supra-regional CCU or because their condition is expected to improve quickly. The decision to remain or transfer is the responsibility of the local consultant caring for the patient with liaison to the PCCU team centrally.

There are also a group of children who are ill but who can be looked after locally by Paediatrics with agreed policies for escalation of treatment if required – see chapter 6 on local RHDUs outside of Dublin. These teams should be working together within a PCC delivery framework, including paediatric

transport (IPATS). This network needs to provide the level of service appropriate to the local needs and in line with the quality standards for critically ill children.

However, children needing advanced critical care, i.e. > Level 1 (except in specific designated Level 1 RHDU) should be referred to PCCU via the 24/7 referral service and transferred out as soon as a bed is made available. Treatment of children in ACCUs is not acceptable in the long term and if required should be done in consultation with the central PCCU. All units treating critically ill children should fulfil the quality standards for PCCM.[5] Exceptions can be made in acute, short-term single organ failure, where the decision to remain in Adult Critical Care is taken in conjunction with adult intensivists, paediatrics and in consultation with paediatric critical care network.

## 7.2 Future planning of bed operations

As part of our internal clinical audit and research activities, admissions in OLCHC and TSCUH are manually categorised by the lead PICANet research nurse as General PCCU, Cardiothoracic or Cardiology. This PCCU-only classification is based on a manual review of the primary diagnoses, comorbidities and procedures as coded in our PICANet dataset.

Annual bed days used is taken as the summation of length of stay (sum total LOS) of all those admitted in each calendar year, where length of stay is taken as the integer number of calendar days spanned by the PCCU admission.

### (a) Summary from PICANet (OLCHC and TSCUH combined)

Table 7.1 shows annual admissions and bed days from OLCHC and TSCUH combined.

**Table 7.1: Annual admissions and bed days from OLCHC and TSCUH combined**

| Admissions | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| All admissions | 1483 | 100 | 1540 | 100 | 1609 | 100 | 1595 | 100 | 1509 | 100 | 1417 | 100 | 1419 | 100 | 1493 | 100 | 1453 | 100 |
| General PICU | 979 | 66.01 | 994 | 64.55 | 1091 | 67.81 | 1134 | 71.1 | 1064 | 70.51 | 989 | 69.8 | 958 | 67.51 | 1020 | 68.32 | 1002 | 68.96 |
| Cardiothoracic | 427 | 28.79 | 412 | 26.75 | 391 | 24.3 | 360 | 22.57 | 322 | 21.34 | 332 | 23.43 | 360 | 25.37 | 387 | 25.92 | 373 | 25.67 |
| Cardiac | 77 | 5.19 | 134 | 8.7 | 127 | 7.89 | 101 | 6.33 | 123 | 8.15 | 96 | 6.77 | 101 | 7.12 | 86 | 5.76 | 78 | 5.37 |

| Bed days | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| All admissions | 10103 | 100 | 10061 | 100 | 10599 | 100 | 10663 | 100 | 10903 | 100 | 10226 | 100 | 10432 | 100 | 9669 | 100 | 10120 | 100 |
| General PICU | 5597 | 55.4 | 5680 | 56.46 | 6248 | 58.95 | 6910 | 64.8 | 6950 | 63.74 | 7048 | 68.92 | 6730 | 64.51 | 6166 | 63.77 | 6694 | 66.15 |
| Cardiothoracic | 3870 | 38.31 | 3361 | 33.41 | 3309 | 31.22 | 2942 | 27.59 | 3102 | 28.45 | 2367 | 23.15 | 2668 | 25.58 | 2743 | 28.37 | 2904 | 28.7 |
| Cardiac | 636 | 6.3 | 1020 | 10.14 | 1042 | 9.83 | 811 | 7.61 | 851 | 7.81 | 811 | 7.93 | 1034 | 9.91 | 760 | 7.86 | 522 | 5.16 |

### (b) Future configuration in NCH

The PCCU in the NCH will be configured according to General PCCU (Non-Neonates), General PCCU (Neonates) and all Cardiology/Cardiothoracic. Summary data of current activity are shown in Tables 7.2, 7.3 and 7.4, where it is noted that admissions initially categorised as neonatal will remain so irrespective of length of stay (LOS).

**Table 7.2: General PCCU (non-neonates) current activity**

| General PCCU non-neonates | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| ***OLCHC*** | | | | | | | | | |
| N | 363 | 373 | 443 | 500 | 406 | 415 | 426 | 449 | 459 |
| Sum total LOS | 2062 | 2186 | 2412 | 2946 | 2225 | 2665 | 2765 | 2553 | 2883 |
| ***TSCUH*** | | | | | | | | | |
| N | 361 | 369 | 385 | 366 | 343 | 321 | 280 | 365 | 326 |
| Sum total LOS | 1537 | 1453 | 1642 | 1750 | 1540 | 1508 | 1788 | 2033 | 1751 |
| ***Combined*** | | | | | | | | | |
| N | 724 | 742 | 828 | 866 | 749 | 736 | 706 | 814 | 785 |
| Sum total LOS | 3599 | 3639 | 4054 | 4696 | 3765 | 4173 | 4553 | 4586 | 4634 |

**Table 7.3: General PCCU (neonates) current activity**

| General PCCU neonates | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| ***OLCHC*** | | | | | | | | | |
| N | 127 | 101 | 135 | 131 | 180 | 115 | 154 | 128 | 131 |
| Sum total LOS | 1100 | 1007 | 1309 | 1416 | 2185 | 1582 | 1426 | 1228 | 1518 |
| ***TSCUH*** | | | | | | | | | |
| N | 128 | 151 | 128 | 137 | 135 | 138 | 98 | 78 | 86 |
| Sum total LOS | 898 | 1034 | 885 | 798 | 1000 | 1293 | 751 | 352 | 542 |
| ***Combined*** | | | | | | | | | |
| N | 255 | 252 | 263 | 268 | 315 | 253 | 252 | 206 | 217 |
| Sum total LOS | 1998 | 2041 | 2194 | 2214 | 3185 | 2875 | 2177 | 1580 | 2060 |

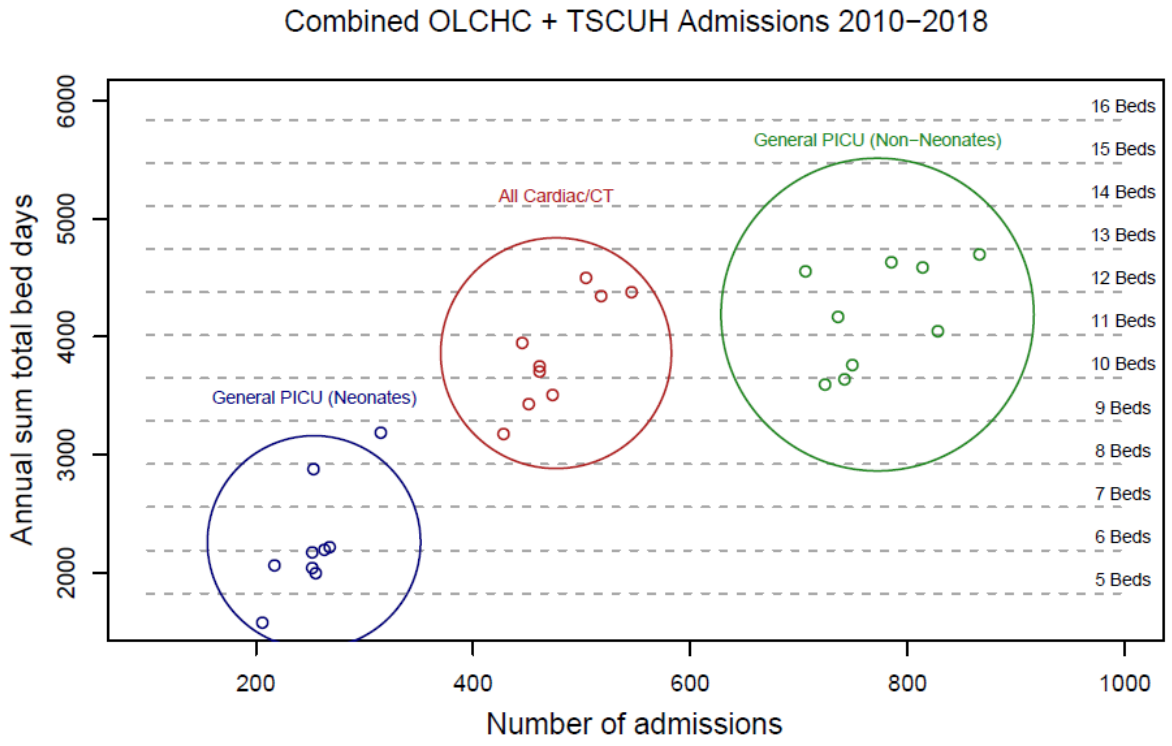
**Table 7.4: Cardiology/Cardiothoracic current activity**

| Cardiology/ Cardiothoracic | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| ***OLCHC*** | | | | | | | | | |
| N | 504 | 546 | 518 | 461 | 445 | 428 | 461 | 473 | 451 |
| Sum total LOS | 4506 | 4381 | 4351 | 3753 | 3953 | 3178 | 3702 | 3503 | 3426 |
| ***TSCUH*** | | | | | | | | | |
| N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sum total LOS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Combined*** | | | | | | | | | |
| N | 504 | 546 | 518 | 461 | 445 | 428 | 461 | 473 | 451 |
| Sum total LOS | 4506 | 4381 | 4351 | 3753 | 3953 | 3178 | 3702 | 3503 | 3426 |

### (c) Current activity combined OLCHC and TSCUH admissions, 2010–2018

Current overall activity is summarised in Figure 7.1, where the horizontal lines represent equivalent annual bed days from *N* beds expressed as *N*365*.

**Figure 7.1: Combined OLCHC and TSCUH admissions 2010–2018**




Source: Local PICANet Database OLCHC and TSCUH

The expression of sum total length of stay in terms of number of annual bed days would assume 100% utilisation of the available bed days. To simulate the PICS standard of 85% occupancy of the available beds, we multiply by a factor increase of (100/85) = 1.18.

Current activity follows from Figure 7.1 as:

- **General PCCU (neonates)**: **250–300** admissions equivalent to 5–8 annual bed days at 100% utilisation and **5.9–9.4** beds at 85% utilisation.
- **General PCCU (non-neonates**): **720–870** admissions equivalent to 9–13 annual bed days; **10.6–15.3** beds at 85% utilisation.
- **Cardiac/CT**: **420–550** admissions equivalent to 8–12 annual bed days; **9.4–14.2** at 85% utilisation.

## 7.3 Capacity planning with respect to PCCU beds in ROI

According to national planning, it is expected that the population of ROI will continue to rise and will in turn mean an increase in neonates, infants and children requiring PCCM. For that reason, the future planning need for PCCU beds must be built into infrastructure, staffing and resources.

The need to plan increased capacity in the NCH is due to:

- Increasing complexity due to developments in medicine and surgery
- Additional future intake from population growth
- Extra cardiac cases from Northern Ireland
- Establishment of the Respiratory ECLS (Extracorporeal Life Support) Programme
- Any transfer of Neonatal ICU/SCBU/HDU activity currently undertaken in maternity units
- Improvement of bed occupancy to 85%, down from current >95%, in some instances.

### Combined OLCHC and TSCUH PCC activity

See Table 7.5 for the combined OLCHC and TSCUH activity, 2010–2018.

### Table 7.5: Combined OLCHC and TSCUH activity, 2010–2018

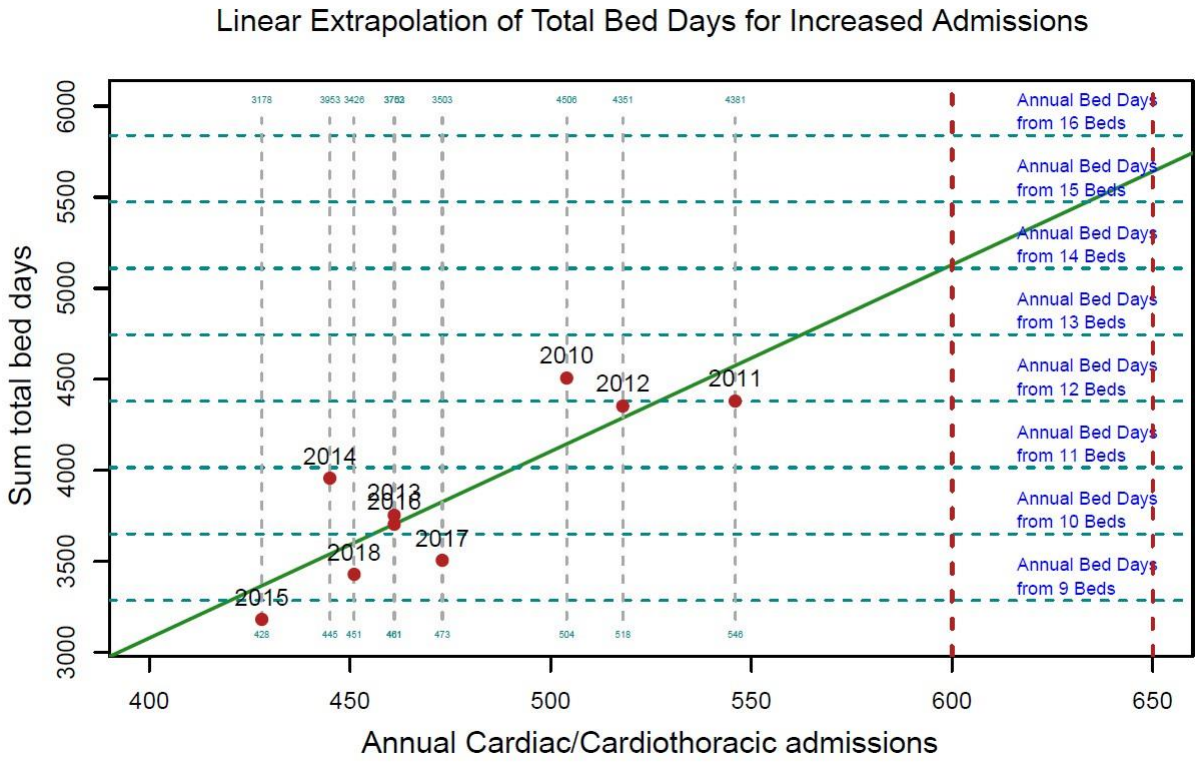
| Category | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| Admissions | 1540 | 1609 | 1595 | 1509 | 1417 | 1419 | 1493 | 1453 |
| *Sex* | | | | | | | | |
| Male | 852 (55%) | 909 (56%) | 868 (54%) | 834 (55%) | 820 (58%) | 801 (56%) | 806 (54%) | 813 (56%) |
| Female | 688 (45%) | 700 (44%) | 727 (46%) | 675 (45%) | 597 (42%) | 618 (44%) | 687 (46%) | 640 (44%) |
| *Age (years)* | | | | | | | | |
| Mean | 2.8 +/– 4.35 | 3.05 +/– 4.47 | 3.37 +/– 4.74 | 3.03 +/– 4.59 | 3.12 +/– 4.51 | 3.08 +/– 4.62 | 3.76 +/– 5.01 | 3.78 +/– 5.02 |
| Median | 0.5 (0–3.8) | 0.8 (0.1–4) | 0.8 (0.1–4.7) | 0.5 (0–4.1) | 0.6 (0.1–4.7) | 0.5 (0–4.1) | 0.9 (0.1–6.2) | 1 (0.1–6.5) |
| *Category of age* | | | | | | | | |
| Neonates (corrected for gestation) | 431 (27.99%) | 423 (26.29%) | 419 (26.27%) | 470 (31.15%) | 398 (28.09%) | 413 (29.11%) | 352 (23.58%) | 348 (23.95%) |
| Age <1 year (excluding neonates) | 469 (30.45%) | 430 (26.72%) | 402 (25.2%) | 386 (25.58%) | 369 (26.04%) | 373 (26.29%) | 396 (26.52%) | 371 (25.53%) |
| Age <1 year (including neonates) | 900 (58.44%) | 853 (53.01%) | 821 (51.47%) | 856 (56.73%) | 767 (54.13%) | 786 (55.39%) | 748 (50.1%) | 719 (49.48%) |
| *Admission source* | | | | | | | | |
| Same hospital | 1092 (70.91%) | 1127 (70.04%) | 1128 (70.72%) | 1061 (70.31%) | 948 (66.9%) | 945 (66.6%) | 1037 (69.46%) | 1025 (70.54%) |
| Other hospital | 448 (29.09%) | 482 (29.96%) | 467 (29.28%) | 448 (29.69%) | 469 (33.1%) | 474 (33.4%) | 456 (30.54%) | 428 (29.46%) |
| *Admission type* | | | | | | | | |
| Planned | 850 (55.19%) | 810 (50.34%) | 763 (47.84%) | 713 (47.25%) | 579 (40.86%) | 515 (36.29%) | 580 (38.85%) | 534 (36.75%) |
| Unplanned | 690 (44.81%) | 799 (49.66%) | 832 (52.16%) | 796 (52.75%) | 838 (59.14%) | 904 (63.71%) | 913 (61.15%) | 919 (63.25%) |
| Following surgery | 695 (45.13%) | 667 (41.45%) | 658 (41.25%) | 630 (41.75%) | 550 (38.81%) | 494 (34.81%) | 593 (39.72%) | 539 (37.1%) |
| Emergency as other hospital and/or unplanned | 882 (57.27%) | 964 (59.91%) | 940 (58.93%) | 912 (60.44%) | 900 (63.51%) | 962 (67.79%) | 966 (64.7%) | 960 (66.07%) |
| *Length of stay (calendar days)* | | | | | | | | |
| Mean | 6.53 +/– 13.24 | 6.59 +/– 11.37 | 6.69 +/– 11.47 | 7.23 +/– 14.06 | 7.22 +/– 14.2 | 7.35 +/– 13.12 | 6.48 +/– 10.68 | 6.96 +/– 9.9 |
| Median | 3 (2–6) | 4 (2–7) | 4 (2–7) | 4 (2–8) | 4 (2–7) | 4 (2–7) | 4 (2–7) | 4 (2–7) |
| Sum total LOS | 10061 | 10599 | 10663 | 10903 | 10226 | 10432 | 9669 | 10119 |
| Maximum LOS | 304 | 224 | 222 | 311 | 312 | 214 | 231 | 109 |
| *Invasive ventilation* | | | | | | | | |
| Requiring invasive ventilation | 983 (63.83%) | 1025 (63.7%) | 975 (61.13%) | 989 (65.54%) | 942 (66.48%) | 916 (64.55%) | 919 (61.55%) | 903 (62.15%) |
| *Duration of invasive ventilation (calendar days)* | | | | | | | | |
| Mean | 6.43 +/– 13.88 | 5.64 +/– 10.57 | 6.05 +/– 12.21 | 6.34 +/– 14.37 | 6.56 +/– 15.45 | 7.2 +/– 14 | 5.51 +/– 8.62 | 6.22 +/– 9.35 |
| Median | 3 (2–6) | 3 (2–6) | 3 (2–6) | 3 (2–6) | 3 (2–6) | 4 (2–7) | 3 (2–6) | 3 (2–7) |
| Sum total days ventilation | 6317 | 5786 | 5898 | 6271 | 6183 | 6598 | 5060 | 5614 |
| Maximum days ventilation | 241 | 213 | 183 | 307 | 312 | 214 | 99 | 104 |
| *Requiring non-invasive ventilation* | | | | | | | | |
| Duration non-invasive ventilation (calendar days) | | | | | | | | |
| Mean | 3.6 +/– 4.47 | 4.44 +/– 5.82 | 3.79 +/– 4.41 | 4.17 +/– 5.57 | 4.45 +/– 5.44 | 3.45 +/– 3.35 | 3.81 +/– 3.78 | 3.9 +/– 4.27 |
| Median | 2 (1–4) | 2 (2–5) | 2 (1–4) | 3 (2–5) | 3 (2–5) | 2 (2–4) | 3 (2–4) | 3 (2–4) |
| Sum total days ventilation | 561 | 1044 | 1180 | 1508 | 1445 | 1185 | 1245 | 1474 |
| Maximum days ventilation | 36 | 46 | 40 | 64 | 54 | 27 | 32 | 41 |
| *Crude mortality* | | | | | | | | |
| RIP at PICU discharge | 83 (5.39%) | 69 (4.29%) | 72 (4.51%) | 82 (5.43%) | 72 (5.08%) | 56 (3.95%) | 60 (4.02%) | 59 (4.06%) |
| RIP at 30-day post discharge | 21 (1.36%) | 25 (1.55%) | 21 (1.32%) | 33 (2.19%) | 28 (1.98%) | 20 (1.41%) | 20 (1.34%) | 22 (1.51%) |
| RIP total | 104 (6.75%) | 94 (5.84%) | 93 (5.83%) | 115 (7.62%) | 100 (7.06%) | 76 (5.36%) | 80 (5.36%) | 81 (5.57%) |

Additional PCCU activity may be considered within the framework of the following linear extrapolations of the current activity data as tabulated in the previous section.

### (a) Current cardiac/cardiothoracic admissions to OLCHC PCCU

Figure 7.2 shows a linear extrapolation of data from 2010 to 2018 of annual bed days, annual patient numbers and annual bed numbers used to facilitate capacity and workforce planning.

**Figure 7.2: Linear extrapolation of total bed days for increased cardiac/cardiothoracic admissions**




Source: Local PICANet database for OLCHC and ICCA

**Admission-based target:**

- Increased intake to ~600 annual admissions indicates 14 beds.
- Factor increase of 1.18 to simulate 85% occupancy = **16.5 beds**.

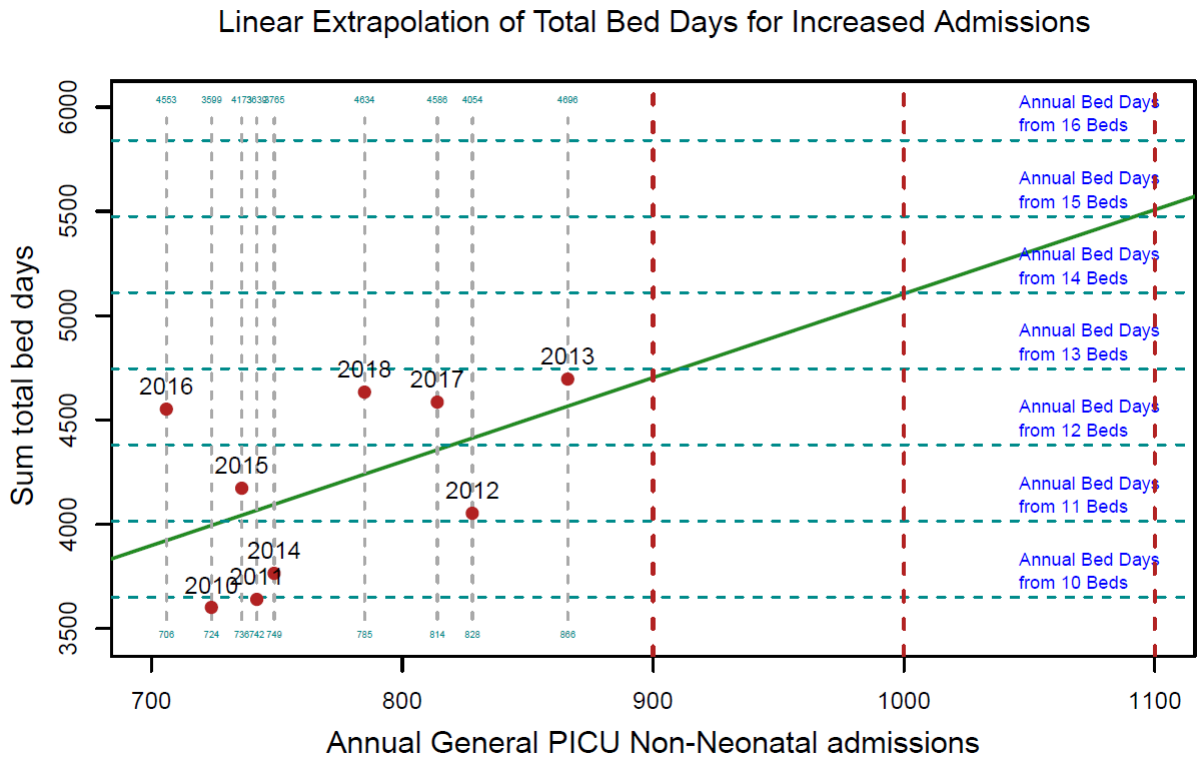
**Bed-based target:**

- 20 beds at 100% utilisation indicates 835 admissions when read from the green line in Figure 7.2.
- 85% utilisation = 17 beds or 720 admissions.

### (b) General PCCU (non-neonates) admissions to OLCHC and TSCUH PCCUs

Figure 7.3 shows a linear extrapolation of data from 2010 to 2018 of annual bed days, annual patient numbers and annual bed numbers used to facilitate capacity and workforce planning.

**Figure 7.3: Linear extrapolation of total bed days for increased general PCCU (non-neonates) admissions**




Source: Local PICANet database for OLCHC and TSCUH combined and ICCA

**Admission-based target:**

- Increased intake to ~1000 annual admissions indicates 14.0 beds.
- Factor increase of 1.18 to simulate 85% occupancy = **16.5 beds**.

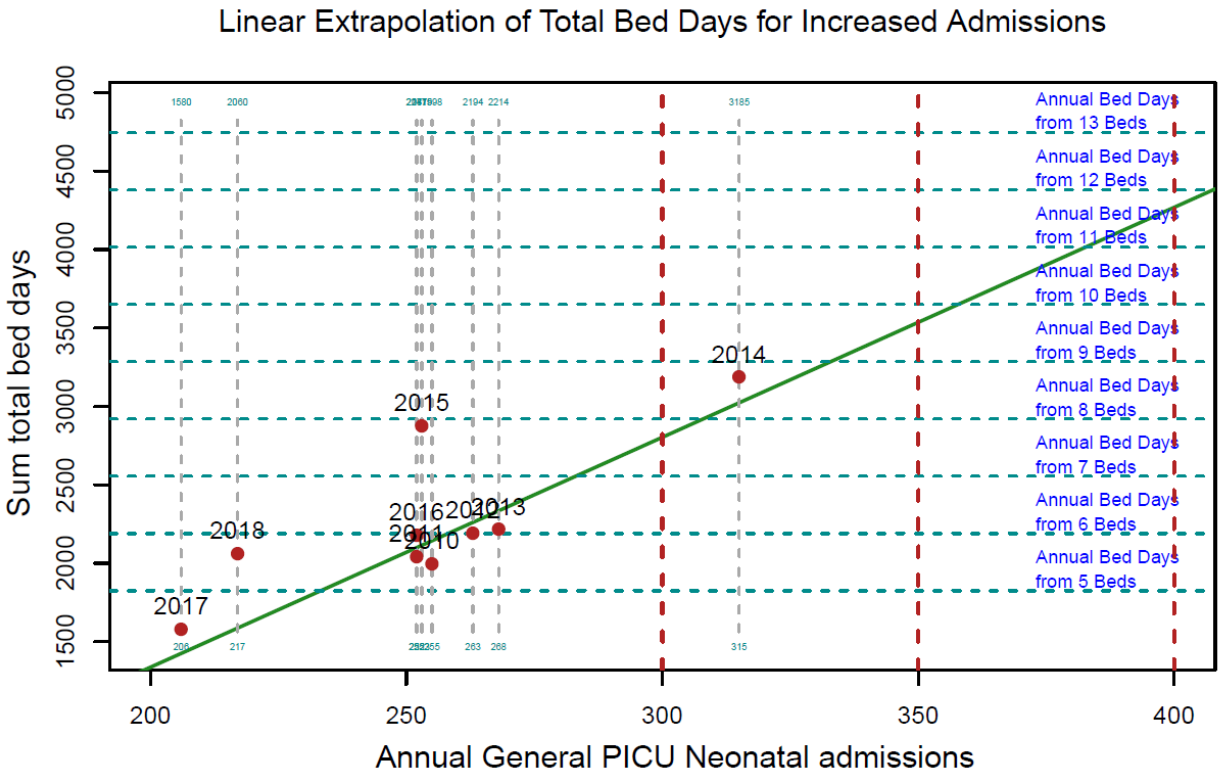
**Bed-based target:**

- 20 beds at 100% utilisation indicates 1350 admissions when read from the green line in Figure 7.3.
- 85% utilisation = 17 beds or 1160 admissions.

### (c) General PCCU (neonates) admissions to OLCHC and TSCUH PCCUs

Figure 7.6 shows a linear extrapolation of data from 2010 to 2018 of annual bed days, annual patient numbers and annual bed numbers used to facilitate capacity and workforce planning.

**Figure 7.6: Linear extrapolation of total bed days for increased general PCCU (neonates) admissions**




Source: Local PICANet database for OLCHC and TSCUH combined and ICCA

**Note:** 2015 and 2018 data points were omitted from the linear regression.

**Admission-based target:**

- Increased intake to ~350 annual admissions indicates 10.5 beds.
- Factor increase of 1.18 to simulate 85% occupancy = **12.4 beds**.

**Bed-based target:**

- 15 beds at 100% utilisation indicates 435 admissions when read from the green line in Figure 7.6.
- 85% utilisation = 12.75 beds or 395 admissions.

# 8. SURGE CAPACITY PLANNING FOR PAEDIATRIC CRITICAL CARE

## 8.1 Background

Paediatric Critical Care is increasingly faced with the challenge of ensuring patients have access to care during intervals when demand exceeds available resources. This challenge is maximised when mass casualty incidents (MCI) or epidemics take place. The American College of Emergency Physicians defines surge capacity as a measurable representation of ability to manage a sudden influx of patients.[26] It depends on a well-functioning incident management system and the variables of space, supplies, staff and any special considerations (e.g. contaminated or contagious patients). It is essential that healthcare systems therefore develop and maintain outpatient and inpatient surge capacity for the triage, treatment and tracking of patients at the hospital or in alternative sites of care or alternative hospitals during outbreaks of infectious disease or exposures to hazardous materials or MCIs.

Furthermore, healthcare facility and system plans should maximise conventional capacity as well as plan for contingency capacity and crisis capacity. Contingency capacity adapts patient care spaces to provide functionally equivalent care, while crisis capacity adapts the level of care provided to the resources available when usual care is impossible.

Surge capacity is developed by expanding existing capacity as well as creating capacity by limiting elective appointments and procedures and practising 'surge discharge' of patients that can be effectively managed in non-hospital environments.[26] For surge capacity planning to be effective, it must integrate facility plans (e.g. in-hospital major incident planning) with a regional disaster response programme that involves other area healthcare institutions and considers hazard vulnerability assessments (HVAs) and historical natural disaster threats. Funding sources should be available for surge capacity planning, training, research, equipment, supplies, oversight, and process improvement at local, regional and national level.

## 8.2 Surge levels

In ROI, surge levels defined by the Critical Care Services Major Surge Planning Committee in July 2011 are:[27]

- **Pre-surge:** Current critical care facility staffed and open capacity.
- **Surge 1:** Opening of all critical care beds irrespective of reasons for current closure.

- **Surge 2:** Acceptance that isolation no longer an option due to patient numbers and cohorting the next best option.
- **Surge 3:** Acceptance that neither isolation nor in-ICU an option. Define potential to provide critical care outside walls of ICU, but in areas of high dependency, e.g. HDUs, special care units, theatre, recovery, and post-anaesthesia care unit (PACU).
- **Surge 4:** Further critical care expansion into non-ICU areas having exhausted above potential. May include theatres, if deemed appropriate, specific wards, etc.

## 8.3 Paediatric MCI PCC template

The Paediatric Critical Care Major Surge Planning Template provides guidance for local major surge capacity planning preparedness, leadership, surge level manpower (training of nursing and medical staff) and potential impact on elective services. A local plan exists for both OLCHC and TSCUH.

The Health Protection Surveillance Centre (HPSC) is provided with and regularly updates enhanced surveillance data on all children admitted to PCCU with severe acute respiratory infections. An agreed combined TSCUH and OLCHC mass critical incident response interim plan will be in place before the opening of the NCH:

- There is agreement with TSCUH and OLCHC that OLCHC will be the designated trauma centre in the event of an MCI.
- PCCU Floor 1 OLCHC will be the designated trauma unit.
- In the event of an incident, PCCU in TSCUH and OLCHC mass critical incident protocol will be triggered.
- All mobile patients in OLCHC PCCU Floor 1 and PCCU (Cardiac) Floor 2 will be transferred to the wards immediately.
- All ventilated patients in OLCHC PCCU Floor 1 will be transferred to PCCU Floor 2 immediately.
- All HDU patients if not fit for wards will be transferred to the TCU.
- All mobile patients in TSCUH PCCU will be transferred to the wards.
- Ventilated patients from OLCHC will be transferred to TSCUH PCCU in consultation with TSCUH PCCU intensivists.
- Surge 1 and 2 medical teams in OLCHC and TSCUH PCCU will be created. These teams should:
    - Have a lead consultant – consultant on call for either unit
    - Have a second PCCU consultant for TSCUH and OLCHC
    - Have eight ICU registrars

- Liaise with Critical Care Network (includes ACCUs and PCCUs), which will be activated in the event of an MCI.

This plan has been agreed in conjunction with the National MCI Working Group and national designated response units in the event of an MCI in ROI. The local plans will obviously change with the opening of a single NCH.

## 8.4 Relevant legislation/policies/health service

- *Critical Care Services Major Surge Planning*[27]
- *Scope of Nursing and Midwifery Practice Framework*[28]
- *Recording Clinical Practice: Professional Guidance*[29]
- *Development and Evaluation of a Toolkit to Support Nurse and Midwife Clinical Competency Determination and Competency Development Planning*[30]

# 9. MEDICAL STAFFING RECOMMENDATION FOR PAEDIATRIC CRITICAL CARE

## 9.1 Background

This section covers two time periods: (1) up to the opening of the NCH and (2) following its opening and beyond. The Model of Care for Paediatric Critical Care sets out the ideal staffing model for the current provision of PCC for children and in the future following the opening of the NCH. Templates and standards for these staffing recommendations are taken from international publications.[31,18,5] It allows for the estimation of future numbers of paediatric intensivists and for the planning of staffing at NCHD and consultant level in PCCU and the establishment of a formal training programme in PCCU.

Previously, the situation regarding PCC was delineated in the DNV report in 2008,[31] an interim report that made 13 recommendations. We are currently at 40% of the recommended staffing levels at NCHD in PCCU. With the setting-up and implementation of both paediatric retrieval and a national training programme for PCC, we are working towards the recognition of PCCM as a subspecialty in the Medical Council, according to Adult and Neonatal Critical Care.

The level of staffing at consultant and NCHD level is difficult to define without a definite date for the full implementation of the European Working Time Directive (EWTD). The anticipated numbers of NCHDs required will need to take into account the increase in numbers if EWTD or shift systems are put in place. There is currently no document available to give guidance on the projected rosters for NCHDs, i.e. 8/10 hour or 18-hour rosters, so specific NCHD numbers required for out-of-hours call is difficult to predict accurately.

The medical staffing numbers suggested below are based on the number of medical staff required to staff the calculated number of CCU beds available based on capacity planning and which fulfil the national standards.[5]

## 9.2 Model of Care: recommendations for medical training and staffing

This model of care describes the ideal model for the provision of safe, effective care to critically ill children. The staffing with respect to PCCM is clearly outlined in section L3-202 of the *Quality Standards for the Care of Critically Ill Children*[18] and in section 4.5 of the *National Standards for Paediatric Critical Care Services*.[5] These outline the training qualifications for:

1. WTE consultants in critical care should have a minimum of two years' experience in an accredited PCCM training programme – of which one year should be in Paediatric Cardiac Critical Care.
2. Consultants with a special interest in PCCM should have a minimum of one year PCCU training in an accredited PCCM programme.

### Consultant in normal daytime hours and out of hours

We recommend that there should be a minimum of one consultant available to the unit per 10–12 PCCU beds in daytime hours and a minimum of one for every 25 beds out of hours, according to the national standards.[5] Units of 16–24 beds should normally have two consultants working on the unit during normal working hours.

### NCHD in normal daytime hours and out of hours

During normal working hours, one trainee should normally be allocated no more than five to six patients. Outside of normal working hours, for every eight beds, we should aim to have one senior trainee available. Although rotas may vary depending on unit size, number of consultants, number of junior staff, length of shifts and implementation of EWTD, the rotas of intensivists and trainees should be organised to maximise continuity of patient care in PCCU. It is desirable to provide for blocks of CCU time for each consultant and, if possible trainee, rather than changing on a daily basis. Further recommendations for staffing of PCCU are available in section 4.5 of the national standards.[5]

## 9.3 Current and recommended bed status and staffing levels

The current and recommended bed status and staffing levels in OLCHC /TSCUH PCCU are set out in Table 9.1.

**Table 9.1: Current and recommended bed status and staffing levels in OLCHC/TSCUH PCCU**

| | OLCHC 2016 | TSCUH | OLCHC + TSCUH | Standards[18,31] |
|---|---|---|---|---|
| **PCCU beds open** | 21–23 | 6–9 | 28–32 | |
| **PCCU capacity** | 25 | 9 | 32 | |
| **WTE PCCU consultants** | 4 | 2 | 8.5 | 12 |
| **WTE Reg/SpR** | 8 | 4 | 12 | 25 |
| **Admissions** | >1100 | >450 | >1500 | |

### Pre-National Children's Hospital

Until the projected opening of the NCH, there will continue to be two PCCUs in Dublin, giving a total of 32 beds with between 28 and 32 currently staffed due to issues with nurse recruitment. Because the two PCCUs are across two sites (OLCHC and TSCUH), this has implications for the staffing model and numbers required to run two units across two sites (see Table 9.1).

Of particular importance is the staffing of the units at NCHD level. With the setting-up and implementation of the PCCM training scheme, this will provide a continuous supply of trainees who will remain in the PCCU over a two-year period and allow further advancement in teaching and research. We will advance and support the current movement of international trainees coming to Dublin as junior and senior fellows.

A fellowship programme has also been agreed with the College of Anaesthesiologists of Ireland (CAI) in the last 3/4 years. Currently, PCCM is recognised for one year specialty training pre-accreditation and one year post-accreditation.

**NCH PCCU staffing:** Based on our current validated PICANet data (from 2009)[32] and allowing for population expansion and the treatment of Belfast cardiac children in ROI, we have created a capacity-modelling diagram that has allowed us to predict PCCU/CCCU bed numbers for the NCH (see Table 9.2).

**Table 9.2: NCH PCCU bed numbers and staffing recommendations (PICS Standards 2010/DNV 2008)**

| | NCH PCCU | NCH CCCU | Total |
|---|---|---|---|
| **Beds** | 20 | 22 | 42 |
| **WTE intensivists** | 8 | 8 | 16 |
| **WTE NCHDs** | 16 | 16 | 32 |
| **24-hour retrieval NCHDs** | +4 | +4 | 40* |
| **Retrieval intensivists** | +2 | +2 | 20† |

* Total NCHDs + Retrieval 24/7.
† Total intensivists.

# 10. PCCU TRAINING PROGRAMME

## 10.1 Background

PCC training, like General/Adult Critical Care in ROI, will be structured as a 'supra-specialty' competency-based training programme. This implies that this supra-speciality training takes place in addition to full accredited training in a base speciality. Currently, these base specialities are Anaesthesiology, Paediatrics, Neonatology, and Emergency Medicine. With supra-speciality training, the knowledge, skills and competencies of the base speciality are focused and built upon so that the training programme is that of a higher specialist training programme. Outlines of the potential pathways from each base speciality are illustrated in Figures 10.1 and 10.2.

**Figure 10.1: PICM training pathway overview with Anaesthesiology as base speciality**

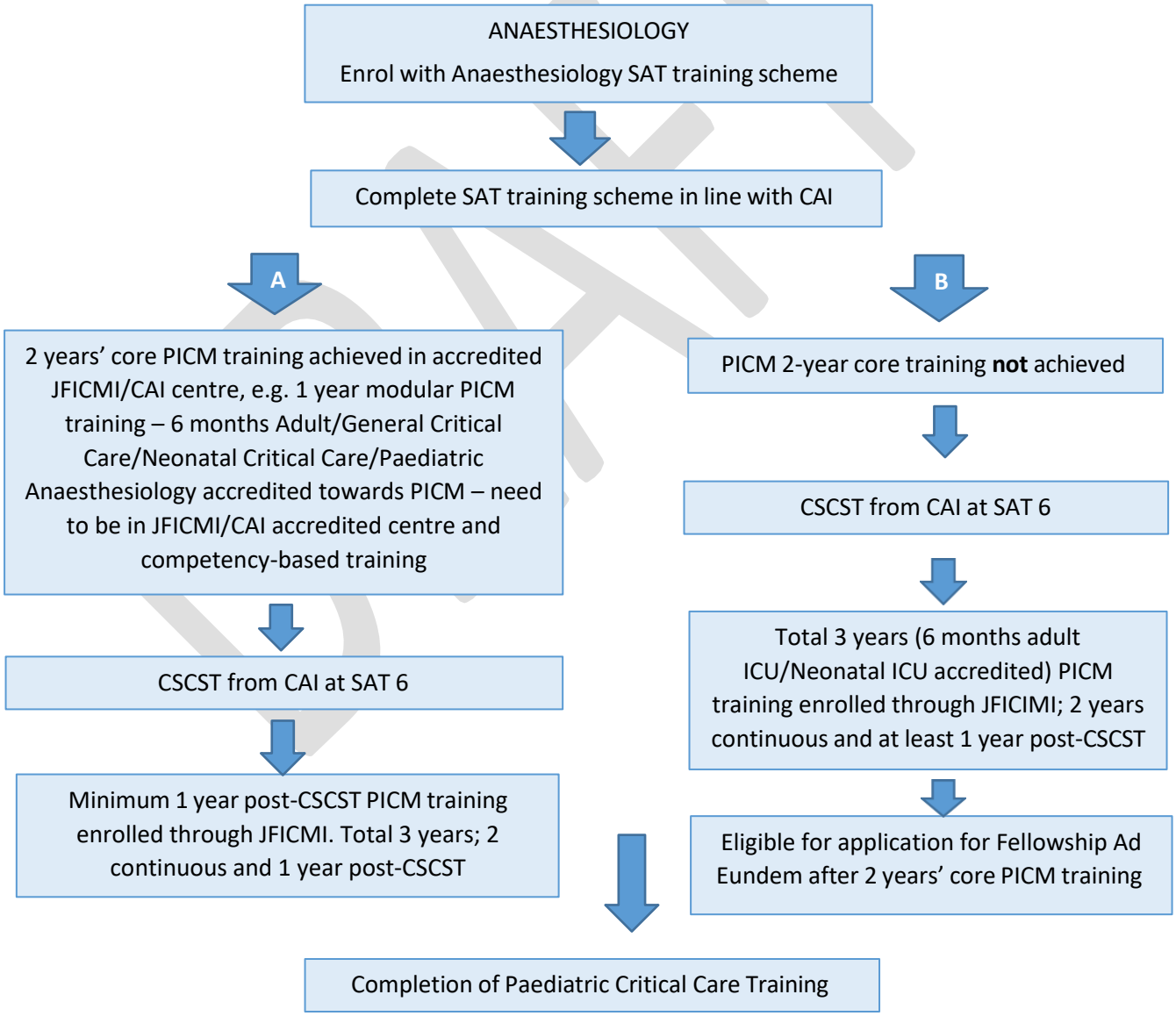
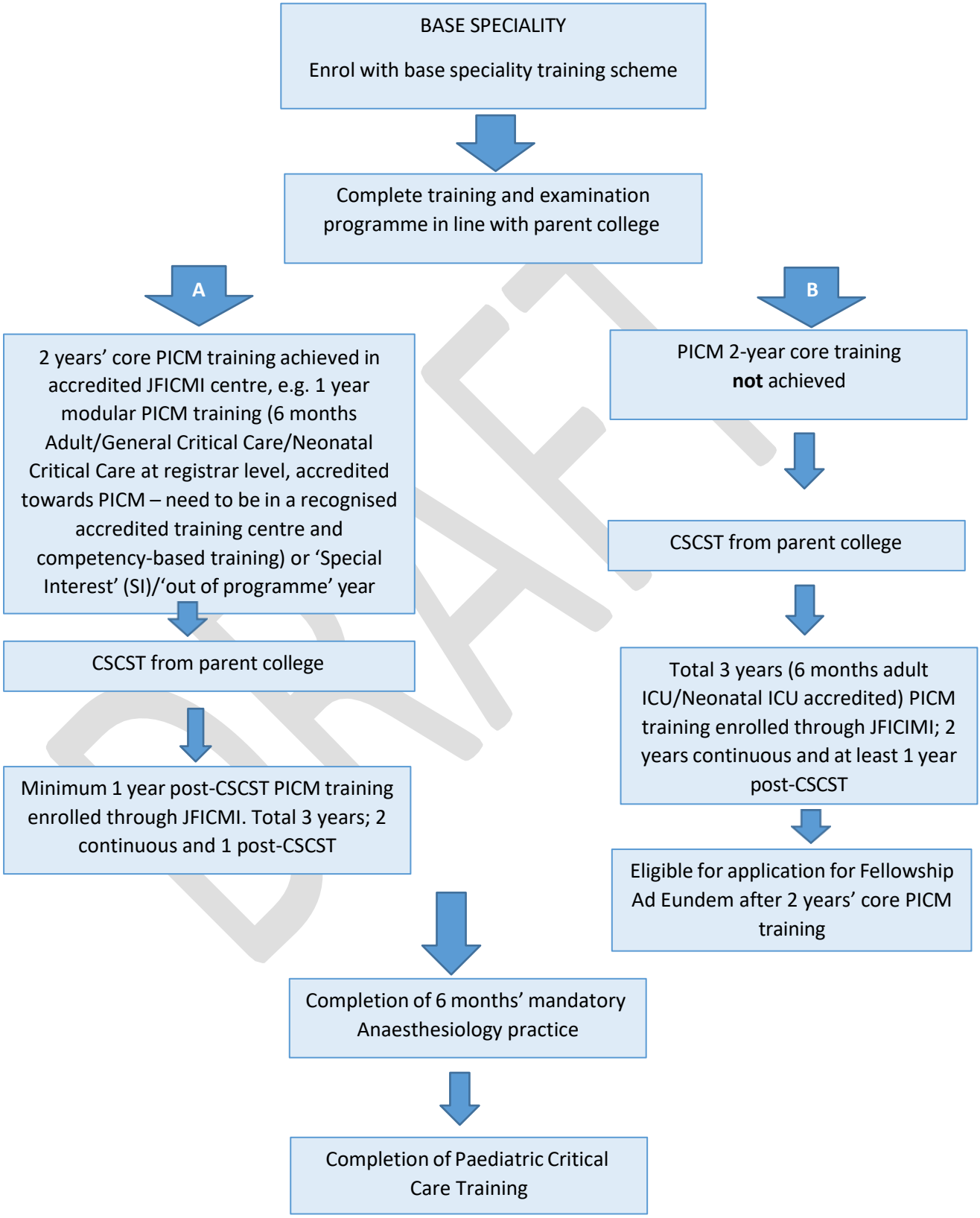


**Figure 10.2: PICM training pathway overview with Paediatrics/Neonatology/Emergency Medicine as base speciality**



## 10.2 Training programme

1. The successful completion of two years of PICM (Paediatric Intensive Care Medicine) training (see Figures 10.1 and 10.2) entails the completion of core PICM training. It allows eligibility, in ROI, for a 'Consultant with a Special Interest in PICM' position and eligibility to apply for a Fellowship Ad Eundem with the Joint Faculty of Intensive Care Medicine of Ireland (see the JFICMI website https://www.anaesthesia.ie/jficmi/jficmi).
2. The successful completion of a pre-approved minimum further specialist year of PICM training will allow dual CSCST (Certificate of Satisfactory Completion of Specialist Training) and accreditation as a completed advanced trainee in PICM and thus eligible for a Consultant in Paediatric Intensive Care Medicine position.
3. The total training time is three years, of which two must be continuous and at least one post-CSCST.
4. Time may be spent in an international centre to address other areas of PICM that are not practised in ROI, e.g. cardiac or liver transplantation.

# 11. STRATEGIC PLAN FOR PAEDIATRIC CRITICAL CARE

## 11.1 Vision of Paediatric Critical Care

The landscape of PCCU is changing. The overall survival rates for children have continued to climb and more children are surviving critical illness than ever before. We also have a growing population of children with significant comorbidities who intermittently require PCCU care and support. Our vision is to ensure the continued growth and development of a world-class critical care service, while ensuring timely access to the appropriate level of care for all the children of Ireland.

Staffing and training is an integral component. This is especially true in the coming years as we combine our services under one hospital and expand our bed capacity. We are establishing a fellowship programme with the Joint Faculty of Intensive Care Medicine, to provide a three-year training pathway for those who wish to receive the highest standards of training and be EWTD compliant. Ongoing recruitment, training and retention of PCCU nursing staff is fundamental. We are looking to establish an Advanced Nurse Practitioner Training Programme within the critical care service in the coming years.

As described in this model of care, the continued development of PHDUs in regional (Model 4R hospitals) will allow many children to remain with their local supports while unwell. We hope to work collaboratively with these centres by providing clinical advice and support as required, as well as delivering training and education opportunities for clinical staff. The expansion of the IPATS service to 24/7 cover will also assist in timely access to the PCCU whenever needed. Within Children's Health Ireland (CHI), we hope to staff a formal PCCU outreach service to provide critical care support to children on the ward. This is to assist in the management of the acutely deteriorating child, as well as supporting those following discharge from PCCU. We hope to further expand our successful cardiothoracic programme and aim to extend the ECLS programme to include respiratory ECLS. We are also exploring the possibility of an Irish Ventricular Assist Device (VAD) Programme.

With our commitment to providing world-class evidence-based intensive care, we wish to consolidate and expand our active research programme. We are looking to establish medical postgraduate research posts, as well as a dedicated research nurse programme. We hope to further expand our collaborative research activity with other leading international research centres, as well as continue centre-led research.

The effect of critical illness on children and their families cannot be underestimated. We are committed to inaugurating any supports that can assist families navigate such a difficult time. We hope to have dedicated psychology support for patients and parents. We are also exploring a family liaison nursing programme that has proved very successful around the world. We aspire to providing further support in the form of a PCCU outpatient follow-up clinic.

### 11.2 Summary of strategic goals for PCC

1. Recognition by the Irish Medical Council of PCCM as a standalone specialty
2. Creation of a National Paediatric Training Scheme for PCCM
3. Expansion of PCCM research capacity
4. Delivery of an Advanced Nurse Practitioner Training Programme for PCCM
5. Provision of 24/7 critical care outreach – initially within the hospital with a view to expansion (within the NCH)
6. Creation of a Respiratory ECLS Service
7. Creation of a Cardiac VAD Programme
8. Development of a Cardiac Transplantation Programme in conjunction with CT and Cardiology colleagues
9. Enhanced services (including clinics) for long-term follow-up of our patients when discharged from PCC.

# 12. PAEDIATRIC RETRIEVAL AND TRANSPORT MEDICINE

The term Retrieval and Transport Medicine refers to the interhospital transfer or pre-hospital transfer of patients with critical illness or life-threatening injuries using specialised expert clinical teams, equipment and transportation platforms. These patients are typically transported to access a higher level of critical care (e.g. high dependency to Level 3 intensive care), specialist care (e.g. Paediatric Intensive Care, Neonatal Therapeutic Cooling) or specialised diagnostics (e.g. Cerebral Angiography). The aim of retrieval medicine is to deliver the same or a higher level of clinical care as that delivered at the point of referral during transport. Patients requiring retrieval can be in the highest patient risk category, as they may not have complete diagnoses or the required therapeutic intervention at the point of presentation and transfer. Therefore, the practice of retrieval and transport medicine must be based on skilled medical expertise, preparedness, risk-averse processes and anticipation that reliably meets patient need in a timely manner.

Paediatric Transport Medicine integrates the specialties and disciplines of Paediatric Critical Care; Adult Critical Care; Anaesthesiology; Emergency Medicine; Acute Surgery; Paediatrics; Neonatology; Nursing; and the National Ambulance Service (NAS). This section describes the governance, clinical coordination, operational tasking, and the standardisation of equipment, training and audit pertaining to paediatric transport and retrieval medicine.

## 12.1 Retrieval/transfer

A national retrieval–transfer system facilitates and advocates a clinical service delivery within supra-regional centres with links to regional hospital paediatric departments.

## 12.2 Retrieval/transport service requirements

In ROI, between 2015 and 2018, there were on average 455 external transfers to the PICUs each year. Specific data are required for future planning but it is likely based on current data that the Critical Care Retrieval services will need to accommodate 450 patients per year to include unplanned and planned paediatric critically ill patient movements.

## 12.3 Governance

This model of care provides a framework within which paediatric transport medicine services will operate. This will lie within the overall structure of Irish PCC services and that of the National Ambulance Service Critical Care Retrieval Services (NASCCRS). The three services of the National

Transport Medicine Programme (NTMP) – MICAS, NNTP and IPATS – are incorporated within the NASCCRS.

NASCCRS became a service under the governance of the NAS in 2018, a model in keeping with similar international services. The service is a discrete clinical directorate within the NAS, drawing clinical staff from partner hospitals and paramedical, emergency medical technician, administrative staff, vehicles and logistical support from the NAS. To ensure that the vision, mission and direction of the service are aligned with patient need and national policy, a National Ambulance Service Critical Care Retrieval and Transport Medicine Advisory Committee has been established. There is also a NASCCRS operational group whose role it is to oversee and plan the operational direction of the services. The NASCCRS Advisory Group and the NASCCRS Operations Management Group set the standards and expectations for the practice of transport medicine.

The clinical directorate has a parallel vertical reporting relationship with the director of the NAS and the National Director of the Acute Hospitals Division. The service is led by a clinical director, overseen by the Advisory Group that oversees the operational, financial, safety and strategic performance of the service. In terms of funding, the service has ring-fenced financial support into the future. The service is tasked with the development of retrieval services in Ireland aligned to patient need, health service configuration and health policy. Regarding staffing, the service will seek the provision of clinical staff and services (e.g. clinical engineering) from partner hospitals through memoranda of understanding with the NAS. The service will continue to act as an educational resource for clinical staff and will provide guidance and leadership on transport medicine standards, policies, protocols and logistics. The clinical lead for paediatrics is a postholder within the structure of the NASCCRS.

## 12.4 Categories of transport team in paediatric critical illness

There are two types of paediatric critical care transport teams: a specialist PCCM transport team and a non-specialist transport team (NSTT).

**Specialist transport teams:** In Ireland, the specialist PCC transport medicine teams operating under the governance of the NASCCRS are known as the Irish Paediatric Acute Transport Service (IPATS) and the Neonatal Transport Programme (NNTP). The NNTP currently provides the majority of patient transport under 4 weeks to the PICUs (see Table 12.1). It is a 24/7, 365 day service and retrieves c.600–700 neonates per year.

**Table 12.1: PICU transport teams, 2017**

| 2017 | OLCHC | TSCUH | Total |
|---|---|---|---|
| **Admissions** | 258 (57.5%) | 191 (42.5%) | 449 (100%) |
| Neonatal <4 weeks/preterm | 138 (53.5%) | 53 (27.7%) | 191 (42.5%) |
| Neonatal >4 weeks | 120 (46.5%) | 138 (72.3%) | 258 (57.5%) |
| **Transport teams** | **Patients <4 weeks** | **Patients >4 weeks** | **Total patients** |
| Total | 191 | 258 | 449 |
| *IPATS* | 3 (1.6%) | 74 (28.7%) | 77 (17.1%) |
| *NNTP* | 156 (81.7%) | 16 (6.2%) | 172 (38.3%) |
| *NISTAR* | 5 (2.6%) | 3 (1.3%) | 8 (1.8%) |
| *RVCH, Belfast* | 2 (1%) | 1 (0.3%) | 3 (0.6%) |
| *NSTT* | 25 (13.1%) | 164 (63.5%) | 189 (42.2%) |

## 12.5 Paediatric retrieval: IPATS – structure

PCC is a centralised model of care delivered by OLCHC and TSCUH, now part of the legal entity called Children's Health Ireland (CHI). There are 400–450 external transfers of critically ill children into PICU annually, of which approximately 200–250 constitute neonatal patients. The IPATS service commenced operations on a pilot basis in October 2014 and provides a Monday to Friday, 10 hours a day service for the transport of critically ill children over 4 weeks corrected gestational age and/or greater than 3.5 kg. IPATS is currently delivered from the PCC services of OLCHC and TSCUH under the stewardship of the NASCCRS, with ambulance support from the NAS and the Saoirse Foundation. This service will form part of a broader initiative to combine the activities of both PICUs, in keeping with the model of care for the Children's Hospital Group.

The current funding envelope for IPATS only allows for a Monday to Friday daytime service, meeting only 30–40% of the demand for a PCC transfer service (outside of that met by NNTP). The target for meeting the service demand is 80–85% of all paediatric transfers (remainder of transfers would be time-critical, thus precluding waiting for the IPATS team to arrive). All paediatric facilities where

undifferentiated paediatric patients present must retain the equipment, designated facilities and competencies to resuscitate, stabilise, package and transfer out critically ill children.

The ongoing development of IPATS to provide a 7-day, 12-hour retrieval and transport service is a prerequisite for the safe operation of the urgent care centres in Blanchardstown and Tallaght, Dublin (to open in 2019 and 2020, respectively), the Paediatric Model of Care and the functioning of the NCH and its networks.

As NASCCRS is a service within the NAS, under the governance of the HSE Acute Hospitals Division, all doctors will report to the national clinical director of the service through the IPATS clinical lead, while engaged on sanctioned transport retrieval services. When the consultant is not engaged in transport retrieval activity, the normal reporting relationships exist (clinical director of base hospitals).

Nurses who are employed by partner hospitals and allocated to work as part of the NASCCRS remain under the clinical governance of their base hospital, reporting to the director of nursing (DON) in that institution. While engaged on NASCCRS duty, the nurse will report on a day-to-day basis to the paediatric retrieval coordinator and the designated transport consultant of the day. They will adhere to all policies/procedures and standards of the NASCCRS while working on behalf of the service. Where there are no policies/procedures, the nurse will adhere to their own hospital/national policies.

#### Non-specialist transport team – structure and governance

The reporting structure and governance of a NSTT is to the institution where the clinician is employed. The operational standards to which the NSTT team should achieve are defined by the NASCCRS and should be in agreement with the recommendations published by the joint document of the Association of Anaesthetists of Great Britain and Ireland (AAGBI) and the Faculty of Paediatrics at the Royal College of Physicians of Ireland (RCPI).[33]

### 12.6 Organisation of the service

**Referral** is via a single point of telephone contact for referring clinicians, accepting paediatric intensivists/anaesthesiologists, accepting specialists, and transport medicine clinicians in order to facilitate access to immediate specialist clinical advice.

**Allocation of a PICU bed** is via a clear algorithm for the accepting PICUs so as to identify a PICU bed and provide appropriate care.

**Triages** aim to provide and dispatch transport teams within a clinically appropriate time window and work with referring hospital teams to guide stabilisation of patients before transfer to the accepting PICU.

**Transfers abroad:** The ultimate aim of IPATS is to provide transport and/or logistical support for high-risk critically ill infants, children and adolescents for continuing medical care not available in ROI. It also aims to repatriate (or facilitate) the repatriation of patients from PICUs to continue their care in an institution in ROI. Currently IPATS, where feasible, provide a second transport team (IPATS-B team) on a locum basis, funded by the requesting hospital, to transfer critically ill patients abroad but is looking to broaden this service for PICU patients to be included in the normal remit of the rostered teams.

IPATS also aims (when both the clinical appropriateness and IPATS service needs allow) to repatriate patients from PICUs to facilities nearer the patients' home.

### 12.7 Hours of clinical service

IPATS is operational between the hours of 10:00 and 20:00 on a Monday to Friday, with the exception of national holidays. It is expected that the team will have returned to base by 20:00. The IPATS team accepts national referrals up until 16:00 and referrals from the greater Dublin area until 17:00. It is hoped that the service will expand initially to a seven days per week service and finally to a 24/7/365 service, when additional funding and appropriate staffing are in place.

### 12.8 Acceptance criteria for transfer to PICU

To activate a transfer, the referring consultant will be required to make an initial telephone referral to ACCEPT Paediatric Intensive Care and Retrieval Services (1800 222 378). This will be a consultant-to-consultant referral. During IPATS hours of operation, the IPATS consultant will join the referral call with the PICU intensivist. The patient must be accepted to PICU by the receiving intensivist before the IPATS team are activated and dispatched. The IPATS team will not accept referrals outside of this protocol.

### 12.9 Neonatal patients

**Neonatal patients** (see Neonatal Model of Care)[34] will ordinarily be transferred by the NNTP. Exceptions to this will be considered only on request from the consultant neonatologist on duty for the NNTP. Neonatal patients, who present to acute medical services after having been discharged

from a NICU or neonatal unit, can be transported by IPATS if they fall within the age and weight criteria defined above.

**Time-critical patient transfers:** Patients with certain conditions, e.g. neurosurgical, cardiac or surgical emergencies, deemed time-critical by an appropriate specialist should not wait for IPATS and should be immediately transported by the local referring hospital, as any delay in transport may lead to adverse outcomes for the patient.

**Activation of IPATS team:** The decision to activate the IPATS team is based upon the clinical information provided by the referring consultant to the receiving PICU and the IPATS consultant by a direct telephone referral.

### 12.10 Mode of transport, equipment and resources

IPATS is a ground (ambulance), rotary wing (helicopter) and fixed wing (plane) transfer service.

### 12.11 Training and education

Team members who form part of the IPATS team undertake an advanced training course as part of their induction when they join the teams. The training is a multidisciplinary programme delivered biannually. Competencies have been devised for use by the IPATS team, based on competencies from transport groups in the UK, the AAGBI and PACT (post-anaesthetic care tool) retrieval competencies. This is followed by 'buddy shifts' in the transport environment, with recognised learning outcomes and achievement of core competencies for all team members. Furthermore, all doctors engaged with transport and retrieval will undergo a programme for focused education and mentoring for transport medicine.

### 12.12 Documentation

Standardised documents have been devised for use in transport, including a Patient Transport Record, which is activated at the initiation of the transport and is used until the patient is handed over in the receiving unit. The unique identifier for this document is sourced from the unique case reference generated by National Emergency Operations Centre (NEOC).

A version of this document is designed for local team transport, to ensure that a comprehensive record of care is maintained when the transfer is done by the NSTT. It is available on the IPATS webpage of the NASCCRS website and can be accessed on **www.ipats.ie** or **www.nasccrs.ie**. There are also a

number of guidelines, checklists and tools available on the IPATS webpage to assist the NSTT when carrying out a transfer of a critically ill child.

### 12.13 Parents/legal guardian and consent

Parents/legal guardians will be kept fully informed of all aspects of their infant/child's care. These discussions will be recorded in the patient's transfer records.

### 12.14 Parental presence

Due to the team composition of IPATS and seating constraints, the opportunity for parents to accompany their infant/child during transport is limited. Where possible and appropriate, one parent may be invited to travel with their infant/child. The presence of a parent during retrieval/transport is entirely the remit of the IPATS clinician on site.

### 12.15 Death of a patient during transfer

In the event of the death of a patient in transfer, the IPATS team will follow NASCCRS policy and proceed to the accepting hospital, or return to the sending facility, depending on proximity and after full discussion with the referring and receiving consultant.

### 12.16 Non-specialist transport teams

It is important that in the event of a delay or unavailability of an NASCCRS retrieval team, the local regional hospital should have a policy and contingency plan to temporarily care for a critically ill child with guidance from the retrieval team consultant or the consultant intensivist on call in the receiving hospital.

### 12.17 Stabilisation at referring hospital

Each hospital receiving or admitting children must have a protocol in place to resuscitate and stabilise a critically ill child. Part of this team is the previously nominated Team Leader in Anaesthesia and Paediatrics, who has set up an agreed protocol for treatment of these patients, according to the Model of Care for Paediatric Anaesthesia.

### 12.18 Components of transport team

A critically ill patient must be transported by a minimum of two clinicians, typically a doctor and a nurse. The doctor transporting any ventilated patients should possess advanced airway skills.

### 12.19 NSTT training: outreach education

The goal of the outreach education programme is to allow full engagement between the specialist transport teams and all of those who look after or may encounter seriously ill patients requiring transport. It allows for the building of relationships between the specialists and locally sourced NSTTs in order to encourage open, collaborative working relationships, with specific emphasis on standardisation of policies, procedures and guidelines and sharing of knowledge. As local teams around the country will continue to undertake transfers, outreach education programmes will continue and be further developed. These will be delivered nationally and will include adult, paediatric and neonatal teams using generic and high-fidelity simulation in-ambulance training.

### 12.20 National standardisation of equipment

Standardisation of medical equipment is a key enabler of patient and staff safety in retrieval and transfer medicine. Equipment for use in the transport environment has been standardised (where possible) across the specialist retrieval teams. It is NASCCRS policy to standardise critical care trolleys and ancillary equipment as well as consumables and medications for teams in referring hospitals. All equipment for use on ground transports must comply with CEN 1789:2007 EU Standards for Ambulances. Equipment used for air transport must be certified with the aircraft avionics (communication or navigation systems), be appropriately secured or stowed to aviation standards (Irish Aviation Authority or Irish Air Corps) in the event of excessive air turbulence or emergency landing.

# 13. PAEDIATRIC NEUROCRITICAL CARE

## 13.1 Current context in ROI

The referral of infants and children with neurological diagnoses or symptoms to PCC services accounts for up to 20% of patients admitted to PCCU,[25,35] ranking second to respiratory as the principle reason for admission. The current arrangement of services and support services in ROI poses challenges for critically ill children.

National neurological critical care is provided in both TSCUH and OLCHC PCCUs. However, neurosurgical critical care in children under 7 years is provided primarily in TSCUH. Historically, children over 7 years with isolated head injury, i.e. traumatic brain injury, have been admitted for emergency neurosurgery to Beaumont Hospital, Dublin. Children over 7 years with polytrauma or complex paediatric or multisystem disease are admitted to TSCUH PCCU.

## 13.2 Paediatric neurocritical care model of care

Common conditions referred to paediatric neurocritical care include the following.

### Epilepsy

By far the most common presenting complaint for PCCU referral is epilepsy. Many of these children will have been previously diagnosed with a neurodevelopmental condition as part of a multisystem illness, with significant comorbidity. New onset epilepsy is also a common presentation, particularly refractory status epilepticus. These patients are managed in both PCCUs in partnership with Neurology. Finally, epilepsy surgery is facilitated in TSCUH or Beaumont Hospital using the aforementioned age (or complexity) discriminators.

### Infection and postinfectious neurological disease

Infection causing acquired acute neurological conditions is a frequent reason for PCCU referral. Many of these patients will need immunomodulatory therapies, such as continuous plasmapheresis and haemofiltration, as part of their PCCU care, which requires highly skilled nursing support.

### Traumatic brain injury

Annually, approximately 30 patients with severe traumatic brain injury are admitted to CCU in either TSCUH or the Richmond ICU of Beaumont Hospital. Children less than 6 years are referred to TSCUH and those older than 6 years are referred to Beaumont Hospital.

### Neoplastic brain disease

Similar to traumatic brain injury, postoperative critical care for neoplastic brain disease is managed between TSCUH for those aged 6 years and under and Beaumont Hospital for older children without complex critical care needs. Postsurgical oncological care occurs in OLCHC.

### Ischaemic brain injury

Perinatal ischaemic brain injury is managed in Neonatal Critical Care Units.

### Neurovascular brain disease

Infants and children with malformations or older children with arteriovenous malformations (AVMs) pose significant logistical challenges. Currently, these are managed in conjunction with Cardiology in OLCHC with expert intervention from radiologists from Beaumont Hospital. However, it is no longer acceptable to transfer these children to Beaumont for intervention; it is currently recommended that these children are either treated in OLCHC or referred to sites abroad.

## 13.3 Patient pathway

The current plan to centralise all paediatric neurosurgery and invasive neurocritical care up to the age of 16 years in TSCUH from Beaumont Hospital should continue. By the time of transfer of all paediatric services to the NCH, all paediatric neurosurgical care should be based in TSCUH.

## 13.4 Trauma bypass for major paediatric neurotrauma

Paediatric patients presenting to emergency services following major trauma should be referred directly to either the ED of TSCUH or OLCHC within the timeline defined in the Trauma Network report.[36] In cases where neurotrauma is suspected, the patient should be transferred directly to TSCUH.

## 13.5 Stabilisation and transfer

Patients presenting outside the children's hospital where retrieval is considered should have an acuity-based determination by the appropriate specialist. If patients are deemed to be time-critical by a neurosurgeon, neurologist or paediatric intensivist, they should be transferred immediately. This may require the referring hospital to transfer the patient.

## 13.6 Fast-track neuroimaging

**Code Stroke:** Infants and children presenting with symptoms consistent with acute stroke should have access to rapid assessment for suitability for thrombolysis or interventional neuroradiology in order to achieve thrombectomy or thrombolysis within the 90-minute window.

## 13.7 Components of neurocritical care service

The following services, assets and skill sets should be available, over and above those normally available in a PCCU, which can enable highly specialised neurocritical care.

### Neurointensive care resources

- Paediatric intensivist lead for neurocritical care
- Neurocritical care advanced practice nurse
- Nurse clinical education facilitator(s) with special interest in neurocritical care
- Core nursing group with expertise in the management of complex brain injury
- Neurocritical four-bed clinical hub or node to include facilities for:
    - Invasive and non-invasive neurophysiological monitoring
    - Continuous attenuated EEG, full-array EEG and video
    - Real-time laboratory assay for brain-specific biomarkers
- Close proximity to radiology (CT/MRI), including neurointerventional radiology 24/7/365
- Close proximity to neurosurgical operating suite 24/7/365
- Intrahospital critical care transport equipment and processes
- Haemodialysis/haemofiltration service.

# 14. NATIONAL PAEDIATRIC INFECTIOUS DISEASES UNIT

## 14.1 Role of critical care in paediatric patients with category 4 pathogens

Critical care consultation and engagement is appropriate for patients with category 4 infectious disease pathogens, such as Ebola, when they fulfil standard critical care medicine (CCM) referral criteria.[37,38] This patient population presents with specific diagnostics and treatments relevant to critical care medicine, and includes management of hypovolaemia, electrolyte abnormalities, refractory shock, hypoxaemia, haemorrhage, septic shock, multiorgan failure, disseminated intravascular coagulation (DIC), vasopressors, nutrition, secondary bacterial infections, among other issues.[39,40] Therefore, specific interventions and expertise relevant to all of these is a part of critical care practice.

## 14.2 Location/isolation of the paediatric patient with Ebola

The Mater Misericordiae University Hospital (MMUH) in Dublin contains the National Isolation Unit (NIU) for adults presenting with category 4 infectious disease pathogens, such as Ebola, in ROI. Previous recommendations were made for a separate Paediatric Isolation Unit situated on the grounds of a Model 4S paediatric hospital adjacent to the PCCUs. However, this has not come to pass. Currently, in the event of a paediatric patient presenting with a category 4 pathogen and requiring critical care, we do not have any critical care facility in ROI that reaches international guidelines with respect to the infrastructure, staffing or training required to look after these patients. The adult unit in MMUH is not suitable for the care of critically ill children. In the current situation, the recommendation for the paediatric patient presenting with a category 4 pathogen, such as Ebola, is the transfer of the patient by a specialised transport team from the Royal Free Hospital in London and treatment in the PCC facility at the Royal Free Hospital.

With reference to the building of the NCH, currently underway, specific recommendations have been made by consultant staff from Critical Care and Infectious Diseases that a specific Paediatric Isolation Unit be built adjacent to ACC but with the separate facilities required, according to guidelines of the Centers for Disease Control and Prevention (CDC).[41] This unit should follow international guidelines for isolation with respect to category 4 outbreaks, such as Ebola, but also needs to have fully equipped critical care facilities available in line with critical care standards.

*The Ebola Clinical Care Guidelines: A Guide for Clinicians in Canada*[42] provides useful guidance for the management of the critically ill Ebola patient. These guidelines include specific considerations for the in-hospital location and environment of such a patient.

Planning needs to include an identified clean gowning-up (full personal protective equipment (PPE)) area separate from dirty areas, areas for removing PPE safely, and waste.[43] A work area is required outside of this isolated zone to allow case discussion and communication. IT and communication facilities need to be suitable for staff, patient and visitor use. The defined isolation and work area will need to be segregated physically from the rest of the ICU, where non-Ebola virus disease (non-EVD) patients are being cared for.

### 14.3 Personal protective equipment

The use of PPE shall be in accordance with *The Management of Viral Haemorrhagic Fevers in Ireland*[44] and *Irish Guidelines on Personal Protective Equipment (PPE) to Be Used in Suspected or Confirmed Ebola Virus Disease (EVD) Scenarios*[45] issued by the Health Protection Surveillance Centre (HPSC) or as advised by the National Personal Protective Equipment Group. Current standards include the use of airborne infection isolation rooms for these patients when feasible for aerosol-generating procedures (AGPs) – see CDC guidelines for *Infection Prevention and Control Recommendations for Hospitalized Patients under Investigation (PUIs) for Ebola Virus Disease (EVD) in US Hospitals*.[41]

### 14.4 Critical care staffing

The demands of care for a category 4 infection patient, the extra risks for the nursing and medical staff, and the difficulties pertaining to working while dressed in PPE will necessitate shorter shifts and thus greater numbers of nurses and an extra rota of doctors for ICM separate (or supporting) to those already rostered to the care of the remaining ICU patients. Different hospitals will require different configurations of such staffing; but it is presumed that six-hour shifts would be the maximum tolerable for any nursing staff in this context. Therefore, a staffing ratio of 3:1 nurses to patient (normal 1:1) per standard shift would be required. This will significantly deplete the numerical pool of ICU nursing staff for any institution and dictate closure of a number of ICU beds, which would impact negatively on the ability of that centre to care for other acutely ill patients. Furthermore, it would call for restrictions to major elective surgeries and redistribution of ambulance take.

## 14.5 Clinical care and interventions for the critically ill

The clinical decision as to the appropriateness of intubation and mechanical ventilation will be consultant based and patient specific.[37,38] In 2018, the CDC issued guidance with regard to haemodialysis for patients with Ebola virus disease, both modalities of intermittent and continuous renal replacement therapy (RRT).[46]

## 14.6 Laboratory and ICU point-of-care testing

Laboratory and point-of-care testing shall comply with the EVD laboratory biosafety guidance.[47] Note that the blood bank or the Blood Transfusion Service shall not cross-match blood for these patients and hence only O-negative or type specific (if known) will be made available.

## 14.7 Recommendations on PCC facilities for infectious diseases

1. Until the opening of the NCH, critically ill children with life-threatening infectious diseases in ROI should be transferred to the specialised isolation facilities in the Royal Free Hospital, London. There are currently no suitable isolation facilities available for this group in ROI.
2. Transfer of these critically ill patients should be carried out by a specialised transport group from the UK.
3. Construction of a specialised Paediatric Isolation Unit should be part of the NCH infrastructure.
4. A Paediatric Infectious Diseases Unit in the NCH should be in proximity to the CCU to facilitate staffing and training of the unit in the event of an outbreak such as Ebola.
5. The infrastructure of a Paediatric Infectious Unit should be in line with international standards with respect to isolation and safety of both patients and staff and the other patient population in the hospital.
6. A service-level agreement should be signed between the Royal Free Hospital and the Children's Hospital Group and put in place.

## 14.8 Useful information websites

**Health Protection Surveillance Centre**
http://www.hpsc.ie/A-Z/Vectorborne/ViralHaemorrhagicFever/Ebola/

**Centers for Disease Control and Prevention**
http://www.cdc.gov/vhf/ebola/

# 15. PAEDIATRIC CRITICAL CARE NURSING

## 15.1 Background

In 1959, the Platt Report contended that children have different healthcare needs to adult patients and consequently require care suited to their specific needs.[48] In more recent years, a number of high-profile national and international inquiries into serious adverse incidents and deaths relating to the care of children have recommended that children should be cared for by children's nurses with the requisite knowledge, skills and educational preparation.[49,50,51,52,53]

Paediatric critical care nursing is a subspecialty of children's nursing that requires additional skills and knowledge to care for critically ill children and their families, which must be met with the requisite education and training to support nurses in this role. Nurses working in PCCU in ROI today are operating within a healthcare environment that is influenced by legislation, health policy and a changing demographic and epidemiological profile of patients. Work trends are constantly changing and healthcare services are striving towards a consumer-responsive and cost-effective healthcare service. Nurses will be required to further expand their roles and develop skills and expertise to care for infants and children with increasingly complex care needs.

Furthermore, children's healthcare in ROI is undergoing the most significant change to its organisation and delivery with the *National Model of Care for Paediatric and Neonatal Healthcare in Ireland*[54] and the development of the NCH. Therefore, the purpose of this chapter is to:

1. Describe the current PCCU nursing context.
2. Consider the future for PCCU nursing.
3. Consider the strategies and dependencies required to support the development of the PCCU nursing service into the future, including education requirements, competencies, skill mix and workforce planning.

## 15.2 Current situation

There are currently three children's hospitals in Ireland: OLCHC, TSCUH and the National Children's Hospital, Tallaght, all of which are located in Dublin. PCCU services are currently provided in OLCHC and TSCUH.

### 15.3 OLCHC

The PCCU in OLCHC has a maximum capacity of 25 beds, but is funded for 23 beds over two units and two floors:

- **Floor 2:** An eight-bedded unit that is predominantly used for cardiology and cardiothoracic patients.
- **Floor 1:** A 17-bedded unit (with two beds unfunded) consisting of 10 PCCU beds and five HDU beds. The five HDU beds can be used as PCCU beds if needed, based on patient dependency levels.

In addition, a seven-bedded TCU provides care for children with complex care needs who are technology dependent and/or long-term ventilated. Prior to the establishment of TCU, these children would have been cared for in PCCU.

### 15.4 TSCUH

The PCCU in TSCUH has a maximum capacity of nine beds. A separate six-bedded neonatal HDU provides care for infants up to 5 kg requiring high dependency care only. Infants requiring invasive ventilation are transferred to PCCU. Children with complex care needs who are technology dependent and/or long-term ventilated are currently cared for across the ward areas within the hospital.

### 15.5 Current workforce in PCCU

The UK Paediatric Intensive Care Society have indicated an establishment of at least 7.01 qualified nurses per bed for children in the PCCU setting.[18] The current staffing numbers in ROI PCCUs are outlined in Table 15.1; they allow for 5.5 nurses per PCC bed and 3.5 nurses per high dependency bed.

We recognise that this is the minimum safe standard that we can apply when challenged with staffing numbers.

**Table 15.1: Current PCCU workforce arrangements in ROI**

| Data | OLCHC | TSCUH | NCH |
|---|---|---|---|
| **Beds** | PCCU x 18 beds<br>HDU x 5 beds | Beds x 9<br>HDU x 6 | PCCU/CICU x 42 beds |
| **Current funded staffing of PCCU** | DNM x 1 WTE<br>(not exclusive to PCCU)<br>CNM3 x 1 WTE (Manager)<br>CNM3 x 1 WTE (ECLS)<br>CNM2 Shift Leaders x 11.5 WTE<br>SN x 116.5 WTE<br>CNF x 3.5 WTE<br>Foundation Course Coordinator x 1 WTE<br>PCCU Graduate Diploma Coordinator x 1 WTE<br>Research Nurse CNM 2 x 1 WTE<br>HCA x 5 WTE | DNM x 1 WTE<br>(not exclusive to PCCU)<br>CNM3 x 1<br>CNM2 Shift Leaders x 5.1 WTE<br>SN x 41.22 WTE<br>CNF x 1.9 WTE<br>ICIP Nurse x 0.8 WTE<br>Audit Nurse x 0.5 WTE<br>HCA x 1.8 WTE | DNM x 1 WTE (Cardiac and General Critical Care only – 42 beds)<br>CNM3 x 2 (Manager)<br>CNM3 x 1 (ECLS)<br>CNM 2 Shift Leader x 21 WTE<br>CNM 2 x 1 WTE (ECLS)<br>CNF x 9 WTE<br>Foundation Course Coordinator x 1 WTE<br>PCCU Graduate Diploma Coordinator x 1 WTE<br>Research CNM 2 x 1.5 WTE<br>Audit Nurse x 2 WTE<br>HCA x 9 WTE |
| **Nursing shift arrangements** | 39 hrs/week<br>11.14 hrs per shift<br>Shift Leader every shift | 39 hrs/week<br>11.5-hr shifts<br>Shift Leader every shift | 39 hrs/week<br>12-hr shifts<br>Shift Leader every shift |
| **Nurse: patient ratio** | Operate on levels of care 0.5:1, 1.1, 2.1, as per PICS standards, 2015 | Operate on levels of care 0.5:1, 1:1, 2:1, as per PICS standards, 2015 | Operate on levels of care 0.5:1, 1:1, 2:1 |
| **Nursing turnover rates over past 5 years** | 2016 – 14%<br>2015 – 22%<br>2014 – 15.8%<br>2013 – 12.6%<br>2012 – 13%<br>2011 – 9.3% | 2015 – 9.6%<br>2014 – 6% | |
| **Initiatives around recruitment** | Local, national and international recruitment campaigns ongoing in collaboration with HR department | Continuous recruitment drive advertised on hospital website plus nationally and internationally | Local, national and international recruitment campaigns ongoing in collaboration with HR department |

| | | | |
|---|---|---|---|
| | Structured career pathway for PCCU nurses<br><br>Encourage students while on placement to consider PCCU as a career; Back to Nursing Campaign; Local ward to unit rotation programme | Structured career pathway for PCCU nurses<br><br>Encourage students while on placement to consider PCCU as a career | Encourage students while on placement to consider PCCU as a career |
| **ECLS team** | 20 WTE from overall PCCU complement provide 24/7 cover to this service and patient cohort | N/A | 23 WTE<br>CNM3 Coordinator<br>CNM2 Deputy |
| **CVVH team** | 20 WTE from overall PCCU complement provide 24/7 cover to this service and patient cohort | 10.5 WTE are fully trained in CVVH and TPE, and 6 WTE have nearly completed their hours | CVVH Nurse x 38 WTE |
| **Retrieval service** | 1.5 WTE (from 116.5 WTE) dedicated to retrieval<br>ANP x 1 (currently in training) | | |
| **Concerns and initiatives around retention** | Problems with burnout and constant level of activity; Leavers seek promotion, better cost of living and relocation; A highly marketable workforce<br><br>Range of initiatives:<br>• Investment in induction, orientation<br>• Robust career pathway<br>• Specific training for ECLS, CVVH and Retrieval<br>• Developmental pathways/performance management<br>• Consultative forums<br>• Flexible rostering<br>• Financial support for career development<br>• Staff facilities and family-friendly arrangements | Relocation; Cost of living very high in Dublin; Childcare costs; Promotions; Opportunities abroad; Problems with burnout<br><br>Range of initiatives:<br>• Comprehensive orientation package<br>• Professional development profiles<br>• Opportunities to join the CVVH team and Retrieval team<br>• Self-rostering system<br>• Financial support for career development | Problems with burnout, intensive work environment; Relocation and increased cost of living in Dublin<br><br>Initiatives as discussed by OLCHC and TSCUH should be maintained. Other initiatives would include:<br>• Development of a CNM 1 grade for all nursing staff competent in CVVH, ECLS and Transport<br>• Potential to skip an increment while working in PCCU<br>• Transport facilities and car parking – 24-hour access to hospital over 7-day period |

PCCU = Paediatric Critical Care Unit; CICU = Cardiac Intensive Care Unit; HDU = High Dependency Unit; DNM = Divisional nurse manager; WTE = Whole-time equivalent; CNM = Clinical nurse manager; ECLS = Extracorporeal Life Support; SN = Staff nurse; CNF = Clinical nurse facilitator; HCA = Healthcare assistant; ICIP = IntelliVue Clinical Information Portfolio; HP = Human resources; CVVH = Continuous venovenous haemofiltration; TPE = Therapeutic plasma exchange ANP = Advanced nurse practitioner.

## 15.6 Nursing attrition, recruitment and retention

An international shortage of healthcare professionals has evolved over the last 20 years. In 2006, the World Health Organization (WHO) estimated a global shortage of 4,300,000 healthcare professionals and more recently detailed a shortage of 2,400,000 nurses in India alone.[55] Ireland in general and children's nursing in particular are not immune to these international trends.

Many factors are cited for these shortages, including the increasingly complex nature of paediatric healthcare, which directly creates the need for more nurses. From a supply perspective, factors influencing the recruitment and retention of nurses include a diminution in the number of nurse training positions, an ageing workforce, increased turnover due to employee dissatisfaction, recruitment freezes arising from reduced health spending, and an over-reliance on developing countries as a nursing market.[56,57]

Nursing recruitment and retention has been a priority in PCCU since the start of 2000. It is widely accepted that children should be nursed by appropriately qualified nursing staff and, in the case of critically ill children, should be nursed in appropriately staffed PCCUs. Nurses are an integral part of the intensive care team and their contribution is indeed vital in ensuring that OLCHC and TSCUH can provide a high-quality critical care service. The current PCCU workforce is predominantly a young workforce, and information from both PCCUs shows that retention of this cohort of nurses is heavily influenced by the cost of living in Dublin, long commutes and parking availability.

An additional factor that influences retention of staff and increases the need for effective and robust recruitment strategies is the proportion of an ageing workforce who are within five years of retirement. It is estimated that approximately 13% of the current PCCU workforce will retire within the next five years. This experienced and senior cohort of nurses make a significant contribution to the PCCU and consideration must be given to the means by which they can be supported to remain in the workforce for longer.

## 15.7 Skill mix

Historically, Ireland has been an exporter of nurses, particularly to the UK, United States (US) and Australia. However, from the late 1990s, Ireland began to experience nursing shortages due to reduced training numbers, increased turnover and expanding healthcare services. In response, Irish hospitals, supported by the Department of Health (DOH), began an aggressive overseas recruitment programme in 2000 targeted at the Philippines and India, which were recognised exporters of nurses.

This significantly changed the profile of nursing in Ireland from 2000 to 2010, when 35% of new recruits into the Irish nursing labour market were non-EU migrant nurses.[28] Consequently, Ireland became proportionately more reliant on the international nursing market than the UK, US or Australia.[56]

There is increasing evidence that skill mix impacts on the quality and safety of patient care and outcomes.[58] The development of clinical competence for PCCU nurses is underpinned by Benner's theory of novice to expert[59,60] and these stages of competence are used in the PCCU to determine the skill level at which each nurse is practising.

- **Stage 1:** The novice nurse has little or no experience of the situations in which they are expected to perform. The novice nurse will perform safely and effectively with constant supervision.
- **Stage 2:** The advanced beginner has prior experience and operates on general guidelines and has the ability to perceive recurrent meaningful patterns in clinical practice. A practitioner at this level will still require support and guidance with critically ill patients.
- **Stage 3:** The competent practitioner has in-depth knowledge and exposure and is capable of delivering safe and effective care to critically ill PCCU patients without direct supervision.
- **Stage 4:** The proficient nurse understands a situation as a whole because they perceive its meaning relative to long-term goals. The proficient nurse learns from experience what typical events to expect in a given situation and how plans need to be modified in response to these events. The proficient nurse can recognise when the expected normal picture does not materialise.

## 15.8 Education and training – planning for the future

The PCCU nursing mission is to constantly improve the health and wellbeing of children and adolescents in a safe environment, which is driven by quality healthcare and supported by excellence in knowledge, education and research. A children's nurse has achieved a competent standard of practice following successful completion of an approved academic and practical programme of nursing education at undergraduate or post-registration level. Following this, CPD takes place after completion of nursing registration education programmes. It consists of continuing education and learning experiences that are designed to augment the knowledge, skills and attitudes of a registered nurse.[28] The Nurses and Midwife Act (2011) creates a legislative imperative for employers of

registered nurses to facilitate the individual nurse's maintenance of their professional competence, pursuant to a professional competence scheme.

A continuing education programme is required to ensure staff remain competent with rapidly evolving critical care therapies. It should be compliant with the requirements for training, accreditation and maintenance of professional skills of all critical care professionals.[5] The transition challenges for a new nurse into the PCCU are substantial and well recognised. Teamwork and collaboration are therefore important foci to create and maintain a healthy work environment. Maintaining and enhancing knowledge, skills and competencies are factors in improving overall recruitment and retention. The PCCU nurse will have unique knowledge and skills to care for and manage critically ill children and their families.

### 15.9 PCCU CPD pathway

The PCCU has a robust and systematic professional development pathway to support nurses practising in the PCCU environment. This CPD pathway is outlined in Figure 15.1 and Tables 15.2 and 15.3.

**Figure 15.1: CPD pathway for PCCU nursing**

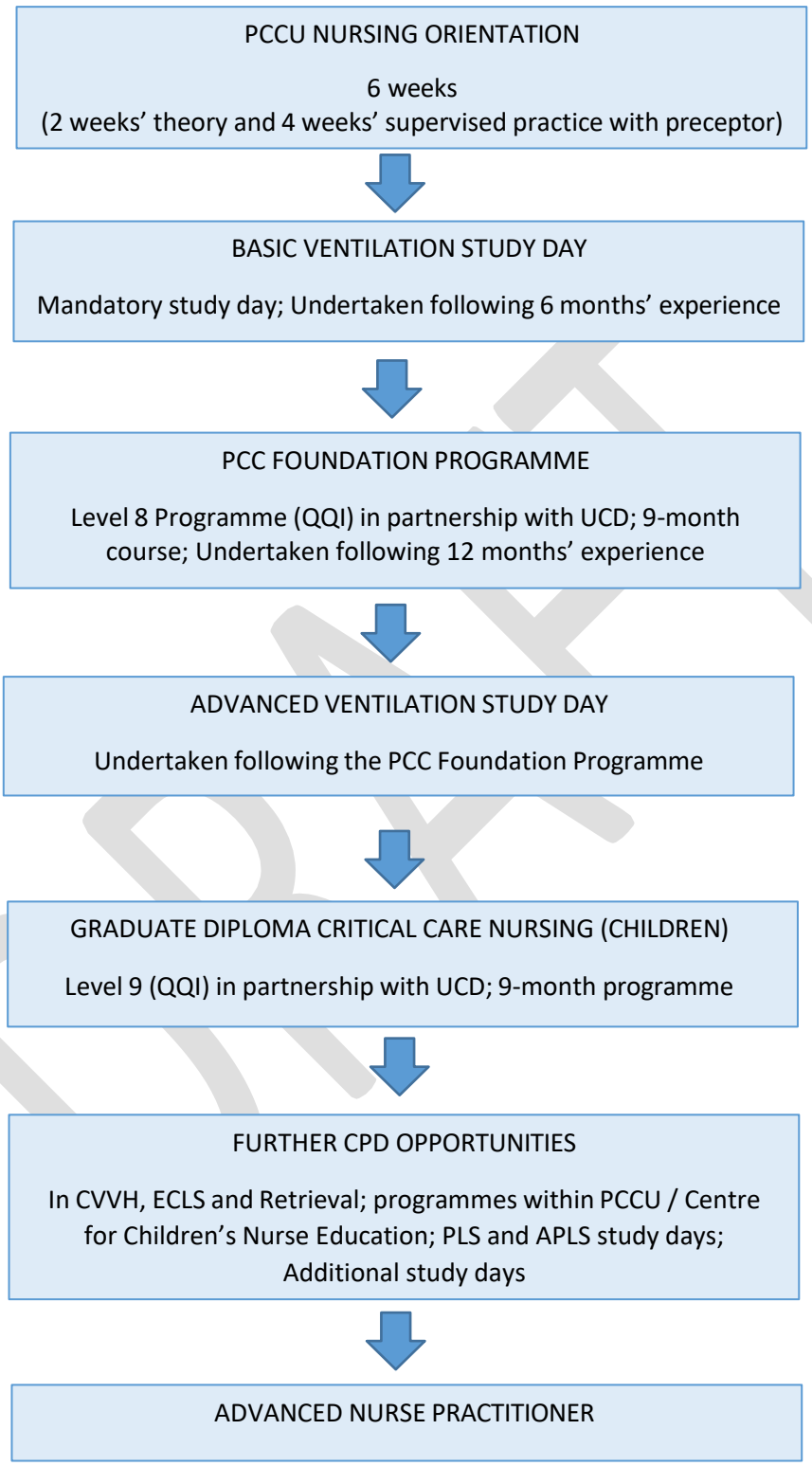


**Table 15.2: CPD pathway for PCCU nursing**

| Programme | Details |
|---|---|
| Orientation | 6 weeks (2 weeks' theory and 4 weeks' supervised practice with preceptor) |
| Basic Ventilation Study Day | Mandatory study day<br>Undertaken following 6 months' experience |
| PCC Foundation Programme | Level 8 Programme (QQI) in partnership with UCD<br>9-month course<br>Undertaken following 12 months' experience<br>**Aim of programme:** Further develop the nurse's body of knowledge, skills and attitudes to enable them to develop a therapeutic and holistic approach to care of the critically ill infant/child and their families in the PCCU environment.<br>**Expected outcomes*:*** On completion of programme, nurses will be practising at an advanced beginner level. |
| Advanced Ventilation Study Day | Undertaken following the Foundation Programme |
| Graduate Diploma Critical Care Nursing (Children) | Level 9 (QQI) in partnership with UCD<br>9 month programme<br>**Aim of programme:** To build on existing knowledge and skills in caring for infants and children within the PCC setting.<br>**Expected outcomes:** Possessing this advanced knowledge will enable utilisation of a range of therapeutic interventions and enhances a nurse's ability to review differing approaches and trends in the care and treatment of infants and children in PCC nursing. On completion of diploma, critical care nurses will be practising at a senior level. |
| Further CPD opportunities | PCCU nurses have the opportunity to develop further in areas of CVVH, ECLS and Retrieval, supported by further education and training programmes within the PCCU and through the Centre for Children's Nurse Education.<br>Nurses are also supported to attend PLS and APLS study days.<br>Additional study days that support the PCCU nursing CPD pathway are: Preceptorship; Intravenous; Infection prevention and control; Breastfeeding; PaedAIM; Quality; Total parenteral nutrition; Enteral feeding; Child protection; Basic and advanced ventilation days; Medication management. |

| | |
|---|---|
| Advanced Nurse Practitioner | ANPs adjust the boundaries of nursing; pioneering and developing clinical roles sensitive and responsive to the changing needs of critically ill children and their families. The development of the role of the ANP is influenced by international, national and local drivers that have impacted significantly on the current provision of nursing and medical staffing. |

**Table 15.3: Development of role of ANP**

| ANP | Vision | Staffing | Role/Duties |
|---|---|---|---|
| **ANP** | To have a team of 10 WTE PCCU ANPs; Expert nurses with a strong foundation and dedication to PCCU | • CICU x 3 WTE<br>• PCCU x 3 WTE<br>• Outreach team x 4 WTE | • Expert practitioner in the specific speciality<br>• Pioneering professional and clinical leadership<br>• Audit and research |
| **Outreach ANP** | To develop a 24-hour outreach team (nurses and medical staff) throughout the hospital | Team of 4 ANPs | • Respond to PEWS calls<br>• PCCU follow-up on discharge<br>• Initiate treatment at ward level<br>• Respond to '2222' calls |
| **PCCU & CICU ANP** | To progress to a 24/7 service | • 3 ANPs allocated to PCCU<br>• 3 ANPs allocated to CICU | • Contribute to management of children's illness/health<br>• Monitor and manage delivery of quality health service within PCCU<br>• Stabilise child/infant in consultation with medical staff, while providing physical and psychological care measures<br>• Lead and develop practice; innovation and practice development based on evaluation and research |

## 15.10 Supporting documentation

The hospitals have developed numerous clinical and nursing guidelines to support clinical practice. Nurses in PCCU have been actively involved in developing these. For example, treatment of major conditions such as meningococcal disease, sepsis, diabetic ketoacidosis, status epilepticus, status

asthmaticus; drug administration and medication management; intubation/extubation guidelines and suctioning; care of the neurosurgical patient; pain management; tracheostomy management; ECLS/CVVH; end-of-life care; infection control; and breastfeeding.

## 15.11 Nurse specialists in PCCM

### (a) CVVH and plasma exchange

Currently, in OLCHC, there are 16.5 WTE trained CVVH specialists providing cover 24/7. Training consists of a day of didactic lectures and practical demonstrations, followed by 30 hours of supervised training. Specialists maintain their skills by attending a yearly refresher day, maintaining 40 hours per year of CVVH care and by attending practical sessions for lining and priming the pump. OLCHC is affiliated with PICANet for renal data collection and to audit current practices to potentially drive future research into best practice. Plasma exchange is available to the PCCU patient population, but at present is delivered by apheresis specialists. It is planned that this service will be provided by PCCU nurses in the future.

In TSCUH, there are 10.5 WTE fully competent in CVVH and therapeutic plasma exchange (TPE). There is a competency document which the practitioner must complete before taking CVVH alone, which includes an eight-hour study day followed by 33 hours of supervised training. Thereafter, the practitioner attends a yearly updated lecture and practical sessions to ensure continued competence. TSCUH is also affiliated with PICANet.

### (b) Retrieval – specialist PCC transport team

In ROI, the specialist paediatric critical care transport medicine team is known as IPATS – the Irish Paediatric Acute Transport Service. IPATS is an arms-length service from the PCC services of OLCHC and TSCUH. The term 'arms-length' refers to the distinction between the operational standards, funding, organisation and reporting structure of IPATS, which is to the National Transport Medicine Programme (NTMP). Clinical performance, professionalism and professional accountability and staffing of the IPATS service are to the hospital where the nurse is employed under the following criteria:

- Each nurse, or nurse practitioner, will report to the director of nursing (DON) in the hospital where the nurse is employed.
- The clinical competencies of a nurse on the IPATS team are defined by the IPATS training document as it pertains to transport medicine.

- It is understood that the nurses are competent and proficient in the practice of PCCM prior to undertaking training for IPATS and becoming part of the team.
- The role of the ANP in transport is critical to the future model of this service.
- Minimum standards/criteria for nursing staff are defined by the NTMP.

## 15.12 Retrieval – training and education

- All new nursing staff will undergo a Paediatric Retrieval and Transport Induction course hosted by the NTMP.
- Subsequently, nursing staff will be expected to complete a competency document in line with the Paediatric Critical Care and Neonatal Transport Group standards.
- All nursing staff are required to undergo training on all equipment, resources and modes of transfer and keep up to date with relevant policy changes.
- Training will be recorded on the Education database and reviewed on an annual basis.
- Following the Paediatric Retrieval and Transport Induction course, all nursing staff will complete three 'buddy' shifts, and will complete training competencies as set out by the programme. If extra shifts are deemed necessary, these will be facilitated following discussion with the retrieval consultant and retrieval coordinator.

## 15.13 Retrieval – advanced nurse practitioners

- Currently, the NTMP provides funding towards ANP training in the UK for suitable candidates.
- ANPs play a pivotal role in international paediatric retrieval teams. They provide direct expert clinical care for paediatric patients in the retrieval environment. They perform at an advanced level independently but with the support of the retrieval consultant, enhancing the robustness of the retrieval service.
- See Table 15.4 for current and projected ANP posts for the Retrieval Service.

**Table 15.4: Current and projected ANP posts for Retrieval Service**

| Year | No. of ANP WTE posts |
|---|---|
| 2017 | 1 |
| 2018 | 1 |
| 2019 | 2 |
| 2020 | 3 |

### 15.14 PCCU advanced nurse practitioners

Advanced practice in ROI refers to registered nurses and registered midwives who engage in CPD and clinical supervision to practise as expert practitioners and demonstrate exemplary clinical leadership.[28] The ANP provides healthcare to patients and families and demonstrates a high level of independence. ANPs collaborate with the critical care team in developing and delivering a dynamic plan of care. In addition, they combine clinical practice with education, research, consultation and leadership.

### 15.15 Environment and wellbeing recommendations

The PCCU environment should have appropriate facilities for families, patients and staff:

- There should be an area off the unit where families can sit and have time with relatives.
- Families should be provided with a kitchen for food preparation and an area with toilet and shower facilities that include a baby-changing area.
- Families should be provided with breastfeeding and expressing facilities on the unit or as close to the unit as possible.
- Families should be provided with accommodation in close proximity to the PCCU.
- Families should have access to 24/7 chaplaincy and bereavement support. Medical social workers, interpreters and patient advocacy should also be easily available to families.
- Patients should have a play therapist available to them so that play, distraction and stimulation can be provided for.
- A psychology team should be available to provide psychotherapy to parents as they go through the PCCU experience.
- A PCCU liaison officer for parents should be available to provide ongoing support for parents and families.
- The PCCU should have access to an out-of-hours pharmacist, which would be of benefit to patients.
- Access to out-of-hours ward clerk cover to support service delivery should be provided. This would be highly beneficial as it would maximise the nurse-to-patient contact and provide efficiencies in the service where telephones could be answered without delay; admission and discharge paperwork efficiencies could be enhanced; and the intercom for families could be answered at all times in an appropriate timeframe.
- Changing, showering and eating facilities should be available for staff.

- A quiet room should be provided for staff to self-care during break times away from the eating area.
- A library for staff to have access to IT and journals should be provided.
- Given the critical nature of the environment, staff should also have access to a psychology team and bereavement counselling.

## 15.16 Conclusion

PCCU requires a model of care tailored to the specific patient population and unique considerations of the environment. The role of the intensive care nurse, current workforce shortages and alternate staffing models are some of the challenges that need to be explored as subjects of further research, so that we can create solutions while looking at new ways to care for critically ill patients in the future.

# 16. EXTRACORPOREAL LIFE SUPPORT (ECLS) SERVICE

## 16.1 Background

Extracorporeal life support (ECLS) is an advanced life support system acting as a modified form of heart–lung bypass facilitating the support of neonates and children with severe respiratory or cardiorespiratory failure who have continued to deteriorate, despite receiving optimal conventional therapies.

The ECLS programme was established in 2005 to support a small but critically ill group of initially cardiac children who could not survive without ECLS. OLCHC ECLS programme is a member of the Extracorporeal Life Support Organization (ELSO), an international organisation that supports healthcare professionals involved in ECLS.

The agreed dataset of patient data is collected by ELSO, which allows us to compare our patient population and outcomes internationally against other ECLS centres. ELSO data can be used for educational purposes and to support clinical research. In addition, ELSO guidelines are utilised for training ECLS specialists and for maintaining competencies.

## 16.2 ECLS training

Training for ECLS specialists consists of three days of didactic lectures and practical demonstrations, followed by 44 hours of supervised training and a written exam. Specialists maintain their skills every year by maintaining a minimum of 69 pump hours, attending a refresher day, sitting a written exam and performing practice water labs at regular intervals. OLCHC currently has 20 WTE trained ECLS specialists providing 24/7 cover.

## 16.3 Respiratory ECLS

### Background

The ROI Respiratory ECLS service is currently not funded by the HSE; therefore, any infant/child requiring respiratory ECLS is referred abroad. Currently, approximately 8–10 infants/children require respiratory ECLS each year and up to 60% are referred from neonatal ICUs outside of the PCCUs. With respect to infant and child inpatients in OLCHC emergency, ECLS can be initiated by the cardiac ECLS team, but only on the proviso that a bed is available outside the State and is sought outside the State. This state of affairs is neither satisfactory nor best practice.

The time from commencement of ECLS to transfer has been 6–52 hours, depending on bed availability, the availability of a suitable transport team, a suitable vehicle and weather conditions.

Based on a recent audit carried out, it is clear that the cost of funding ECLS abroad over an eight-year period has cost in excess of €8 million. With further expansion of infrastructure and staffing and at a lower cost, it is clear that it would be possible to supply respiratory ECLS to the children of ROI, thereby avoiding sending respiratory-failure patients requiring ECLS abroad with its added risk and difficulty to the families of these children.

The risks associated with the transfer abroad of critically ill neonates along with the additional stress and anxiety for families make it difficult to justify continuing to refer this patient group abroad, especially when the costs associated with the referral could be redistributed towards the expansion of the service at OLCHC.

### Recommendations for expansion of Respiratory ECLS Service

The ELSO guidelines[61] advise:

- ECLS centres should be located in tertiary centres with a tertiary-level PCCU.
- In order to be cost-effective and to develop clinical expertise, an ECLS centre should be developed in geographic areas that can support a minimum of six ECLS patients per year.
- ECLS centres should be actively involved in ELSO, including participation in the Central Register.
- Haematology, blood transfusion and biochemistry services should be available on a 24-hourly basis.
- Support services should be available for paediatric cardiology and cardiothoracic surgery. Also, cardiac theatres, respiratory, radiography and ultrasonography, biomedical engineering, general surgical, radiology, neurology, nephrology, genetics, occupational therapy and developmental expertise should be available.
- Facilities to provide long-term follow-up of this cohort of patients should be available.

Based on the above criteria and cardiac ECLS activity to date, the development of a National Paediatric ECLS Centre in Ireland is supported.

Many international ECLS programmes were introduced to support neonates in respiratory failure due to conditions such as meconium aspiration syndrome, persistent pulmonary hypertension and

congenital diaphragmatic hernia. This group of patients currently has the best outcomes with ECLS, with over a 71% survival rate, according to the ELSO:[62]

- In 2016, the average run length for neonatal respiratory cases was 7.5 days.[62]
- In 2016, the average run length for paediatric respiratory cases was 11.7 days.[62]

Based on figures extrapolated from ROI and the UK (four centre meeting in 2015), we can reasonably assume that the demand for respiratory ECLS in the future will be:

- 6–12 neonatal cases per year, but on average 5 neonates per year have been transferred overseas from ROI in the period 2011–2015.
- 4 paediatric cases per year.

However, from data received, it is clear that the referral rate for assessment for ECLS must be considered. Assuming five PCCU bed days per patient would be required for assessment, this would result in an additional 100 PCCU bed days (for the neonatal group) as a minimum. As these neonates do not currently come to OLCHC, this should be considered as additional activity for the hospital. Also, while neonatal cases will be transferred back to referring centres following their ECLS run, paediatric patients will not. This patient group will remain in PCCU and inpatient ward areas in OLCHC.

In order to accommodate respiratory ECLS, the team will need to expand to 25 WTE. To avoid closure of beds during an ECLS run (nurse ratio 2:1 as per PICS standards), a further 5 WTE staff nurses will need to be accounted for in the unit complement (see Table 16.1).

**Table 16.1: ECLS specialists**

| ECLS specialists | Current complement | Future complement |
|---|---|---|
| WTE | 20 | 25 |

# 17. PHARMACY

## 17.1 Background

The substantial use of medications to maintain comfort and to sustain life in patients in PCCU requires considerable clinical pharmacist input, particularly as many of the agents are high-risk medications, further compounded by the complexity of prescribing for paediatric patients. The clinical pharmacist has been shown to be an essential member of the critical care multidisciplinary team, providing not only clinical input from their daily medication review for patients resident in the unit, but also showing benefit in reducing incidences of adverse events, costs and mortality rates.[63,64,65]

Paediatric patients, particularly those in critical care, are at particular risk from medication errors.[64,66] In ROI, medication incidents account for 14.7% of the 10 most commonly reported incidents.[67] Interventions proposed to improve medication safety include ward-based clinical pharmacists and the increased use of technology across the entire medication use process.[64,68,69] All medications are currently ordered electronically in PCCU in OLCHC, while paper prescriptions are still in use in TSCUH.

The use of standardised concentration infusions (SCIs), replacing traditional weight-based paediatric infusions, and the use of smart-pump technology have both been advocated by international safety agencies to reduce the particular risks associated with paediatric infusion errors.[70,71]

A cross-site multidisciplinary project has ensured that the majority of all infusions are currently run via a standardised infusion pump drug library. A broader-scale national project is underway to extend this system to neonatal and paediatric patients in adult and maternity hospitals nationwide, including during transport.

Currently, all medications, including high-risk medications for infusion, are prepared at the bedside by nursing staff. Enhanced utilisation of nursing resources, reduction in medication wastage and substantial benefits from a medication safety perspective would be realised by the provision of a Centralised Intravenous Additive Service (CIVAS).

Adequate pharmacy resources are required to ensure continued development of health information technology PCCU, in line with Ireland's current eHealth strategy.[68] Priority future developments include expansion of electronic prescribing to TSCUH PCCU and to theatres at both sites, the introduction of ready-to-use infusion solutions and the use of barcoded single-use medications.

The importance of the role of hospital pharmacists in the design, specification of parameters and evaluation of health technology within the medicines processes is well recognised.[72]

Currently, there are no national guidelines or standards with regards to pharmacy resources for PCCU. Furthermore, neither PCCU is currently in line with UK standards[73,18] nor adult recommendations.[3,74]

## 17.2 Education/training and competencies

Currently, there is no specialist training for PCCU pharmacists. The Hospital Pharmacists Association of Ireland (HPAI) is currently involved in negotiations with the Department of Health/HSE regarding the implementation of new career structures, as detailed in the *Report on the Review of Hospital Pharmacy*.[75] If successful, this will help to validate specialist pharmacist posts.

The Pharmacy Education and Training Reform Programme, which got underway in Spring 2013, comprised the following elements:

- *Core Competency Framework for Pharmacists*, which was published in August 2013 by the Pharmaceutical Society of Ireland (PSI).[76] This document sought to provide a platform for the development of advanced/specialist practice frameworks.
- The Irish Institute of Pharmacy (IIOP) was established at the Royal College of Surgeons in Ireland (RCSI) in 2014. The RCSI facilitates training and education for specialisation and advanced practice.

## 17.3 Current service provision

**Technician services:** OLCHC has a twice-weekly ward top-up to ensure there is an efficient drug supply of all stock medicines to the unit. TSCUH does not currently have a PCCU technician service.

**PCCU pharmacists:** There is a Monday to Friday daily clinical review of patients resident in PCCU, including providing advice on therapeutic drug monitoring, drug handling in critically ill children, including during the utilisation of CVVH and ECLS, IV infusion compatibilities, and the management and weaning of sedatives and analgesia.

The PCCU pharmacist:

- Orders/dispenses all non-stock medicines (OLCHC only). In TSCUH, the PCCU pharmacist oversees the dispensary supply of medicines to PCCU.
- Provides safe prescribing training of PCCU medical trainees.

- Reports PCCU medication errors and medication safety issues.
- Inputs to PCCU clinical and nursing guidelines, SOPs and drug monographs.
- Provides educational lectures to PCCU nursing staff from both sites as part of the Graduate Diploma in Nursing (Paediatric Critical Care), CVVH and ECLS Specialist Training Courses.

## 17.4 Programme metrics and evaluation

- Medication error reports
- Number of PCCU patients without daily clinical pharmacist review
- Number of paediatric centres without access to appropriate and current paediatric medicines information
- Number of infusions not administered via a smart-pump drug library.

## 17.5 Proposed model of care

### Recommendation 1 (based on UK PICS, 2015)[18]

Increase PCCU pharmacy resources to:

- 0.1 WTE post per Level 3 Critical Care bed, at senior pharmacist grade or higher.
- 0.07 WTE post per Level 2 Critical Care bed, at senior pharmacist grade.
- Provision of on-call 24/7 access to a specialist PCCU pharmacist.

Adequate clinical pharmacist resourcing would facilitate the following:

- All patients in PCCU should receive a daily clinical pharmacy review of all medications. Current resources often only allow partial unit review.
- PCCU pharmacists should attend morning and evening ward rounds.
- The number of patients for whom individualised weaning schedules can be provided should be extended. Current weaning is suboptimal and may be delaying extubation and discharge from PCCU.
- Medicine reconciliation should be carried out on all admissions to and discharges from PCCU in line with the recent HIQA recommendations *Principles of Good Practice in Medication Reconciliation*.[77] The transcription from electronic to paper orders is a particularly problematic area at the point of discharge from PCCU.
- All medication-related guidelines and protocols should be completed and kept up to date.

- Research on medication use in PCCU should be facilitated to reduce the extensive lack of evidence-based practice.
- Regular rotation of all senior pharmacists (or equivalent future grade) to PCCU should be carried out at each respective site for training purposes and to facilitate covering in the absence of the PCCU pharmacists.

### Recommendation 2

- A lead clinical PCCU pharmacist and a joint PCCU pharmacy working group should be appointed to agree clinical governance structures that will facilitate further standardisation of all guidelines, including IV administration guidelines, electronic drug files, drug formulary and protocols across both sites. This would also facilitate input into paediatric-specific national guidelines.

### Recommendation 3

Provision of further informatics pharmacy resources to:

- Continued support and implementation of a national drug library of paediatric standard concentration infusions should be allowed to all sites involved in the stabilisation, transfer and care of critically ill neonatal and paediatric patients.
- A review of current clinical information management system (CIMS) configuration in TSCUH should be allowed to facilitate the implementation of electronic prescribing at that site using the OLCHC drug file.
- The increased use of pharmacy informatics such as automated dispensing cabinets and barcoded single-use medications should be facilitated.

### Recommendation 4

A dedicated part-time pharmacy resource allocated to IPATS and NNTP should be provided to improve current paper-based medication processes and to assist in the development of guidelines for the stabilisation of all neonatal and paediatric patients in non-specialist centres prior to transfer to a PCCU bed.

# 18. END-OF-LIFE CARE

## 18.1 Palliative care

Infants and children with a diagnosis of a life-limiting condition may benefit from an increased focus on the relief of distressing symptoms and on accepting enhanced quality of life over increased quantity of life. The principles of symptom relief and palliative care management may be incorporated into daily medical and nursing care of children in the PCCU.

Some children who have had a complicated clinical course or multiple PCCU admissions have particular needs with regard to symptom management. Additional advice should be available from the hospital's palliative care medicine team. Referral to the palliative care medicine team may occur while the child is in PCCU and they will contribute to the multidisciplinary care of the sick infant or child. Children who are clinically stable may be discharged to the ward with ongoing medical care from their primary team and the palliative care medicine team.

## 18.2 Organ donation in PCCU

There is a worldwide shortage of donated organs for transplantation in infants and children. To increase the availability of organs for children and adults who require transplantation, there should be a close referral relationship between PCCU and Organ Donation and Transplant Ireland (ODTI).

Organ and tissue donation is an important element of PICM and should be supported in practice with supporting clinical pathways, guidelines, audit and staff training. In each PCCU, there should be a clinical lead for organ donation among the paediatric consultant intensivist staff to provide leadership to the PCCU multidisciplinary team.

## 18.3 Bereavement support

When a child dies in the PCCU, it has profound emotional and psychological effects on the child's family and the PCCU team who have been caring for the child. Standardised formal support should be provided in the PCCU and as part of wider hospital services. Bereavement support may take many forms in order to meet a wide range of needs. Memory-making, open family visiting, photography, and clay handprints are some of the immediate supports that may be considered. For some children, extubation and end-of-life care at home may be possible. Families should be offered the opportunity to return to the hospital for bereavement follow-up in the weeks following the death of their child. Communication with the child's general practitioner and public health nurse, and appropriate referral

and signposting to community-based supports, e.g. Anam Cara and FirstLight, are necessary steps in the discharge process after death.

Multidisciplinary support for families and staff may be provided by a combination of psychology, social work, pastoral care, peer support and collegiality. Encouraging a culture of emotional support within the PCCU on a daily basis is key to compassionate care for all involved in the care of critically ill children.

# 19. PSYCHOLOGICAL SERVICES

## 19.1 Paediatric Liaison – Psychological Medicine for Paediatric Critical Care

Admission of a child to PCCU can be a traumatic event. Twenty-one per cent of children admitted to PCCU had symptoms of post-traumatic stress disorder (PTSD) following their PCCU admission.[78] Children may also develop depression and other anxiety disorders associated with their admission, which can impact on treatment, comorbidity and longer-term outcomes. Parents too may experience significant depression and anxiety. Consideration should be given to providing psychological support for children and parents after PCCU admission.[78]

### Neuropsychiatric/neuropsychological consequences of PCCU

There is evidence that following intensive care treatment and significant medical illness or surgery there can be neuropsychological and neuropsychiatric symptoms that may be persistent.[79,80] The Paediatric Liaison/Psychological Medicine team provide specialist assessment and follow-up of paediatric patients where these consequences of critical illness are a concern and should be part of routine care and follow-up.

### Psychiatric presentations complicating PCCU admission – children with ASD, ADHD, ID

For children with pre-existing mental health or psychiatric disorders, admission to PCCU can be particularly stressful. Children with autism spectrum disorder (ASD) and learning disabilities, such as attention deficit hyperactivity disorder (ADHD) and intellectual disability (ID), can pose challenges for care. Paediatric Liaison/Psychological Medicine specialists provide assessment and specialist support, guidance and treatment approaches for children with these difficulties to support them and their families through their intensive care admission and afterwards.

### Psychological support for parents in PCCU

Both mental health and family dynamics can be affected by the PCCU admission. Parents who experience the stress of PCCU need appropriately trained and specialist support and intervention. When child maltreatment or abuse is a concern, Paediatric Liaison can assist medical social workers in their assessment of risk and intervention approaches.

There are several therapeutic approaches now proven to be effective in addressing the mental health needs of children and parents in the PCCU and NICU.[81]

### Staff education and support

Paediatric Liaison/Psychological Medicine specialists are trained to provide education and support to staff in PCCU in the area of psychological stress encountered in the workplace. Support may include case or individual supervision, reflective group process and complex case reviews.

### Service staff complement

- A consultant paediatric liaison psychiatrist would be available to provide clinical cover to the PCCU and NICU.
- A clinical psychologist would provide psychological assessment and therapeutic support to paediatric CCU and NICU.
- A clinical nurse specialist would provide specialist nursing liaison and education to nursing staff. These staff would form part of a multidisciplinary team approach to the mental healthcare of PCCU/NICU patients and their families.

## 19.2 Clinical psychology

The role of the psychologist in the PCCU has been acknowledged internationally as crucial in assisting patients and their families in coping with the devastating effects of a critically ill child. A large body of literature has accumulated over the last 20 years which recommends that psychological support within the PCCU for child, parent, family and staff is an essential requirement for good patient outcomes and a healthy and efficient workforce. Rees *et al.* carried out a retrospective cohort study in 2004 and concluded that PTSD diagnosis and symptomatology is significantly more common in families where a child has been admitted to PCCU.[78] Their recommendations suggested that consideration should be given to providing psychological support for the children and parents during their PCCU admission. Less well recognised, however, are the problems posed for those who work in an intensive care unit and who provide the complex medical and nursing care required by critically ill, often dying patients.

The significant increased psychological need of patients, parents and staff appears to be due at least in part to advances in critical care that have led to increased survival, raised expectations of parents in terms of survival, and their increased involvement with the decision-making about their child's care on PCCU.[82] A small number of parents without past mental health issues appear to develop significant psychological reactions above the normal level of distress expected when their child has a prolonged

PCCU admission, which can interfere with medical intervention when unaddressed and cause significant stress to staff.

The patient journey through PCCU is often complicated with many aspects to treatment and care. Parents can often struggle with the complexity of the situations they are presented with and require more than parental support that is currently provided by the medical, nursing and medical social work teams. Often parents require the unique skill set of a psychologist and the provision of some form of psychotherapy. This is in line with the *National Standards for Paediatric Critical Care Services* in Ireland.[5]

### Psychology provision in PCCU

The role for dedicated psychology provision in the PCCU is also outlined in the Faculty of Intensive Care Medicine's *Guidelines for the Provision of Intensive Care Services* (2015)[83] with the following recommendations. A senior psychologist should:

- Provide psychological support to patients, relatives and staff, with evidence showing that all three groups suffer from significant stress and traumatic reactions.
- Provide staff with group stress management and drop-in sessions, in efforts to support and retain staff with onward referrals as needed outside the organisation.
- Provide training to increase staff knowledge and understanding of psychological reactions and psychological outcomes of patients.
- Increase staff competency in providing basic psychological support to critical care patients, particularly those who are distressed, agitated, hallucinating or delusional.
- Play a role within the multidisciplinary team, attending ward rounds, and being available for consultation by other staff on matters relating to communication, sleep, effects of sedation, anxiety, stress, mood, delirium and family issues.
- Be involved in developing holistic care plans for long-stay patients in conjunction with medical social work colleagues.

All available guidelines in Ireland and internationally advocate that to fulfil all of these important roles a large unit should employ a full-time senior psychologist. At the very least, units should have access to dedicated sessions from a senior psychologist. This is not currently the situation in ROI, with psychology provision available only on a limited emergency rota basis.

# 20. ALLIED HEALTH PROFESSIONALS IN PCCM

## 20.1 Physiotherapy

### Background

Physiotherapy is an integral and important part of the treatment and management of infants and children with a wide range of complex conditions in the CCU. The Physiotherapy Departments in OLCHC and TSCUH provide a 24/7/365 service to all respiratory patients in the hospitals including the CCUs. Physiotherapy is the only AHP group that provide an on-call and weekend service.

### Role of physiotherapist in PCCU

The role of the physiotherapist in the PCCU includes:

- Respiratory physiotherapy
- Modified bronchoalveolar lavage (MOD BAL)
- Active assisted and passive range of movement for patients on ECLS
- Early mobility and rehabilitation for different patient groups
- Early neurorehabilitation for neurosurgical patients
- Mandatory on-call training package for non-critical care physiotherapists
- Evidence-based practice PCCU physiotherapy clinical guidelines
- Induction of new staff members
- Undergraduate training

### On-call and weekend respiratory physiotherapy service

The Physiotherapy Departments in OLCHC and TSCUH provide a 24/7/365 service to all respiratory patients in the hospital but largely the CCUs, with TSCUH providing some orthopaedic and neurosurgical cover also. In each setting, there is 1 WTE physiotherapist allocated to cover weekend duty Friday, Saturday and Sunday night on call, and Saturday and Sunday day duty. There is 1 WTE physiotherapist allocated to on-call duty each weekday night.

### Education, training and competencies

In addition to managing a clinically complex caseload and supervising junior staff, education and training of non-critical care physiotherapy staff providing an on-call and weekend service demands

experienced senior and clinical specialist physiotherapy staff. The rotation of junior staff through PCCU also achieves competency for the on-call and weekend service.

Currently, there is no specialist training for PCCU physiotherapists in ROI. Due to the unique nature of the job role, it is necessary to attend courses and conferences abroad to maintain, develop and share expertise. For example, there exists a working group in the UK for PCCU physiotherapists which is affiliated to the Association of Paediatric Chartered Physiotherapists (APCP). The meetings are educational and run on a six-monthly basis. Attendance from Ireland would be highly recommended.

Mandatory on-call training and ongoing CPD is completed regularly by each PCCU and non-PCCU physiotherapist in order to maintain competencies. The Physiotherapy Departments in OLCHC and TSCUH also have a commitment to the training of undergraduate physiotherapists.

Each member of the Physiotherapy Department is eligible for membership of the Irish Society of Chartered Physiotherapists (ISCP), the national physiotherapy professional body which entitles the member to use the title 'Chartered Physiotherapist'. Chartered physiotherapists represent the highest standard of practice and service and set the benchmark for professional practice in Ireland.

The physiotherapy profession is also currently undergoing regulation by CORU, Ireland's multi-profession health regulator. CORU aims to protect the public by promoting high standards of professional conduct, education, training and competence through statutory registration of health and social care professionals.[84]

### Allocation of staff

In either of the paediatric hospitals there is no physiotherapist specifically allocated to the CCUs alone.

- Based on our statistics, in OLCHC there are 2.3 WTE physiotherapy posts allocated to cover 25 PCCU beds.
- In TSCUH, the staffing provision is 1 WTE physiotherapists for the nine-bedded PCCU.

The 2009 clinical guidance, *Rehabilitation after Critical Illness*, of the National Institute for Health and Care Excellence (NICE)[85] suggests staffing levels are 1.0 WTE physiotherapist to four Level 3 critical care beds: 'Physiotherapy staffing should be adequate to provide both the respiratory management and rehabilitation components of care.'

The UK Intensive Care Society Standards Committee[86] recommend a staffing ratio of 1.0 WTE physiotherapists to 4.8 critical care beds, assuming an occupancy at 100%, a physiotherapy referral

rate of 90% and a single physiotherapy session of 30 minutes each day or 0.2 WTE dedicated physiotherapists per critical care bed. In terms of paediatric-specific physiotherapy staffing, no critical care bed ratios exist.

### Future workforce planning

The NCH has planned for 42 PCCU beds. It is imperative that future workforce planning in relation to physiotherapy services includes serious consideration to staffing of the day-to-day, on-call and weekend service for this bed number, ensuring adequate skill mix and senior level support (see Table 20.1). Staffing levels should also reflect the demand for the provision of on-call training and competency skills for non-critical care staff and the need for specialised overseas education opportunities in order to maintain and develop this level of expertise.

**Table 20.1: Current and future physiotherapy staffing**

| | Current staffing (both sites) | Proposed NCH staffing |
|---|---|---|
| PCCU beds | 34 | 42 |
| Weekend duty | 2 WTE | 4 WTE |
| Day-to-day duty | 3.3 WTE | 8.2 WTE |

## 20.2 Occupational Therapy

### Background

Occupational therapy is an essential component of the multidisciplinary team in the CCU and plays an integral role in the rehabilitation process. Occupational therapists (OTs) facilitate early mobilisation, restore function, prevent further decline, and coordinate care including transition and discharge planning.[87] OTs have a good understanding of the match between the patient's needs, abilities and environment, which assists the patient's successful transition to the home, community or next level of care.[87]

### Role of OT in PCCU

The initial role of the OT in the PCCU includes the prompt identification of changes in body structures and functions that place a child at risk of longer-term impairments.[88] An experienced OT carries out assessments when the child is sufficiently medically stable to assess their ability to engage and participate in different occupations. Consideration is given to the child's tolerance, response to the environment, communication ability, sensory processing and liaison with the family/caregivers and the multidisciplinary team (MDT).

The roles of the OT in the PCCU includes:

- Provision of positioning aids for optimal positioning and to support respiratory care
- 24-hour postural management and pressure care interventions
- Prescription and provision of specialised seating
- Prescription and fabrication of thermoplastic splints to maintain or increase joint range of motion
- Advice on moving and handling to facilitate activities of daily living
- Advice to support carer–child bonding and contact
- Prescription and advice on adaptions to PCCU environment to limit sensory overload
- Parental coaching to interpret the child's sensory processing cues
- Assessment and management of tone
- Commencement of rehabilitation
- Support for discharge from PCCU and transitions to ward or home
- Support for children and their families to adapt to any loss of function.

### On-call and weekend occupational therapy service

To date, occupational therapy staffing has not included on-call services for critical care nor has it included weekend working. HSE services (under the direction of the 2013 Haddington Road Agreement)[89] will move towards a seven-day service provision. It is therefore essential that consideration be given to increasing occupational therapy resources working in critical care. This will ensure sufficient staffing numbers for continuity of care for this patient cohort and will further enable development of this vital role.

### Education, training and competencies

OTs working in critical care must be at a minimum of senior grade in order to take a clinical lead role within this area. This requires at least three years' experience post-qualification from an undergraduate BSc Occupational Therapy or MSc Occupational Therapy and CORU registration.84 All occupational therapy staff, including students, working in critical care environments should receive clinical and professional supervision. There is currently no standard training that needs to be maintained on an annual basis to work in the critical care environment. Staff are required however to commit their CPD to achieve and maintain competence in assessment and interventions appropriate to critical care. Core competencies for clinical specialist, senior and staff grade OTs have been outlined by the Association of Occupational Therapy of Ireland (AOTI) and the Therapy Project Office.[90]

Competencies for OTs specifically working in the critical care setting should be developed. These may incorporate domains such as: (1) principles of critical care; (2) interventions for critically ill children; (3) communication; (4) optimising rehabilitation and quality of life; (5) care planning and collaborative practice; and (6) professional and ethical practice in the context of critical care.

### Allocation of staff

Currently, there is no dedicated OT working in a CCU in the Children's Hospital Group or nationally (see Table 20.2). Children referred for occupational therapy are allocated a therapist based on the admitting specialty area and/or the relevant competencies required according to the child's case. Workforce planning for the NCH urgently requires a review of this situation to ensure appropriately skilled and dedicated staffing for the PCCUs are part of the workforce. Staffing resources need to be a combination of clinical specialist, senior and staff grades.

**Table 20.2: Current and proposed dedicated OT working in CCU**

| OLCHC current staff | TSCUH current staff | NCH proposed staff (UK ratio) |
|---|---|---|
| 0 | 0 | 8.75 |

### Future workforce planning

The establishment of dedicated OT posts within the CCU is a necessity for the Children's Hospital Group to address the primary needs of vulnerable and critically ill children. Additional staffing is an essential requirement to support future service developments.

## 20.3 Speech and Language Therapy

### Background

Children and infants who are admitted to PCCU are at risk for a range of communication, feeding and swallowing disorders. Oral feeding is a complex skill requiring the integration of breathing, sucking and swallowing in the context of overall motor stability and incoming sensory stimuli.[91,92,93] It depends upon brainstem central pattern generators whose activity is increasingly influenced by chemosensory and oral tactile input.[94,95,96] For the preterm infant, the transition to oral feeding from gavage (tube) feeding can be a challenge, as it requires the ability to coordinate the muscles of the jaw, lips, tongue, palate and pharynx, upper trunk and respiratory systems in order to support a safe swallow. It is also dependent on normal sensory functioning, for example, the presence of reflexes of rooting, gagging, swallowing, as well as intraoral and pharyngeal sensation. Therefore, both sensory and motor systems must reach a critical stage of development for the infant to be able to feed orally. Speech and communication is also integrally related to the development of these same subsystems, as well as depending on overall developmental skills and progression.

Children who had birth trauma, prenatal and perinatal asphyxia, and a multitude of genetic syndromes with accompanying structural and neurologic impairment are also at high risk for swallowing and feeding dysfunction.[97] In addition to specific aspects of oropharyngeal dysphagia, swallowing and feeding problems in infants and young children can result from or be exacerbated by neurologic, airway, respiratory, craniofacial, gastrointestinal, nutritional, and behavioural/interaction factors.

In PCC, the following patient groups are likely to require specialist speech and language therapy input:

- Tracheostomy
- Sick neonates
- Ventilated patients
- Acquired brain injury patients
- Neurosurgical and neurology patients
- Complex cardiac conditions
- Complex respiratory conditions
- Craniofacial patients
- Complex ENT and airway presentations
- Minimally conscious patients

- Life-limiting conditions/end-of-life care

Intubation and tracheostomy have long been associated with high risks of dysphagia (swallowing difficulties) and aspiration. The prevalence of swallowing dysfunction after extubation has been reported in 20–83% of adult patients intubated for longer than 48 hours. Swallowing problems may be undiagnosed in the critical care population due to silent aspiration, yet have a greater impact in this vulnerable group. Long duration of mechanical ventilation is independently associated with post-extubation dysphagia, which is independently associated with the need for tracheostomy, longer hospitalisation and poor patient outcomes.

**Feeding/swallowing/dysphagia**

Speech and language therapists (SLTs) have extensive knowledge of anatomy, physiology, and functional aspects of the upper aerodigestive tract for swallowing and speech across the age spectrum, including infants and children. The upper aerodigestive tract includes oral, pharyngeal and cervical oesophageal anatomic regions. Speech language pathologists also have extensive knowledge of the underlying medical and behavioural aetiologies of swallowing and feeding disorders. In addition, they have expertise in all aspects of communication disorders that include cognition, language and behavioural interactions, many of which may affect the diagnosis and management of swallowing and feeding disorders. Because of the complexities of assessment and treatment in most persons with swallowing and feeding disorders, speech language pathologists and other professionals work as a team with families, caregivers and patients. Those teams may vary in their composition of specialists depending on the setting, population, and needs of individuals.[98]

**Communication/speech and language**

Communication difficulties will arise associated with ventilation, intubation and other comorbid conditions that the patient may present with in CCU (i.e. prematurity, acquired brain injury, tracheostomy, complex neurological conditions). SLTs have clinical expertise in the assessment and management of communication difficulties, whether they arise due to the nature of the underlying medical conditions (e.g. COPD); due to concomitant conditions (e.g. neurogenic conditions); or due to the presence of equipment/technologies used to support life (e.g. tracheostomy). SLT expertise is therefore integral to the critical care multidisciplinary approach, providing specialist knowledge and skills which all people with complex communication or swallowing needs should be entitled to access.

**Minimally conscious patients and vegetative state**

The essential defining characteristics of an individual in a minimally conscious state (MCS) are a limited level of awareness of self and/or surroundings with a limited ability to respond or communicate.[99] However, among individuals in MCS there is definite evidence of awareness despite profound cognitive impairment.[100] SLTs in conjunction with OTs and clinical neuropsychologists have become increasingly involved in the assessment and management of vegetative state and MCS patients. The expertise of these groups of clinicians in supporting and refining diagnostic assessment has been recognised and indeed recommended.[101] SLTs working with minimally conscious patients have an important role in determining suitable oral stimulation and hygiene protocols in addition to providing environmental stimulation to encourage responsiveness and general communication.

### Role of SLTs in PCCU

The role of the SLT in critical care working within the MDT includes:

- Using specialist skills to inform differential diagnoses regarding the nature and cause of communication and swallowing difficulties, including higher level cognitive-linguistic difficulties, cognitive difficulties and disorders of consciousness.
- Carrying out specialist instrumental assessment for swallowing difficulties, such as fibreoptic endoscopic evaluation of swallowing (FEES) and videofluoroscopy, where appropriate.
- Providing specific communication and swallowing rehabilitation, goals, programmes, equipment and advice to optimise and maintain function, in liaison with the MDT.
- Providing screening, assessment and advice on laryngeal injuries and dysphonia, and tracheostomy speaking valve use.
- Providing training to the MDT and carers regarding communication and swallowing difficulties, in areas such as screening and managing non-complex difficulties.
- Assessing and managing swallowing and communication in ventilator-dependent and tracheotomised patients, contributing to the MDT assessment of weaning and the ability of the patient to safely swallow oropharyngeal secretions and oral diet and fluids.
- Identifying communication and swallowing difficulties that may impact on the patient's ability to function in their normal environment, and support appropriate discharge destination planning and referral to rehabilitation if required (including patients with higher-level cognitive communication difficulties).

- Carrying out clinical audit and engaging in collaborative research (e.g. user experience) and evaluating patient outcomes of SLT intervention.[3,18]

### Education, training and competencies

The education, training and CPD required for SLTs to implement the model of care for the NCH involves:

- Adherence to CPD standards as outlined by the Irish Association of Speech and Language Therapists and the statutory registration board for health and social care professionals (CORU).[84]
- Maintenance of dysphagia competencies in neonates, paediatrics and instrumental procedures.
- Maintenance of skills in tracheostomy and long-term ventilated patients for both communication and feeding.
- Engaging in training of other healthcare professionals involved in the MDT.

**Quality improvement**

- SLTs must maintain and update knowledge and skills according to:
    - IASLT tracheostomy management clinical guidelines (2017)[102]
    - RCSLT knowledge and skills framework: videofluoroscopic evaluation of oropharyngeal swallowing: paediatric competencies (2013)[103]
    - RCSLT FEES guidelines (2015)[104]
    - RCSLT five good communication standards (2013)[105]
    - RCSLT position paper on speech and language therapy in adult critical care (2014)[106]
    - IASLT feeding, eating, drinking and swallowing standards of practice (2012)[107]
    - IASLT feeding, eating, drinking and swallowing standards of practice for neonates and babies (2013)[108]
    - Communication Matters, AAC Service Standards (2012).[109]
- Participation in regular and ongoing audit, research and quality improvement.
- Development and review of clinical guidelines for SLTs working in ICU.
- Access to supervision and training.
- Ensure implementation of training to facilitate good communication standards for vulnerable patients, according to the Royal College of Speech and Language Therapists (RCSLT) in 2013.[105]

### Allocation of staff

The current service provision in the Dublin acute paediatric hospitals (TSCUH and OLCHC) are as follows (see also Table 20.3).

**TSCUH Speech and Language Therapy Department**

- No specific SLT allocation to the CCU alone.
- An approximate average of 1.2 WTE dedicated towards assessing and treating patients under the following specialities: Neurology, Neurosurgery, Cleft Lip and Palate, and general paediatric dysphagia referrals that would include Neonatology and ICU referrals. This would also include an assignment to Videofluoroscopy Feeding Clinics.

**OLCHC Speech and Language Therapy Department**

- 0.5 WTE senior SLT post for TCU (i.e. long-term ventilator-dependent seven-bedded unit).
- 1.5 WTE senior SLT post in Cardiology.
- No specific SLT allocation to ICU or Critical Care.
- No specific SLT allocation to neonatal services.

**Table 20.3: Current service provision in TSCUH and OLCHC**

| Specialty | TSCUH SLT Dept | OLCHC SLT Dept |
|---|---|---|
| CCU/Cardiology | – | 1.5 WTE |
| Neurology/Neurosurgery/Cleft Lip and Palate/General Paediatric Dysphagia Referrals (incl. Neonatology/ICU referrals)/ Videofluoroscopy Feeding Clinics | 1.2 WTE | 0.0 WTE |
| TCU | – | 0.5 WTE |
| ICU/Critical Care | 0.0 WTE | 0.0 WTE |
| Neonatal services | 0.0 WTE | 0.0 WTE |

### Future workforce planning

There is no current SLT allocation to critical care at OLCHC. There has been a 0.5 WTE senior SLT allocated to TCU for long-term ventilator-dependent children since 2006. However, there has been no increase in TCU or PICU SLT staffing allocation since 2006, despite the considerable growth in both numbers of patients and patient complexity. Therefore, there is an urgent need for the following allocation to implement the PCC model of care:

- 1.0 WTE clinical specialist SLT in critical care
- 1.0 WTE senior SLT in critical care.

## 20.4 Medical Social Work

### Background

The medical social worker is an integral part of PCC by providing essential psychosocial support to the parents and families of the children attending the unit. The emotional and practical support provided to parents at this time is a vital part of their understanding and management of the family crisis that surrounds the serious ill-health of a child.

### Role of medical social worker in PCCU

The medical social worker's main role is to support patients and their families with any psychological, emotional, social or practical difficulties associated with their child's illness or condition. A medical social worker provides families with:

- Help in coping with illness and the impact of a child's illness on parents. This can be especially important for those dealing with a new diagnosis or a serious deterioration in a child's health status.
- Counselling and support in relation to managing traumatic events causing their child to be admitted to the CCU.
- Support and liaison in situations where other family members have been involved in the trauma causing the admission.
- Support and assessment of parents with pre-existing vulnerabilities that may impact on their ability to parent during the child's admission (e.g. addiction issues, mental health history).
- Assessment and support to parents where the child's admission is the result of neglect or abuse, including linking with the appropriate authorities in relation to same, and ensuring that the hospital undertakes its responsibilities in these situations under national child protection guidelines.
- Support for families whose children are facing end-of-life care and working with them to make the most suitable and appropriate arrangement for end-of-life care.
- Bereavement support and counselling.
- Advice on practical and financial matters, including accommodation for parents, liaising and organising financial support as needed, preparing letters and forms for various support schemes.

- Support for families and staff in a situation where there is conflict or disagreement, especially when parents do not understand or agree with the plan for the ongoing care of their child.
- Support for families where cultural or religious aspects of their lives present challenges to them while their child is in CCU.
- Support and advocacy for families where parents are not in an ongoing relationship but who wish to be involved in their child's care during the critical period in the unit.
- Liaison with CCU staff where a family's social issues present challenges in their presentation or management in CCU.

### Education, training and competencies

In order to carry out the complex and challenging work of a medical social worker in PCCU, the social workers in this unit should be at senior medical social work grade or experienced main grade. At this level, the medical social worker will:

- Possess advanced clinical skills in social work, including the areas of child protection, end-of-life care, bereavement work, and dealing with families with a complex social background.
- Be well experienced in providing clear communication with medical nursing and HSCP colleagues in a complex and challenging environment.
- Have the ability to mentor and supervise staff with less experience.
- Be experienced in a co-working model with a social work colleague, should the need arise.
- Have an in-depth knowledge of national policies and legislation pertinent to the care of children in CCU.

### Allocation of staff

At TSCUH, there is currently 1.5 WTE senior medical social worker providing full cover to the PCCU (see Table 20.4). In OLCHC, medical social work cover is provided by the social worker allocated to the speciality under which the child is admitted.

### Future workforce planning

In order to address the size and volume of work that will be created for medical social worker in the NCH, it is critical that the number of senior and main grade medical social workers are appointed to ensure that the families of the children admitted there are adequately supported. It is expected that

four senior medical social workers and four experienced main grade medical social workers would be the minimum required to serve 42 PCCU beds and 18 NICU beds (see Table 20.4).

**Table 20.4: Proposed medical social work cover for NCH**

| TSCUH current staffing | OLCHC current staffing | Proposed NCH staffing* |
|---|---|---|
| 1.5 WTE† | 1 WTE‡ | 4 WTE Senior MSW<br>4 WTE Main Grade MSW |

* Minimum required to serve 42 PCCU beds and 18 NICU beds.
† Senior medical social worker providing full cover to the PCCU.
‡ Social worker allocated to the speciality under which the child is admitted.

## 20.5 Clinical Nutrition and Dietetics

### Background

Critically ill infants and children have complex, frequently changing nutritional requirements. They are at significant risk of both undernutrition and overnutrition, as well as cardiovascular, respiratory and immune system dysfunction and necrotising enterocolitis. Undernutrition occurs more frequently, with 24–53% of children developing significant protein-energy malnutrition during their PCCU stay. This can lead to impaired wound healing, muscle and immune function and increased rates of sepsis.[110] The impact of undernutrition is more significant in paediatric and neonatal populations.[111]

The presence of dedicated dietetic services for ICU is associated with better nutritional performance and better patient outcomes.[112,113,114,115] Implementation of feeding protocols improves nutritional intake in critically ill children.[116]

### Role of dietitian in PCCU

Substantial input from the dietitian is essential in this patient group. Dietitians have unique expertise in:

- Nutritional assessment
- Calculation of nutritional requirements
- Provision and monitoring of enteral and parenteral nutrition support
- Assessment and monitoring of growth
- Provision of therapeutic diets and transition to normal, age-appropriate feeding.

**Clinical service delivery**

- A clinical specialist dietitian should take a lead role in developing and delivering the clinical nutrition and dietetic service in PCCU.
- All admissions to PCCU should be screened and, where nutrition support is indicated, referred to the dietitian for assessment.
- The dietitian should lead the development of guidelines for out-of-hours enteral and parenteral nutrition support and educate the MDT on their use.
- The dietitian should attend ward rounds and MDT meetings.
- The dietitian should ensure appropriate transfer of nutritional care when patients are discharged to other clinical areas and other institutions (including in Northern Ireland).

### Education, training and competencies

A dietitian working in a PCCU must be a clinical specialist or at senior level, with extensive experience of nutritional assessment and anthropometry in paediatrics, nutrition support and disease-specific dietary interventions.

**Quality improvement**

- Participation in regular and ongoing audit, research and quality improvement.
- Development and review of clinical guidelines and nutrition care pathways and algorithms for PCCU.
- Education, training and CPD:
    - Adherence to CPD standards as outlined by the Irish Nutrition and Dietetic Institute (INDI) and the statutory registration board for health and social care professionals (CORU).[84]
    - Development of and participation in a regular and ongoing programme of education of all ICU staff and other dietitians.
    - Provision of ICU-specific competencies for dietitians that encompass clinical, strategic, educational and research roles.

### Allocation of staff

The current service provision is outlined for OLCHC and TSCUH (see Tables 20.5 and 20.6).

**OLCHC**

**Table 20.5: OLCHC dietetic provision**

| Unit | Beds | WTE senior dietitian |
|---|---|---|
| CCU | 23 | 1.0* |

* 0.5 WTE funded and 0.5 WTE allocated from departmental resources.

- This allocation allows only the highest priority patients to be assessed and reviewed, at the expense of less complex patients and non-clinical duties.
- In 2015, there were 181 new and 2061 review patient contacts. This figure is consistent with previous years.

**TSCUH**

**Table 20.6: TSCUH dietetic provision**

| Unit | Beds | WTE senior dietitian |
|---|---|---|
| CCU | 9 | 0.5* |
| HDU | 6 | 0.5* |

* These posts are allocated from departmental resources with no dedicated funding.

- These allocations are frequently inadequate, resulting in diversion of dietetic resources to provide prioritised cover. This compromises service provision in other clinical areas within the hospital.
- In 2015, there were 295 new and 1736 review patient contacts in ICU and HDU. This represented an increase of more than 45% when compared with 2014.

### Future workforce planning

The proposed service provision is outlined for the NCH (see Table 20.7).

- Current or planned PCCU beds should be associated with dedicated staffing of 0.1 WTE post per bed, at clinical specialist or senior grade.[86]
- There are currently 32 CCU beds and 6 HDU beds across both sites.
- It is anticipated that there will be 42 critical care and 18 neonatal intensive care beds in the NCH.

**Table 20.7: Current and proposed dietetic staffing**

| Current staffing | Proposed staffing (interim) | Proposed staffing for NCH |
|---|---|---|
| 1.0 WTE senior dietitian, OLCHC<br>1.0 WTE senior dietitian, TSCUH | 3.8 WTE senior dietitians | 1.0 WTE clinical specialist dietitian<br>5.0 WTE senior dietitians |

# 21. CLINICAL INFORMATICS AND BIOMEDICAL ENGINEERING

## 21.1 Biomedical Engineering (Healthcare Technology/Clinical Engineering and Medical Physics)

### Background

Optimal and safe use of medical technology requires more than the devices to be properly procured, commissioned and maintained.[117,118,119,120,121] It requires an MDT approach where clinicians and allied health professionals work together to advance care through the application of technology at the point of care. Currently, in the PCCU environment, clinical engineers are employed as health professionals who play an important role in providing specialist skill and knowledge of the technology and the environment in which the equipment is used. Healthcare technology management is a term used to describe this approach, which combines clinical and technical skills.[122] Given the diversity of equipment used in PCC setting, the clinical engineers who support the PCCU will be a dedicated group who will specialise in supporting this department.

### Role of clinical engineer in PCCU

The clinical engineering role is an integral part of the MDT in PCC and the expertise of clinical engineers is essential in providing specialist engineering skills and knowledge at the point of care to support the specialist medical devices and therapies. These include but are not limited to:

- High frequency ventilation (Oscillator)
- Neurally adjusted ventilatory assist (NAVA)
- Delivery of nitric oxide
- Paediatric retrieval and transport team
- Internal hospital paediatric transport
- Application of CPAP and BiPAP
- Transport of ECLS patients between departments within the hospital
- Administration of volatile anaesthetics to invasively ventilated patients (AnaConDa)
- Humidification and delivery of nebulised therapies, including AIRVO
- Integration, management and support of medical devices into clinical information systems.

### On-call and weekend service

Currently, clinical engineers support a 9 to 5 service during normal working hours. However, in the 24/7 service provision demanded in the PCCU environment, this needs to be augmented with a 24-hour on-call service by clinical engineers to ensure availability for emergency support out of hours. This has staffing implications.

### Teaching and training

Training in the optimal and safe use of medical devices is required not only during commissioning but over the lifetime of that device. Training deals with the practical operational aspects of a medical device or technology in a clinical setting. Training helps ensure patient safety and reduces adverse events. Without it, the risks of adverse events increase. The clinical engineering team in PCCU, recognising the importance of user training, will provide this to medical and nursing staff, operating in cooperation with the medical and nursing leadership and training departments within critical care.

### Research and development

The Healthcare Technology Department (HTD), which includes clinical engineers, will contribute to research of a general medical and scientific significance. Clinical engineering staff working within the PCCU have the opportunity to participate in research and development activity usually concerned with the development of new medical devices and systems. This includes developing methods for data collection and analysis, developing new devices to make measurements or indeed the development of one-off devices or software to allow the research to progress. This also includes keeping up to date with current and future developments and improvements involving medical devices and their associated consumables and accessories.

### Equipment management

The healthcare technologies in PCC are an essential infrastructure and represent a considerable financial investment. This includes planning for the upkeep and replacement of equipment over time, optimising their utilisation and ensuing they are maintained appropriately. The HTD will assume responsibility for medical device asset management across the hospital, and the clinical engineering team in PCCU will do so for equipment in that area.

Over the course of its life, a device will need to be maintained and three types of maintenance activities need to be considered:

- **Scheduled maintenance** consists of all proactive activities whose purpose is to prevent failure and maintain functionality of the device.
- **Unscheduled maintenance** covers all reactive actions which are initiated as a result of a reported real or suspected fault or failure of a device or system.
- **Performance verification** includes all proactive processes that assure devices which appear to be working are in fact working optimally.

With the opening of the NCH these maintenance activities will be managed by clinical engineers/medical physicists supported by contracted services provided by the equipment manufacturers. An equipment support plan will be established for each device and documented in a centralised electronic equipment asset management system.

### Maintenance and repair of medical devices within PCC in NCH

The PCCU clinical engineering operational policy will be written to ensure that equipment, which is not suspected of failure, is kept close to the point of care ready for use. Where equipment is suspected of failure, it will be triaged at the point of care and if repair can be achieved at the point of care, it will be done so. It is only if this cannot be achieved that equipment will be transported to the main department for maintenance action.

The main HTD located at lower ground floor will be augmented by dedicated healthcare technology support workshops and equipment storage in PCCU. This will provide a base for the clinical engineering staff assigned to support PCC, and also other members of the team based in the main department who will need to attend to activity in the unit as required.

### Education, training and competencies

All clinical engineering and medical physics staff working in the PCCU will have the relevant qualifications and experience for their grades in accordance with HSE guidelines.[123] Clinical engineers working unsupervised in critical care should be at a minimum of senior grade. This requires staff to hold a recognised Level 7 or higher qualification in one of the following engineering disciplines: Electronic, Electrical, Instrument Physics, Industrial Instrumentation, Applied Physics, Mechanical, Mechatronic or Biomedical Engineering, or hold a recognised qualification at least equivalent to one of the above; and have a minimum of three years' postgraduate satisfactory and relevant experience in an appropriate medical industry field with at least two years in a clinical engineering environment.

The minimum qualifications for the principal clinical engineering grade are the same but the experience requirement is for five-year postgraduate experience in an appropriate medical industrial field, with at least three years of which should be in a clinical engineering environment.

All clinical engineering staff working in critical care environments should receive scientific, clinical and professional supervision. Staff will be expected to commit to CPD to achieve and maintain competence in accordance with professional norms.

### Governance of PCCU clinical engineering staff in NCH

The Biomedical Engineering Department within OLCHC provides an essential service to PCCU, theatre and the wards. This is a unique service which is integral to the successful application of medical devices in all these three different clinical situations. Clinical engineers working within the PCCU fall within the remit of medical director of PCCU; and in the development of the HTD, which includes clinical engineers, it is critical that there is a close relationship between medical PCCU clinical staff and the HTD.

### Future workforce planning

The exact complement of clinical engineering staff assigned to the PCCU in the NCH has yet to be determined and will be influenced by the final agreed operating model. It will also be influenced by the final operational model of support for electronic health records (EHRs) and clinical systems, which has yet to be determined between the HTD and ICT. Nevertheless, it is envisaged that three healthcare technology staff will be based in the unit and supported by close involvement of at least three others who will be part of the critical care support team providing services from the main department (see (Tables 21.1 and 21.2). To ensure a flexible, holistic and sustainable approach, it is best to regard these as WTE posts rather than named individuals assigned solely to support PCC.

**Table 21.1: Current clinical engineering staff dedicated and assigned to PCCU**

| Site | Senior clinical engineer | Principle clinical engineer |
|---|---|---|
| OLCHC | 2 WTE * | 0.5 WTE |
| TSCUH | 0 | 0 |

*6 within hospital environment.

**Table 21.2: Proposed clinical engineering staff dedicated and assigned to PCCU**

| Site | Principle clinical engineer* | Senior clinical engineer* |
|---|---|---|
| NCH | 1 WTE | 2 WTE |

* Additional support will be drawn as required from the hospital Healthcare Technology Department.

## 21.2 Data Management

The increasing complexity of care given in PCCU dictates that a fully integrated clinical information system is required for the effective, efficient, electronic charting of medical/nursing flow sheets, medical notes, device data logging (clinical telemetry), medication ordering, administration and safety. Consequently, the Philips IntelliSpace Critical Care and Anaesthesia (ICCA) clinical information system was installed in OLCHC and TSCUH in 2012 and is the core responsibility of the PCCU data manager (ICCA system administrator) and the informatics pharmacist under the direction/governance of the PCCU medical director to maintain ICCA on a continuous basis.

Since OLCHC/TSCUH PCCU is committed to the international benchmarking of quality of care, it is also the duty of the data manager alongside the research/audit nurse to continue to submit admissions data to the Paediatric Intensive Care Audit Network (PICANet). PICANet is an international audit of paediatric intensive care which collects data on all children admitted to PCCUs in the UK and Ireland and is coordinated by the Universities of Leeds and Leicester. OLCHC has been submitting anonymised data since 2009 and TSCUH since 2010; data declared is in accordance with Irish data protection law.

### Roles and responsibilities

The role of PCCU data manager is broadly divided into:

- System administration and clinical informatics management
- Data extraction, processing and analysis.

**System administration and clinical informatics management**

- **ICCA system administration:** Configuration of ICCA, medical device integration, troubleshooting, vendor relations, liaison with other hospital departments, user management and systems integration.
- **Pharmacy informatics**: Joint responsibility alongside the informatics pharmacist for the implementation/configuration of medication ordering, administration and safety.
- **User training:** Training in the use of ICCA for medical/nursing staff and for medications ordering for those with prescriber permission.

- **Systems reporting:** Medical handover, admission/discharge documentation, medication administrations report, line insertion/care audit.

**Data extraction, processing and analysis**

- **PICANet:** Management, extraction and processing of data for submission to PICANet.
- **NOCA/SARI**: Notification and case submission to external audits such as the National Office of Clinical Audit (NOCA) and the Severe Acute Respiratory Infection (SARI) surveillance programme.
- **Annual report:** Authoring of PCCU annual report.
- **Research/Audit**: Data extraction, analysis and statistics support for research/audit activities, including provision for MSc/PhD projects, requests for cohort data and service planning.
- **Publications and presentations:** Lead analyst for research publications, poster and oral presentations.

Both aspects of the role of data manager abide by:

- **Data protection:** Ensure that patient-sensitive data remains secure and in accordance with ICT data protection policy and Irish data protection law.
- **Risk assessment:** Presentation, support and follow-up of concerns raised at risk assessment meetings (Risky Huddle) relating to charting in ICCA, care audit and data analytics.
- **Good clinical practice (GCP):** Registered and maintained GCP accreditation is required in order to facilitate participation in multicentre studies.

### Skills

Given the complexity of data systems in PCCU, it is advisable that the PCCU data manager skill set should primarily be sourced from the IT and data analytics sector; it is not sufficient to upskill candidates from a medical/nursing background. IT knowledge takes absolute precedence over medical knowledge and shortcomings in medical guidance will be provided for by the interdisciplinary expertise of the PCCU medical team.

The data manager skill set should encompass most of the following:

- System administration of a complex medical/charting clinical information system, medical device integration, user training and vendor negotiation.

- Database management, reporting, data validation and dataset extraction; SQL (structured query language), Microsoft Access, MySQL, MS SQL reporting services.
- Demonstrable expertise in MS Office (Excel, Word, Access, PowerPoint) and complex data manipulation, presentation and graphing therein.
- Extensive experience of clinical audit and/or research.
- Ability to process/analyse data and write data extraction code in at least one computer language: Visual Basic, C, C++, C#, PHP, Python, R, SAS, SPSS or similar. Internal formulae and calculations in ICCA are written in Visual Basic.
- Compliance with data protection law at all times.

### Allocation of staff

Currently, OLCHC employs 1.0 WTE data manager specialising in ICCA system administration, clinical informatics management and user training and 0.6/0.4 WTE in OLCHC/TSCUH specialising in reporting, data extraction, data processing, analytics and research/audit, although facets of both posts are interchangeable (see Table 21.3). There are also 1.0/0.5 WTE clinical audit/research nurses in OLCHC/TSCUH who are responsible for the submission of data to PICANet, data validation, liaison with medical/nursing staff regarding data entry and provision of medical knowledge support to the PCCU data managers.

The new NCH with a 60-bedded PCCU configured across the four requirements of Cardiac, General PCCU, Neonates and HDU would need 4.0 WTE data managers in order to effectively and safely manage system administration, training of nursing/medical staff, bedside troubleshooting, reporting, data validation and analysis; 1.6 WTE per 23 beds in OLCHC extrapolates to 4.17 per 60 beds (see Table 21.4). The number of clinical audit/research nurses will also need to increase and should be accounted for in the submission from Nursing.

**Table 21.3: Current data management staff in PCCU**

| Site | Data manager (ICCA)* | Data manager (Reporting/research)† | Clinical audit/research nurses |
|---|---|---|---|
| OLCHC | 1.0 WTE* | 0.6 WTE | 1.0 WTE |
| TSCUH | 0.0 WTE | 0.4 WTE | 0.5 WTE |

* Specialising in ICCA system administration, clinical informatics management and user training.
† Specialising in reporting, data extraction, data processing, analytics and research/audit.

**Table 21.4: Proposed data management staff in NCH PCCU**

| Site | Data manager | Clinical audit/research nurses |
|---|---|---|
| NCH | 4.0 WTE | 2.0 WTE |

### Data protection

Recording, processing, storing and reporting of patient data is to remain in accordance with hospital ICT policy and Irish data protection law. Freedom of information requests are facilitated by the PCCU data manager but must be formally requested and released through the hospital's Information Office and in accordance with the permissions and direction of the PCCU medical director. Requests for cohort data and data analysis for the purposes of clinical audit and research must be submitted via a Data Request Form and permission sought from the PCCU medical director. The PCCU medical director is to retain data control at all times. Patient identity is pseudo-anonymised as standard unless medically directed otherwise and only in accordance with data protection policy.

### Data governance

Currently, there is no data governance arrangement between OLCHC and TSCUH and as such no patient data is shared across the two sites. The intended policy of one service, two sites does not currently extend to the seamless transition and integration of electronically charted patient records.

### Recommendations

The post of PCCU data manager should report directly to the PCCU medical director, while the portion of work pertaining to the upkeep of the pharmacy functionality in ICCA should also hold joint responsibility with the PCCU informatics pharmacist.

The clinical functionality of ICCA as determined by its configuration and use should remain the responsibility of the PCCU medical director and change implemented as part of the clinical decision-making process. As such, the positions of ICCA system administrator, PCCU data manager and informatics pharmacist should not be subsumed by the department of ICT and conversely the roles and associated responsibilities will not set precedence for ICT.

Relations with stakeholders from ICT, theatre, medical records, HIPE and other hospital departments are to be maintained through the PCCU medical director.

## 22. LIST OF ABBREVIATIONS

| | |
|---|---|
| AAC | augmentative and alternative communication |
| AAGBI | Association of Anaesthetists of Great Britain and Ireland |
| AAMI | Association for the Advancement of Medical Instrumentation |
| AAP | American Associated Pharmacies |
| ACC | adult critical care |
| ACCM | adult critical care medicine |
| ACCU | Adult Critical Care Unit |
| ADHD | attention deficit hyperactivity disorder |
| AGP | aerosol-generating procedure |
| AHP | allied health professional |
| ALSG | Advanced Life Support Group |
| AMMI | Association of Medical Microbiology and Infectious Disease (Canada) |
| AMOC | Adult Anaesthesia Model of Care |
| AnaConDa | anaesthetic conserving device |
| ANP | advanced nurse practitioner |
| ANSI | American National Standards Institute |
| AOTA | American Occupational Therapy Association |
| AOTI | Association of Occupational Therapy of Ireland |
| APCP | Association of Paediatric Chartered Physiotherapists |
| APLS | advanced paediatric life support |
| ASD | autism spectrum disorder |
| ASHA | American Speech-Language-Hearing Association |
| ASHP | American Society of Health-System Pharmacists |
| BAL | bronchoalveolar lavage |
| BiPAP | bilevel positive airway pressure |
| CAEP | Canadian Association of Emergency Physicians |
| CAI | College of Anaesthesiologists of Ireland |

| | |
|---|---|
| CAU | Children's Assessment Unit |
| CCCU | Cardiac Critical Care Unit |
| CCCS | Canadian Critical Care Society |
| CCM | critical care medicine |
| CCU | Critical Care Unit |
| CDC | Centers for Disease Control and Prevention |
| CDH | congenital diaphragmatic hernia |
| CEO | chief executive officer |
| CHI | Children's Health Ireland |
| CIMS | clinical information management system |
| CIVAS | Centralised Intravenous Additive Service |
| CNM | clinical nurse manager |
| CNS | clinical nurse specialist |
| COPD | chronic obstructive pulmonary disease |
| CORU | Health and Social Care Professionals Council |
| CPAP | continuous positive airway pressure |
| CPD | continuing professional development |
| CSCST | Certificate of Satisfactory Completion of Specialist Training |
| CT | cardiothoracic |
| CT | computed tomography |
| CVP | central venous pressure |
| CVVH | continuous venovenous hemofiltration |
| DCYA | Department of Children and Youth Affairs |
| DIC | disseminated intravascular coagulation |
| DNV | Det Norske Veritas |
| DOH | Department of Health |
| DOHC | Department of Health and Children |
| DON | director of nursing |
| ECLS | Extracorporeal Life Support |

| | |
|---|---|
| ED | emergency department |
| EEG | electroencephalogram |
| EHR | electronic health record |
| ELSO | Extracorporeal Life Support Organization |
| ENT | ear, nose and throat |
| ET | endotracheal |
| EU | European Union |
| EVD | Ebola virus disease |
| EWTD | European Working Time Directive |
| FEES | fibreoptic endoscopic evaluation of swallowing |
| GCP | good clinical practice |
| GCS | Glasgow Coma Scale |
| GI | gastrointestinal |
| HCS | health care scientists |
| HDC | high dependency care |
| HTD | Healthcare Technology Department |
| HDU | High Dependency Unit |
| HIPE | Hospital Inpatient Enquiry |
| HIQA | Health Information and Quality Authority |
| HPAI | Hospital Pharmacists Association of Ireland |
| HPSP | Health Protection Surveillance Centre |
| HR | human resources |
| HSCP | health and social care profession |
| HSE | Health Service Executive |
| HVA | hazard vulnerability assessment |
| IASLT | Irish Association of Speech and Language Therapists |
| ICCA | IntelliSpace Critical Care and Anaesthesia |
| ICM | intensive care medicine |
| ICNARC | Intensive Care National Audit and Research Centre |

| | |
|---|---|
| ICSI | Intensive Care Society of Ireland |
| ICT | information and communications technology |
| ICU | Intensive Care Unit |
| ID | intellectual disability |
| IIOP | Irish Institute of Pharmacy |
| INDI | Irish Nutrition and Dietetic Institute |
| IPATS | Irish Paediatric Acute Transport Service |
| ISCP | Irish Society of Chartered Physiotherapists |
| ISMP | Institute for Safe Medication Practices |
| IT | information technology |
| IV | intravenous |
| JCAHO | Joint Commission on Accreditation of Healthcare Organizations |
| JFICMI | Joint Faculty of Intensive Care Medicine of Ireland |
| LOS | length of stay |
| LTV | long-term ventilation |
| MCI | mass casualty incident |
| MDT | multidisciplinary team |
| MICAS | Mobile Intensive Care Ambulance Service |
| MMUH | Mater Misericordiae University Hospital |
| MOC | model of care |
| MRCPCH | Membership of the Royal College of Paediatrics and Child Health |
| MRCPI | Membership of the Royal College of Physicians of Ireland |
| MRI | magnetic resonance imaging |
| MSW | medical social worker |
| NAS | National Ambulance Service |
| NASCCRS | National Ambulance Service Critical Care Retrieval Services |
| NAVA | neurally adjusted ventilatory assist |
| NCH | National Children's Hospital |
| NCHD | non-consultant hospital doctor |

| | |
|---|---|
| NCNM | National Council for the Professional Development of Nursing and Midwifery |
| NCP | National Clinical Programme |
| NCPCC | National Clinical Programme for Critical Care |
| NEOC | National Emergency Operations Centre |
| NI | Northern Ireland |
| NICU | neonatal intensive care unit |
| NISTAR | Northern Ireland Specialist Transport and Retrieval |
| NIU | National Isolation Unit |
| NMBI | Nursing and Midwifery Board of Ireland |
| NNTP | National Neonatal Transport Programme |
| NOCA | National Office of Clinical Audit |
| NSTT | non-specialist transport team |
| NTMP | National Transport Medicine Programme |
| OLCHC | Our Lady's Children's Hospital, Crumlin |
| ODTI | Organ Donation and Transplant Ireland |
| OT | occupational therapist |
| PACT | Post-Anaesthetic Care Tool |
| PACU | Post-Anaesthesia Care Unit |
| PAMOC | Paediatric Anaesthesia Model of Care |
| PBLS | paediatric basic life support |
| PCC | Paediatric Critical Care |
| PCCG | Paediatric Critical Care Group |
| PCCM | Paediatric Critical Care Medicine |
| PCCMOC | Paediatric Critical Care Model of Care |
| PCCU | Paediatric Critical Care Unit |
| PCCMDS | Paediatric Critical Care Minimum Data Set |
| PEWS | Paediatric Early Warning System |
| PHDU | Paediatric High Dependency Unit |
| PICANet | Paediatric Intensive Care Audit Network |

| | |
|---|---|
| PICM | Paediatric Intensive Care Medicine |
| PICS | Paediatric Intensive Care Society |
| PICU | Paediatric Intensive Care Unit |
| PLS | Paediatric Life Support |
| PMOC | Paediatrics Model of Care |
| PPE | personal protective equipment |
| PRHDU | Paediatric Regional High Dependency Unit |
| PSI | Pharmaceutical Society of Ireland |
| PTSD | post-traumatic stress disorder |
| QQI | Quality & Qualifications Ireland |
| RCOA | Royal College of Anaesthetists |
| RCPI | Royal College of Physicians of Ireland |
| RCSI | Royal College of Surgeons in Ireland |
| RCSLT | Royal College of Speech and Language Therapists |
| RHDU | Regional High Dependency Unit |
| ROI | Republic of Ireland |
| RRT | renal replacement therapy |
| RVCH | Royal Victoria Children's Hospital |
| SARI | severe acute respiratory infection |
| SAT | specialist anaesthesia training |
| SCBU | Special Care Baby Unit |
| SCI | standardised concentration infusion |
| SHPA | Society of Hospital Pharmacists of Australia |
| SLT | speech and language therapist |
| SOP | standard operating procedure |
| SpR | specialist registrar |
| SVT | supraventricular tachycardia |
| TSCUH | Temple Street Children's University Hospital |
| TCU | Transitional Care Unit |

| | |
|---|---|
| TPE | therapeutic plasma exchange |
| UCD | University College Dublin |
| UK | United Kingdom |
| US | United States |
| VAD | ventricular assist device |
| WHO | World Health Organization |
| WTE | whole-time equivalent |

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