NOCA National Office of Clinical Audit

IPCCA Irish Paediatric Critical Care Audit

IRISH PAEDIATRIC CRITICAL CARE AUDIT
NATIONAL REPORT 2017-2019

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NATIONAL OFFICE OF CLINICAL AUDIT (NOCA)

ACKNOWLEDGEMENTS

Irish Paediatric Critical Care Audit

National Report 2017-2019

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17th September, 2021

Dear Dr Healy,

I wish to acknowledge receipt of the *Irish Paediatric Critical Care Audit National Report 2017-2019.*
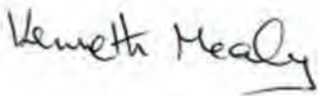
Following your presentation to the NOCA Governance Board on the 16th September 2021 and feedback garnered from our membership, we are delighted to endorse this report.

I wish to congratulate you, Audit Manager Dr Cliona McGarvey and your governance committee in the development of this report which is a valuable quality improvement initiative.

The Board commends your and your colleagues' sustained efforts over several years in finalising this comprehensive first annual report focused on paediatric critical care patients.

Please accept this as formal endorsement from the NOCA Governance Board of the *Irish Paediatric Critical Care Audit National Report 2017-2019* and we wish you every success in your ongoing commitment to improving the care of paediatric critical care patients.

Yours sincerely,

Mr Ken Mealy
Chair
National Office of Clinical Audit Governance Board

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FOREWORD

This publication is the first Irish Paediatric Critical Care Audit (IPCCA) report under the governance of the National Office of Clinical Audit (NOCA) and covering the years 2017–2019. Until now, Republic of Ireland (ROI) paediatric intensive care quality metrics and case-mix-adjusted outcomes have been reported through submission to, and in collaboration with, the Paediatric Intensive Care Audit Network (PICANet) in the United Kingdom (UK). This has captured paediatric intensive care data for the two children's hospitals in the ROI: Children's Health Ireland (CHI) at Crumlin and CHI at Temple Street. Such specific, validated and benchmarked data are essential for the quality assurance of paediatric intensive care in the ROI.

In parallel with data capture at the ROI's two children's hospitals there is a need to capture all paediatric critical care activity at sites outside of CHI. Of note, 111 children aged 16 years or under were admitted to adult Intensive Care Units (ICUs) in the ROI (i.e. outside of CHI) in 2019. These data were captured from the adult Irish National ICU Audit (INICUA) dataset.

Now, through a collaboration across the INICUA and PICANet datasets, we are able to secure meaningful patient-level activity – similar to the adult INICUA dataset, which benchmarks in collaboration with the Intensive Care National Audit and Research Centre in the UK – and thus a composite picture of patient-level activity and case mix programme quality indices is now available for both adult and paediatric intensive care for all participating hospitals in the ROI.

The Irish National ICU Audit Governance Committee endorses and welcomes the significant work that all parties have contributed during a very difficult year in order to bring this report to publication.

Dr Brian Marsh
Chair, Irish National ICU Audit Governance Committee

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GLOSSARY OF TERMS AND DEFINITIONS

NAME	DEFINITION
bed days	This is calculated as the sum of children receiving intensive care in a Paediatric Critical Care Unit (PCCU) each day and is counted if a child is in a bed for any part of the day.
bed occupancy	This is expressed as the percentage of bed days used out of total bed days available each year.
CCRS	Critical Care & Retrieval Services
CDH	congenital diaphragmatic hernia
CHI	Children's Health Ireland
CIS	clinical information system
CPAP	continuous positive airway pressure
CVVH	continuous venovenous haemodialysis
ECLS	extracorporeal life support
ECMO	extracorporeal membrane oxygenation
ECPR	extracorporeal cardiopulmonary resuscitation
ED	Emergency Department
exomphalos	A type of abdominal wall defect that occurs when a child's abdomen does not fully develop while in the womb.
GDPR	General Data Protection Regulation
gastroschisis	A type of abdominal wall defect that occurs when a child's intestines develop outside of their abdomen while in the womb.
HFNCT	high-flow nasal cannula therapy
HIPE	Hospital In-Patient Enquiry
HRG	Healthcare Resource Group
HSE	Health Service Executive
ICU	Intensive Care Unit
ICNARC	Intensive Care National Audit and Research Centre
ICP	Intracranial pressure
INICUA	Irish National Intensive Care Unit Audit
IPATS	Irish Paediatric Acute Transport Service
IPCCA	Irish Paediatric Critical Care Audit
IQR	interquartile range
LOS	Length of stay
NAS-CCRS	National Ambulance Service – Critical Care & Retrieval Services
NAS	National Ambulance Service

NAME	DEFINITION
NHS	National Health Service
NI	Northern Ireland
NNTP	National Neonatal Transport Programme
NOCA	National Office of Clinical Audit
PCC	paediatric critical care
PCCU	Paediatric Critical Care Unit
PPHN	persistent pulmonary hypertension of the newborn
PHDU	Paediatric High Dependency Unit
PPI	Public and Patient Interest
PICANet	Paediatric Intensive Care Audit Network
PIM	Paediatric Index of Mortality
PIM3	Paediatric Index of Mortality 3
QQR	Quarterly Quality Report
RCSI	Royal College of Surgeons in Ireland
ROI	Republic of Ireland
SMR	standardised mortality ratio
UHG	University Hospital Galway
UHL	University Hospital Limerick
UK	United Kingdom
WTE	whole-time equivalent

EXECUTIVE SUMMARY

The Paediatric Intensive Care Audit Network (PICANet) collects information on all patients admitted to paediatric critical care units in the United Kingdom (UK) and the Republic of Ireland (ROI). The objective of this data collection is to measure the quality of care in Paediatric Critical Care Units (PCCUs) and benchmark this against other PCCUs across the UK. Since 2009, reports for the ROI have been produced within PICANet UK in conjunction with the ROI PCCU clinical leads. In 2015, the audit of paediatric critical care was incorporated into the National Office of Clinical Audit (NOCA), which provides support through a clinical audit team and an independent voluntary governance structure.

In 2020, it was agreed that NOCA, PICANet, and the PCCUs at Children's Health Ireland (CHI) at Crumlin and CHI at Temple Street would collaborate and produce a detailed national report for the ROI. This is the first report of the Irish Paediatric Critical Care Audit (IPCCA) produced under the auspices of NOCA, and it provides information on paediatric critical care activity in the ROI for the period from 2017 to 2019. In addition to data from specialised PCCUs and from transfer and retrieval services that traditionally provide data to PICANet, this report also includes data from adult Intensive Care Units (ICUs) and the regional Paediatric High Dependency Unit (PHDU) in University Hospital Limerick (UHL), giving a more complete description of national activity.

The PCCUs in the ROI admit an average of 1,500 patients per annum, with the potential to open 32 PCCU beds at any one time. During the period from 2017 to 2019, up to 10,000 bed days per annum were provided to paediatric patient groups. Bed occupancy exceeded the recommended limit of 85% in both PCCUs during this period and occupancy rates of up to 100% continue to be reported. This is due in part to the unavailability of open beds resulting from staff shortages. Such high occupancy levels contribute to the sudden, unexpected cancellation of semi-elective surgeries, leading to anxiety and upset for families. Crude bed occupancy figures do not reflect the complexity of the patient population in PCCUs which is evident in the breakdown of bedside nursing data (e.g. one-quarter (n=2000) of the total bed days required nurse–patient ratios of 2:1 or 3:1, as opposed to 1:1). An example of where these higher nurse–patient ratios would be required is the complex care of an infant receiving extracorporeal life support (ECLS) and requiring both ventilation and dialysis, which is the highest level of critical care and requires a nurse–patient ratio of 3:1. These higher nurse–patient ratios would show a bed occupancy of 110%, which is not a true reflection of this information.

It is evident from this review of the data that not all 32 funded PCCU beds were consistently open and staffed during the 2017–2019 reporting period. The importance of staff retention, recruitment and flexibility for covering sick leave and maternity leave should be prioritised in order to enable all 32 PCCU beds to remain open consistently throughout the year. Providing the resources adequate to maintain a bed occupancy rate of 85% would provide flexibility in order to cover surges such as flu pandemics and the winter surge, and avoid the late cancellation of semi-elective surgeries.

Despite the continuing high occupancy levels, Irish PCCUs are comparable to international centres with respect to key performance metrics, e.g. emergency readmission rates to PCCU within 48 hours, unplanned extubations, and standardised mortality ratios (SMRs). This underlines the importance of continued participation in an international audit such as PICANet. Overall, the 4% crude mortality rate and an SMR of 1.1 over 3 years for both Units in the ROI was in line with international standards benchmarked against 30 other PCCUs throughout the UK.

PICANet provides a robust mechanism through which to collect high-quality data to monitor and review outcomes. However, from a granular, descriptive perspective, the data in itself is limited. Through the collaboration between PICANet and NOCA, it is hoped to further expand on data description and provide a more detailed analysis of the patient case mix in Irish PCCUs in the future in order to report on narrower age categories, distinguish neonates from older infants,

and include a breakdown of age by gestation and by specific diagnoses with outcomes within specific diagnostic categories. Introduction of new patient metrics rather than service-centred metrics will also be explored.

The inclusion, for the first time, of data on children in adult ICUs from the Intensive Care National Audit and Research Centre (ICNARC) dataset and from the regional PHDU in UHL is welcomed, and it is hoped to extend this data collection to other Units nationally in the future. Provision of good-quality data on the critical care of all children throughout the ROI will assist with the planning of future workforce and bed requirements for paediatric critical care, particularly with the advancement and planned opening of the new National Children's Hospital in Dublin. Continuation and further development of the IPCCA will permit assessment of compliance with national standards as outlined in the *Model of Care for Paediatric Critical Care*, and enable efficient monitoring of outcomes in order to drive improvements in the quality of paediatric critical care medicine.

"THE INCLUSION, FOR THE FIRST TIME, OF DATA ON CHILDREN IN ADULT ICUS FROM THE INTENSIVE CARE NATIONAL AUDIT AND RESEARCH CENTRE (ICNARC) DATASET AND FROM THE REGIONAL PHDU IN UHL IS WELCOMED, AND IT IS HOPED TO EXTEND THIS DATA COLLECTION TO OTHER UNITS NATIONALLY IN THE FUTURE."

KEY METRICS

1	PICANet **METRIC 1**	**Case ascertainment and timeliness of data submission**	Case ascertainment: Almost all admissions (at least 95% in each participating Unit) were reported to PICANet in 2019. The completeness of patients' admission data within 3 months of their discharge from the Unit was 87% for Children's Health Ireland (CHI) at Crumlin and 92% for CHI at Temple Street, or 89% overall for the Republic of Ireland (ROI), over the 3-year period from 2017 to 2019.
2	PICANet **METRIC 2**	**Retrieval mobilisation times**	The Irish Paediatric Acute Transport Service (IPATS) achieved retrieval mobilisation times of less than 1 hour in the majority of urgent transfer events each year throughout the reporting period: 71% in 2017 (n=58), 67% in 2018 (n=56) and 72% in 2019 (n=59). An overall improvement in mobilisation times is evident compared to 2015 and 2016, with all teams mobilised within 180 minutes in 2018 and 2019, but ultimately remain constrained by the team's lack of co-location.
3	PICANet **METRIC 3**	**Number of qualified nurses per bed**	Nurse staffing levels in CHI at Crumlin met the recommended standard (Joint Faculty of Intensive Care Medicine of Ireland, 2018) of 5.5 whole-time equivalent (WTE) staff nurses per critical care bed for every year reported (with an average of 5.9 WTE nurses). Nurse staffing levels in CHI at Temple Street remained below this recommended standard each year, with an average of 4.7 WTE nurses per critical care bed. This has implications for the ability to open staffed PCCU beds on a continuous basis without fluctuations in bed numbers. Consistency in staffing allows the beds to remain open.
4	PICANet **METRIC 4**	**Emergency readmissions within 48 hours**	Of all PCCUs participating in PICANet, the Units in the ROI had the lowest rate of emergency readmissions within 48 hours during the 2017–2019 reporting period, at 1.5% (n=68).
5	PICANet **METRIC 5**	**Mortality in PCCU**	The mortality rate in PCCUs in the ROI is low, with 96% of patients discharged alive. Deaths in PCCU account for one in five deaths in the childhood population in the ROI in any given year. Risk-adjusted standardised mortality ratios (SMRs) for both Irish PCCUs indicate that neither Unit had a mortality rate higher than expected.

AUDIT FINDINGS

The total number of admissions of patients aged under 16 years to Paediatric Critical Care Units (PCCUs) in the Republic of Ireland (ROI) in the period from 2017 to 2019 was 4,407, with an annual average of 1,469.

The rate of admissions during this period, at 132 per 100,000 population, is the lowest of all countries contributing data to the Paediatric Intensive Care Audit Network (PICANet) and is 21% lower than that of Scotland, the country with the highest rate of admissions. This may reflect a lack of capacity due to high bed occupancy and pressure on PCCU beds in the ROI.

Both PCCUs in Dublin accept patients from all counties in the ROI. The counties with the highest rates of admission per 100,000 population (aged under 16 years) were Longford (174.4), Kildare (168.1) and Dublin City (163.9). The highest number of admissions in 2019 were from Co Dublin (n=491), followed by counties Cork (n=130) and Kildare (n=102).

Five percent of admissions (n=76) to PCCUs in the ROI in 2019 were from Northern Ireland, all of which were patients with cardiovascular diagnoses admitted to the Children's Health Ireland (CHI) at Crumlin PCCU, the National Centre for Paediatric Cardiology and Cardiothoracic Surgery.

CHI at Crumlin had the third-highest number of PCCU admissions (n=3074) of all Units in the United Kingdom (UK) and the ROI for 2017–2019. Admissions to the CHI at Temple Street PCCU increased by 20% from 2018 to 2019.

The greatest proportion of children admitted to both PCCUs in the ROI from 2017 to 2019 were unplanned (i.e. emergency) admissions. At CHI at Crumlin, this equated to 55% of admissions, and the majority of these were from within the same hospital (63%). In CHI at Temple Street, three-quarters of admissions to PCCU (76%) were unplanned, and the majority were transfers from another hospital (61%).

More than one-half (52%; n=2285) of patients admitted during the 3-year reporting period were infants aged under 1 year, and almost three-quarters (73%; n=3220) of patients admitted were aged under 5 years. A slightly greater proportion of patients across all age groups were male, with the exception of those aged 11–15 years.

Patients aged 16 years or over comprised 83 additional admissions to PCCUs in the ROI during 2017–2019.

The primary diagnosis of patients admitted to PCCU varied by Unit; over the 3-year reporting period the greatest proportion of admissions to CHI at Crumlin were patients with cardiovascular diagnoses (42%; n=1280), followed by those with respiratory diagnoses (23%; n=721). In CHI at Temple Street, most admissions were of patients with respiratory (35%; n=457) or neurological (22%; n=289) diagnoses. The pattern of admission diagnosis did not change for either Unit over the 3-year reporting period.

AUDIT FINDINGS

In 2019, 111 children aged under 16 years were admitted to adult Intensive Care Units (ICUs) in the ROI. The majority were admitted to Beaumont Hospital Richmond ICU (Neuro) (n=24) and University Hospital Galway (UHG) ICU (n=62), which was the only adult Unit that regularly admitted children aged under 16 years. Mean length of stay (LOS) in UHG was very short (17 hours), most likely indicating rapid transfer to a paediatric unit if intensive care was going to be prolonged.

The average number of bed days delivered in PCCUs in the ROI within the 3-year reporting period from 2017 to 2019 was 10,059 annually, increasing slightly each year. CHI at Temple Street provided an average of 2,327 bed days annually. CHI at Crumlin provided an average of 7,732 bed days annually, which is the third-highest number of bed days provided compared with all PCCUs in the UK and the ROI during this period.

Detailed bed activity data show that both PCCUs in the ROI exceeded the recommended occupancy limit of 85% each year during the reporting period from 2017 to 2019. The average bed occupancy over the 3-year reporting period was 96% in CHI at Crumlin PCCU, and averaged 100% in 2019. Bed occupancy data for CHI at Temple Street PCCU were only available for 2019, and showed an average 88% occupancy.

Bed occupancy levels have increased every year over the reporting period. PICANet census snapshot data show that the proportion of critical care beds occupied in both CHI PCCUs during normal hours in 2019 was 89% (n=24), having increased gradually from 78% (n=21) in 2017 and 82% (n=22) in 2018.

Median LOS in PCCUs in the ROI varied by Unit, age and primary diagnosis on admission, but was highest for infants aged under 1 year in both Units. The median LOS for the 3-year reporting period was 3.03 days for patients in CHI at Crumlin versus 1.84 days for patients in CHI at Temple Street.

Daily activity data show the different levels of critical care provided. Care at (or above) the level of Intensive Care Basic Advanced accounted for 40% of activity in CHI at Crumlin and 28% in CHI at Temple Street; this is reflective of the higher proportion of cardiac cases treated in CHI at Crumlin. This higher-intensity complex care requires an increased nurse–patient ratio at the bedside of 2:1.

Over the 3-year reporting period, 85% of patients admitted to PCCUs in the ROI required respiratory support: 62% (n=2738) received invasive ventilation (e.g. endotracheal tube) and 23% (n=1009) received non-invasive ventilation (e.g. nasal prong or continuous positive airway pressure).

In CHI at Crumlin, 47% (n=1460) of patients admitted from 2017 to 2019 received vasoactive medication, and this is reflected in the daily activity data. Seven percent (n=93) of patients in CHI at Temple Street, the national centre for paediatric neurosurgery, had an intracranial pressure (ICP) device placed.

AUDIT FINDINGS

Every year from 2017 to 2019, infants aged under 1 year accounted for the greatest proportion of patients admitted to PCCUs in the ROI who required assisted ventilation (whether invasive, non-invasive, or both).

From 2017 to 2019, a small number of patients (n=47) received extracorporeal membrane oxygenation (ECMO) in CHI at Crumlin; the majority of these had cardiac diagnoses (n=30). Nine respiratory extracorporeal life support (ECLS) runs were required by patients in CHI at Crumlin, a number of whom were transferred abroad.

Over the 2017–2019 reporting period, a total of 21 patients nationally were referred abroad to international ECLS centres for respiratory ECMO, as there is no formally funded and resourced paediatric respiratory ECMO programme in the ROI. Respiratory ECMO provides life-saving treatment for infants and children with very severe lung failure.

There has been a steady increase in children receiving high-flow nasal cannula therapy in both PCCUs in the ROI as this intervention has become more commonplace.

Transport was successfully arranged for all children accepted to a PCCU bed by one of a variety of transport teams. The Irish Paediatric Acute Transport Service (IPATS) transfers the majority of children who are referred during its current hours of activation. IPATS provides a predominantly consultant-delivered service, although this may change with the development of clinical fellowship and advanced nurse practitioner roles in 2021 and beyond.

The annual average rate of unplanned extubation per 1,000 intubated days was 4.0 per 1,000 in PCCUs in the ROI versus 4.4 per 1,000 across all PCCUs participating in PICANet. Both Units in the ROI fell below the acceptable threshold rate of 10 per 1,000 intubated days.

In 2019, following an audit of unplanned extubations in CHI at Temple Street, rates per 1,000 intubated days in 2018 (7.8) and 2019 (7.6) were twice that reported in 2017 (3.6). Areas of improvement were identified and changes have been implemented, leading to a decrease in the unplanned extubation rate in 2020. In CHI at Crumlin, a reduction in rates was observed, from 4.0 per 1,000 intubated days in 2017 to 2.4 in 2018 and 3.0 in 2019.

The only dedicated regional Paediatric High Dependency Unit (PHDU) operational outside of Dublin is in University Hospital Limerick (UHL), which had 2 available beds and 126 admissions in 2019. The majority (94%; n=119) were unplanned admissions presenting with respiratory (55%; n=69) or neurological (16%; n=20) complaints, and 10% (n=10) were transferred to a tertiary paediatric centre for PCCU (level 2 or 3) care, mostly for escalation of respiratory support.

KEY FINDINGS

Irish Paediatric Critical Care Audit 2017-19

CHI AT CRUMLIN

55%

55% of admissions to PCCU were unplanned (emergency) admissions

42%

42% of admissions were patients with cardiovascular diagnoses

23%

23% of admissions were patients with respiratory diagnoses

96%

96% average bed occupancy from 2017-2019, with 100% in 2019

3.03

3.03 days median length of stay

5.9

Average of 5.9 whole time equivalent staff nurses per critical care bed

72%

72% of IPATS journeys were started within one hour in 2019

85%

85% of patients required respiratory support

62% received invasive ventilation

23% received non-invasive ventilation
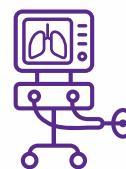
126

126 admissions to the regional Paediatric High Dependency Unit (PHDU) at University Hospital Limerick

94% were unplanned admissions presenting with respiratory (55%) or neurological complaints (16%)

4407
4407* admissions between 2017-2019

95%
95% data coverage

55%
55% male

45%
45% female

52%
52% were infants under one year

CHI AT TEMPLE STREET

76%
76% of admissions to PCCU were unplanned

22%
22% of admissions were patients with neurological diagnoses

35%
35% of admissions were patients with respiratory diagnoses

88%
88% average bed occupancy in 2019

1.84
1.84 days median length of stay

4.7
Average of 4.7 whole time equivalent staff nurses per critical care bed

21
21 patients nationally over the three-year period were referred abroad to international ECLS centres for respiratory ECMO

1.5%
1.5% of patients were readmitted within 48 hours of discharge – the lowest emergency readmission rate of all units participating in PICANet

96%
96% survival rate

* Patients aged 16 years or over comprised 83 additional admissions to paediatric intensive care units in Ireland during 2017–2019.

KEY RECOMMENDATIONS

RECOMMENDATION 1

Children's Health Ireland (CHI) should use the data in this report to work with the Health Service Executive (HSE) in order to inform the planning and implementation of adequate measures for optimising bed capacity in the Paediatric Critical Care Units (PCCUs) in the Republic of Ireland (ROI). Providing the resources adequate to maintain a bed occupancy of 85% would provide flexibility in order to cover surges such as flu pandemics and the winter surge, and avoid the late cancellation of semi-elective surgeries.

RECOMMENDATION 2

CHI and the National Ambulance Service – Critical Care & Retrieval Services (NAS-CCRS) should operationally enable the extension and development of the Irish Paediatric Acute Transport Service to a 24-hour-per-day, 7-day-per-week centralised transport service (CTS). This will help to ensure that a specialised paediatrics retrieval team transfers all critically ill children.

RECOMMENDATION 3

Procedures for recording, collecting and reporting data included in the Irish Paediatric Critical Care Audit (IPCCA), and submitted to the Paediatric Intensive Care Audit Network (PICANet) dataset, should be reviewed by the National Office of Clinical Audit (NOCA) and PICANet.

RECOMMENDATION 4

Future development of the IPCCA should be guided by a review of the scope and governance of the national clinical audit and should include additional detailed data, which will greatly add to the national overview of paediatric critical care.

CAPTURING PATIENT PERSPECTIVES

In 2021, I became a Public and Patient Interest Representative for the National Office of Clinical Audit, working in particular on the Irish Paediatric Critical Care Audit. My experience of Paediatric Critical Care Units (PCCUs) is as a parent of a child who has had a number of stays in the PCCU at Children's Health Ireland (CHI) at Crumlin. I am the proud mother of a 10-year-old boy with a serious congenital heart defect, and due to his condition, we have experienced the PCCU journey and all the emotions, trauma, highs and lows that go with it.

I am an active member of Heart Children Ireland, a charity that supports children and their families in Ireland who are coping with heart disease. Through my involvement with Heart Children Ireland, I was asked to be a Public and Patient Interest Representative on this audit. It is my privilege to be an advocate for families of children in the Republic of Ireland (ROI) who are exposed to the PCCU. As parents, we are the voice for our children. I am eager to enhance the clinical information gathered by sharing the experience, emotional effects and needs of parents and children in PCCU in the ROI. I believe that by marrying statistical data with this experiential narrative, we can make the PCCU a less scary and more comfortable place for our children and their families.

Gillian Nevin
Heart Children Ireland

Through my involvement with Heart Children Ireland, I was asked to be a Public and Patient Interest Representative on this audit. It is my privilege to be an advocate for families of children in the Republic of Ireland who are exposed to the PCCU.

CHAPTER 1
INTRODUCTION

CHAPTER 1: **INTRODUCTION**

PAEDIATRIC CRITICAL CARE IN IRELAND

A Paediatric Critical Care Unit (PCCU) is a specialised facility within a children's hospital that is charged with the care of infants and children, staffed by a specialist team and 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 diagnosed with life-threatening but potentially recoverable conditions, postoperative patients who may benefit from close nursing care, and children with chronic, complex medical comorbidities that exceed the care capabilities of other clinical care areas within the hospital.

In the Republic of Ireland (ROI), there are currently two dedicated PCCUs located in Dublin at Children's Health Ireland (CHI) at Crumlin (23 beds) and CHI at Temple Street (9 beds). The current combined capacity of the two PCCUs is 32 beds. The patient profile of the two Units differs; CHI at Crumlin is the National Centre for Paediatric Cardiology and Cardiothoracic Surgery, the National Paediatric Haematology/Oncology Centre and the National Paediatric Burns Unit. Major specialities at CHI at Temple Street include the national centre for paediatric neurosurgical cases and renal transplants as well as the National Paediatric Craniofacial Centre and the National Centre for Inherited Metabolic Disorders. The new National Children's Hospital – which will be located on a shared campus with St James's Hospital in Dublin – will house one large, state-of-the-art PCCU incorporating a general and cardiac care unit with a planned capacity of 42 beds, and a separate Neonatal Intensive Care Unit (NICU) with a planned capacity of 18 beds, making it one of the largest PCCUs in Europe.

The importance of audit in paediatric critical care (PCC) was outlined in the *National Standards for Paediatric Critical Care Services* (Joint Faculty of Intensive Care Medicine, 2013) developed by the Paediatric Critical Care Group and endorsed by the Intensive Care Society of Ireland. *The Model of Care for Paediatric Critical Care* (National Clinical Programme for Critical Care and National Clinical Programme for Paediatrics, 2019) defines the minimum requirements for a PCCU in terms of resourcing, staffing, delivery and governance.

The Paediatric Intensive Care Audit Network (PICANet) is an audit database, established in 2002, which aims to support the continual improvement of paediatric intensive care provision throughout the United Kingdom (UK) and the ROI by providing detailed information on paediatric intensive care activity and outcomes. This audit collects personal, organisational and clinical data on all infants and children with a clinically determined need for paediatric intensive care. It audits the quality of care delivered against the Paediatric Critical Care Society (PCCS) standards, which cover the entire patient pathway from initial referral to paediatric intensive care, specialist transport and inpatient care (Healthcare Quality Improvement Partnership, n.d.)

The PCCUs at CHI at Crumlin and CHI at Temple Street first submitted anonymised data to PICANet in 2009 and 2010, respectively.

The National Office of Clinical Audit (NOCA) works with PICANet in the UK to ensure appropriate processes of data validation and data analysis. PICANet produces annual audit reports, which monitor activity, and makes comparisons over a 3-year reporting period for PCCUs across England, Scotland, Wales, Northern Ireland (NI) and the ROI.

The PICANet audit includes data from all PCCUs in England along with two non-National Health Service (NHS) Units based in London; all PCCUs in Wales; two PCCUs in Scotland; one in NI; and two in the ROI. Hence, data are now captured from all Units in the UK and the ROI combined. There are 32 PCCUs and 12 specialist transport services currently submitting data to PICANet.

PICANet was established to develop and maintain a secure and confidential high-quality clinical database of paediatric intensive care activity across the UK and the ROI with the following objectives:

- identify best clinical practice
- monitor supply and demand
- monitor and review outcomes of treatment episodes
- facilitate healthcare planning and quantify resource requirements
- study the epidemiology of critical illness in infants and children.

The purpose of this first IPPCA National Report 2017–2019 is to provide an accurate measure of activity, level of care and case complexity across the two PCCUs in the ROI. In addition to the two specialised Units in CHI at Crumlin and Temple Street, there is a cohort of children cared for in regional Paediatric High Dependency Units (PHDUs) or in adult ICUs in regional hospitals across the ROI. Currently there are no accurate data available on the numbers of critically ill children cared for in these Units. Following the rollout of the Irish National Intensive Care Unit Audit (INICUA) to all adult ICUs, NOCA will capture data on all children cared for in adult ICUs in the ROI. This report will, for the first time, establish the levels of activity in regional PHDUs and adult ICUs in 2019.

NATIONAL OFFICE OF CLINICAL AUDIT

NOCA enables the continuous improvement of the healthcare system in the ROI by maintaining a portfolio of prioritised national clinical audits measured against national and international standards. By making reliable data available to those who use, manage and deliver healthcare, clinical audits help to refine Irish healthcare, improve patient outcomes and achieve change at local and national level. NOCA works to promote an open culture of shared learning through national clinical audit in order to improve clinical outcomes and patient safety.

NOCA is funded by the Health Service Executive (HSE) Office of the Chief Clinical Officer, is governed by an independent voluntary board, and is operationally supported by the Royal College of Surgeons in Ireland (RCSI) (Figure 1.1).
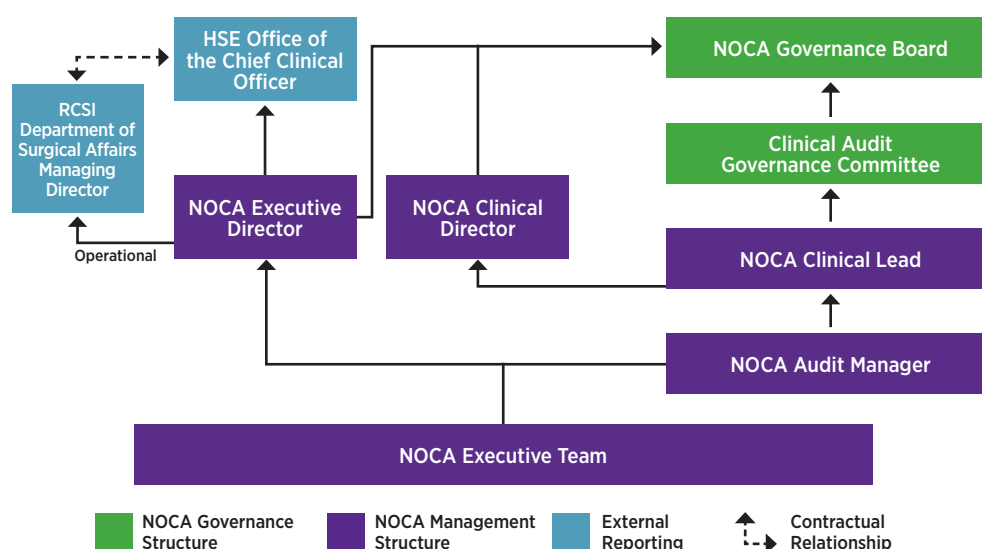
FIGURE 1.1: NATIONAL OFFICE OF CLINICAL AUDIT GOVERNANCE AND MANAGEMENT TEAMS FOR AUDITS

GOVERNANCE AND MANAGEMENT OF THE IRISH PAEDIATRIC CRITICAL CARE AUDIT

INICUA was established by NOCA in 2013 and focuses on the care of patients in ICUs. Patients cared for in these Units are the sickest patients in the hospital. The Irish National ICU Audit Governance Committee oversees two audits:

• INICUA, which focuses on the care of patients in adult ICUs
• the Irish Paediatric Critical Care Audit (IPCCA), which focuses on the care of patients in PCCUs.

The Irish National ICU Audit Governance Committee supports and advises the ICU audit clinical leads on the operation of the audits, and these clinical leads report to the NOCA Governance Board. In addition, the Irish National ICU Audit Governance Committee provides guidance on the strategic direction of the ICU audit programme. Members of the Committee include professional organisations, Public and Patient Interest (PPI) representatives, a senior accountable healthcare manager, the NOCA Clinical Lead for INICUA, the Clinical Lead for the IPCCA, the NOCA Executive Director, ICU audit managers, and representatives from the ICU audit coordinators. Membership is on a 3-year staggered term; please refer to Appendix 1 for a list of Irish National ICU Audit Governance Committee members in 2019.

The NOCA Governance Board has the authority to issue directions to NOCA management concerning the various audit streams. The INICUA audit team is supported by the NOCA Executive Team, which provides expertise in statistical analysis, data quality, and data management and information technology.

The Irish National ICU Audit Governance Committee developed the following aim and objectives for the IPCCA:

OUR AIM

The overall purpose of the IPCCA is to improve critical care services provided to paediatric patients by measuring the quality of care and outcomes against predetermined standards, using data from the UK and the ROI as a whole as a benchmark.

OBJECTIVE 1

Measure the quality of care in CHI at Crumlin and CHI at Temple Street, and benchmark this against other PCCUs across the UK.

OBJECTIVE 2

Provide data on the epidemiology and complexity of care provided for each patient. This has the potential to link in with best practice tariffs reimbursement in the future.

OBJECTIVE 3

Improve the quality of data for the Hospital In-Patient Enquiry (HIPE) scheme by providing data on diagnosis and procedures arising while the patient is in PCCU.

OBJECTIVE 4

Support Irish and international research in order to enhance patient care.

OBJECTIVE 5

Make recommendations based on validated data.

This is the first standalone IPCCA report, summarising:

- paediatric critical care that took place in PCCUs between 2017 and 2019 at two sites: CHI at Crumlin and CHI at Temple Street
- admission of children to adult ICUs across the ROI in 2019 (Chapter 4)
- admission of children to the regional PHDU in University Hospital Limerick (UHL) in 2019 (Chapter 9).

WHO IS THIS REPORT AIMED AT?

This report is intended for use by a wide range of individuals and organisations, including:
- patients and their parents and carers
- patient advocacy groups
- healthcare professionals
- hospital managers and Hospital Groups
- multidisciplinary teams (MDTs) caring for patients in PCCUs or ICUs
- policy-makers.

This report has been presented in two parts:
1. *The Irish Paediatric Critical Care Audit National Report 2017–2019,* presenting the key findings from the audit
2. The *Irish Paediatric Critical Care Audit 2017–2019: Summary Report.*

CHAPTER 2: **METHODOLOGY**

In the ROI, most critically ill children who need complex clinical care are treated in one of two specialist PCCUs. These children may have complex medical needs, undergone surgery, or suffered a trauma or a severe infection. Children are admitted to PCCU from the operating theatre, an Emergency Department (ED), or another ward in the hospital, or they may be transferred from another hospital.

The IPCCA collects demographic, organisational and clinical data on all infants and children with a clinically determined need for paediatric intensive care in the UK and the ROI. These data are used to compare outcomes and activity between PCCUs and specialist transport services as well as between health regions and nations.

There are three different datasets used in this report in order to audit the care given to children admitted to a PCCU or adult ICU in the ROI or to the regional PHDU in UHL:

1.   The PICANet dataset is used to audit data on children transported and admitted to PCCUs.

2.   The Intensive Care National Audit and Research Centre (ICNARC) dataset for adult ICUs is used to audit data on all children admitted to an adult ICU in the participating hospitals in 2019 (see Appendix 2 for a list of participating hospitals).

3.   An adapted PICANet dataset is used to audit data on all children admitted to the regional PHDU in UHL in a pilot study carried out in 2019.

DATASET 1: PICANET DATASET

PICANet is an international clinical audit of PCC activity in the UK and the ROI. It was established in 2002 with the aim of providing a secure and confidential high-quality clinical database of PCC activity (Paediatric Intensive Care Audit Network, 2020). It is now part of the National Clinical Audit and Patient Outcomes Programme and is recognised as the definitive source for PCC data in the UK and the ROI (Healthcare Quality Improvement Partnership, n.d.).

PICANet is used to audit the care provided to children admitted to PCCUs. It collects demographic and clinical data about the child and organisational data about the Unit, and the data are stored in a secure database. Each organisation can view and download its own data and report on its data quality and activity. PICANet publishes an annual report each autumn. Comparisons are made between PCCUs, and each Unit is assessed against established clinical standards and guidelines. PICANet reports on five key performance metrics, which are described in more detail in Table 2.1.

TABLE 2.1: PICANET KEY PERFORMANCE METRICS

Metric	Title	Description
METRIC 1	**Case ascertainment and timeliness of data submission**	This is a measure of how many admissions were reported to PICANet; 100% ascertainment means that information was received for all admissions.
METRIC 2	**Retrieval mobilisation times**	This measures the time it takes for the centralised transport service (CTS) team to start their journey to pick up a child who needs urgent PCC following a clinical decision that PCC transport is required.
METRIC 3	**Number of qualified nurses per bed**	In November each year, all PCCUs record how many qualified nursing staff are employed in the PCCU; both their total funded posts and any vacant posts are included.
METRIC 4	**Emergency readmissions within 48 hours**	For each PCCU, the frequency of emergency readmissions within 48 hours of discharge from the same Unit is recorded and compared to the average for the UK and the ROI. This is calculated using the admission and discharge dates and times. This relative readmission rate allows PCCUs to make comparisons between each other.
METRIC 5	**Mortality in PCCU**	Mortality (death) rates are assessed for every PCCU based on a statistical approach, which accounts for the severity of the child's illness at the time of admission. This is known as risk adjustment. The number of children predicted to die is calculated and then compared to the number who actually die in order to derive the risk-adjusted standardised mortality ratio (SMR).

Data entry and submission

The IPPCA uses PICANet's information technology (IT) infrastructure in order to collect audit data. The PICANet database is hosted in the University of Leeds Secure Electronic Environment for Data (SEED) system. The database enables the recording of admission, transport and referral event data, allowing real-time validation and reporting of the data. Hospitals' access to the database is restricted to each hospital's own data. Permission to access the PICANet web record for a named hospital or organisation (including retrieval teams) must be granted by the lead clinician.

Individual PCCUs submit data to PICANet using a secure web-based portal. Data submission can involve direct entry of patient data or the monthly upload of a data file from an existing clinical information system (CIS) by the data manager. If Units use their own CIS to collect data, the data are exported in a format specified by PICANet in order to allow them to be imported into the PICANet system. Completion of the PICANet data collection form on the CIS is mandatory and it should be completed at the bedside by nurses. Where a PCCU does not have a CIS, the patient flow sheet at the bedside, which includes the daily interventions, has a specific panel for PICANet data. The audit nurse checks the PICANet data daily on the CIS and patient flow sheets in order to ensure their completeness and correctness.

The data collected include the following:

- **Admission data:** These consist of each child's demographic details, including their date of birth, ethnicity and sex. The PICANet database also collects details about where children are admitted from, their date of admission, their clinical diagnoses, and some physiological parameters on admission to PCCU, including arterial blood gas results, blood pressure, medical history and ventilation status. Data on outcome and discharge details are also included. The medical interventions that each child receives each day are also recorded as part of the audit.
- **Referral data:** These include details of the referring hospital, demographic details about the child, the grade of the referring doctor or nurse, the transport team involved, and the destination PCCU.
- **Transport data:** These include details about the transport team, journey times, any interventions carried out, and critical incidents.

Each PCCU has a PCCU audit coordinator, a clinical audit and research nurse coordinator, or a data manager who is responsible for the local data entry and who is supported by a clinical lead. PICANet provides documentation on data definitions and standardised data collection forms for the users.

Information governance

PICANet processes data in accordance with the General Data Protection Regulation (GDPR) that came into effect across the European Union on 25 May 2018. Patient name and full address, while collected at hospital level, are not submitted to PICANet. The UK Information Commissioner's Office released a statement on 28 December 2020 that the treaty (UK-EU Trade and Cooperation Agreement) agreed between the UK and the European Union would allow personal data to flow freely from the European Union (and European Economic Area) to the UK until adequacy decisions were adopted with effect from 1 January 2021.

Inclusion criteria

This report includes analyses of all data reported to PICANet from the PCCUs in the ROI; that is, all admissions of children whose data were submitted to PICANet for reporting and validation from the two PCCUs in the ROI for the years 2017–2019.

Exclusion criteria

Data for patients admitted who are aged 16 years and over will be presented separately in Tables 4.1 and 4.2. Although the number is small, it will be counted in the total admissions recorded in Chapter 4 of this report.

WHO WE WORK WITH

CHI at Crumlin PCCU

This PCCU is a 23-bed Unit split over 2 floors. The Unit provides care from all specialties, including cardiothoracic surgery; general surgery; ear, nose and throat; plastic surgery; respiratory medicine; infectious diseases; general medicine; and haematology oncology. The Unit accepts more than 1,000 admissions per year and is one of the largest PCCUs in Europe.

CHI at Temple Street PCCU

This PCCU is a nine-bed Unit. The Unit provides care from all specialties, including trauma; orthopaedics; neurosurgery; endocrinology; nephrology; general paediatrics; ear, nose and throat; plastic surgery; inherited metabolic disorders; infectious disease; neurology; and respiratory medicine. CHI at Temple Street is the only centre in the ROI for children requiring neurosurgery or a renal transplant. The PCCU accepts an average of 450 admissions per year.

FIGURE 2.1

HOSPITALS AND PEOPLE WE WORK WITH

NOTE: Dublin Hospitals have been displayed collectively by hospital group

SAOLTA UNIVERSITY HEALTH CARE GROUP
Letterkenny University Hospital
University Hospital Galway

RCSI HOSPITALS
Our Lady of Lourdes Hospital Drogheda
Beaumont Hospital
Connolly Hospital

DUBLIN MIDLANDS HOSPITAL GROUP
Tallaght University Hospital
Naas General Hospital
Midland Regional Hospital Tullamore
St James's Hospital

IRELAND EAST HOSPITAL GROUP
Wexford General Hospital
Mater Misericordiae University Hospital
St Vincent's University Hospital
Regional Hospital Mullingar
St Luke's General Hospital, Carlow/Kilkenny

CHILDREN'S HEALTH IRELAND
Children's Health Ireland at Crumlin
Children's Health Ireland at Temple Street

UL HOSPITAL GROUP
Regional Paediatric High Dependency Unit
University Hospital Limerick

SOUTH/SOUTH WEST HOSPITAL GROUP
Cork University Hospital
South Tipperary General Hospital
University Hospital Kerry
University Hospital Waterford

LETTERKENNY UNIVERSITY HOSPITAL

GALWAY UNIVERSITY HOSPITALS

OUR LADY OF LOURDES HOSPITAL, DROGHEDA

CONNOLLY HOSPITAL

BEAUMONT HOSPITAL

ST JAMES'S HOSPITAL

TALLAGHT UNIVERSITY HOSPITAL

MIDLANDS REGIONAL HOSPITAL, TULLAMORE

NAAS GENERAL HOSPITAL

REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK

CLINICAL LEAD:
Dr Orla Neylon
Consultant Paediatric Endocrinologist

UNIVERSITY HOSPITAL KERRY

CORK UNIVERSITY HOSPITAL

SOUTH TIPPERARY GENERAL HOSPITAL

UNIVERSITY HOSPITAL WATERFORD
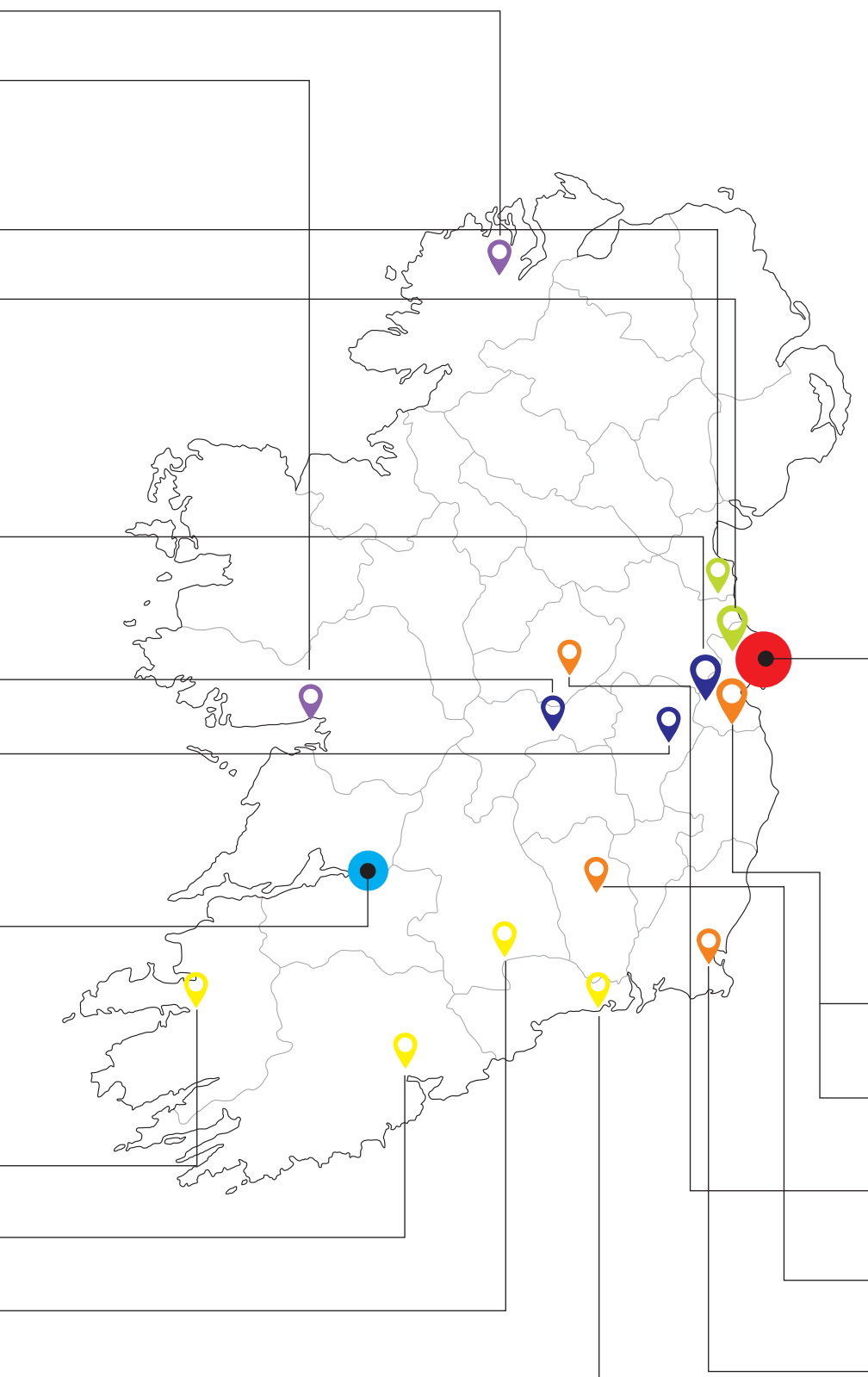
CHILDREN'S HEALTH IRELAND AT CRUMLIN

CLINICAL LEAD:
Dr Martina Healy

PCCU CLINICAL NURSE AUDIT AND RESEARCH COORDINATOR:
Mong Hoi Tan

PCCU CLINICAL AUDIT NURSES:
Jenny Cosgrave and Sharon Jose Annamma

PCCU DATA MANAGER:
Erika Brereton

CHILDREN'S HEALTH IRELAND AT TEMPLE STREET

CLINICAL LEAD:
Dr Heike Bruell

AUDIT COORDINATOR:
Marie Lawlor

IPATS CLINICAL LEAD:
Dr Cathy Gibbons

NAS-CCRS CLINICAL LEAD:
Dr Dermot Doherty

MATER MISERICORDIAE UNIVERSITY HOSPITAL

ST VINCENT'S UNIVERSITY HOSPITAL

REGIONAL HOSPITAL MULLINGAR

ST LUKE'S GENERAL HOSPITAL

WEXFORD GENERAL HOSPITAL

DATASET 2: IRISH NATIONAL ICU AUDIT DATASET FOR ADULT ICUS

Ideally, all children aged 15 years and under should be admitted to a paediatric hospital and a specialist PCCU. In the ROI, there are only two PCCUs, both of which are located in Dublin. Children who present to hospitals outside Dublin and who require specialist ICU care are cared for in adult ICUs. The numbers of children admitted to adult ICUs are small, and will be presented separately from children admitted to PCCUs in this report (see Chapter 4).

INICUA, in partnership with the ICNARC in the UK, reports on benchmarked quality indicators of outcomes and activity for INICUA in order to facilitate quality improvement.

Data entry and submission

NOCA, working in partnership with the HSE, has procured and funded a data collection system for the INICUA. The data are collected via a software application provided by DMF Systems called InfoFlex. The system can interface with a hospital's existing CIS and inpatient administration systems. Each ICU has an ICU audit coordinator who is responsible for local data entry and who is supported by a clinical lead. Data are collected for all admissions by the ICU audit coordinators in the participating Units.

INICUA and ICNARC provide guidance documentation on data definitions, as well as standardised data collection forms for users.

Data protection and information management

Patient-identifiable information is held on the hospital's local database and stored on a HSE server. Hospitals' access is restricted to each hospital's own data, and access to Info flex is restricted to the audit coordinator and the local clinical lead. All Info flex users must adhere to their local hospital's data protection policy. No patient-identifiable information is shared with ICNARC, NOCA or anyone else outside the relevant hospital.

The INICUA dataset covers the patient journey throughout the entire acute hospital stay, and is outlined in Table 2.2.

TABLE 2.2: IRISH NATIONAL INTENSIVE CARE UNIT AUDIT DATASET

Dataset	Examples
Pre-ICU admission data	Demographic data; hospital transfer details; length of stay (LOS) in hospital prior to ICU admission
Severity of illness scoring systems	Acute Physiology and Chronic Health Evaluation (APACHE II); ICNARC Model; Sequential Organ Failure Assessment (SOFA) Score
Chronic illness	Metastatic; cardiovascular; other chronic disease
Interventions in ICU	Ventilation; invasive monitoring; dialysis; nutrition; intracranial pressure monitoring; transfers to operating theatre
Organ support	Respiratory, cardiovascular, renal, neurological, liver, dermatological and gastrointestinal support
Data to support HIPE coding	Diagnosis (current) during ICU stay; hours of ventilation
Infection in ICU	Unit- and hospital-acquired infection
Organ donation	Potential and actual organ donation
Post-ICU discharge data	Outcome and LOS in Unit, ward and hospital; patient journey details

Inclusion criteria

The data reported on from the INICUA include all admissions of children aged under 16 years in 2019, whose data were submitted to ICNARC for reporting and validation from all participating adult ICUs (Appendix 2).

DATASET 3: PICANET DATASET FOR THE REGIONAL PHDU IN UHL

There are children in the ROI who are cared for in regional hospitals classified as PHDUs. A pilot audit was carried out in the regional PHDU in UHL using an adapted PICANet dataset for High Dependency Unit areas for the reporting period of 2019. The findings of the pilot are discussed further in Chapter 9.

Data entry and submission

Data collected by the regional PHDU in UHL include the following three core datasets:
• admission details, primary diagnosis, operations and procedures
• daily interventions and organ support
• discharge details.

ANALYTICAL TECHNIQUES

Data Analysis

NOCA received the first part of the data from PICANet on 4 December 2020, and the second part of the data (with all the tables and figures) on 18 December 2020. Statistical analysis includes simple cross-tabulations and the calculation of crude and risk-adjusted SMRs and 95% confidence intervals.

Data included

Demographic, process and outcome measures are presented in this report for the participating Units in the ROI. PICANet audits and reports on the clinical care of children admitted to PCCUs in both the UK and the ROI. Therefore, in this report, overall performance on pre-selected metrics (selected by PICANet) is also presented (see Table 2.1). This report presents data for these quality metrics for the ROI and benchmarks performance against other participating PCCUs in England, Wales, Scotland and Northern Ireland. Specifically, it includes data from CHI at Crumlin, from CHI at Temple Street and from the Irish Paediatric Acute Transport Service. The data are presented for 2017–2019. This report should be read in conjunction with the Paediatric Intensive Care Audit Network Annual Report 2020 (PICANet, 2021). Figures and tables have been sourced from the PICANet annual report, and NOCA has reproduced some data from that report.

CHAPTER 3
DATA
QUALITY

Relevance

Accuracy and reliability

Timeliness and punctuality

Coherence and comparability

Accessibility and clarity

CHAPTER 3: **DATA QUALITY**

The overall objectives of the IPCCA are to benchmark the quality of care and outcomes across PCCUs in Ireland and to drive improvements in the quality of care. This data quality statement highlights the assessment of the quality of the IPCCA data using internationally agreed dimensions of data quality as laid out in *Guidance on a data quality framework for health and social care* (Health Information and Quality Authority, 2018).

An overview of the aim and objectives of the data collection is included in Chapter 1, and the IPCCA data source description is detailed in Chapter 2.

This report examines paediatric critical care in:
- Paediatric ICUs: The PICANet data are collected by the PCCU audit coordinator, the PCCU data manager or the clinical nurse audit and research coordinator in each participating Unit. Once collected, a robust data validation process verifies the quality of the data from the 2017–2019 reporting period.
- Adult ICUs: These data were collected by the ICU audit coordinator in 2019.
- Regional PHDU in UHL: These data were collected by the paediatric non-consultant hospital doctors (NCHDs) assigned to the IPCCA by the lead consultant in 2019.

This is the first report from the IPCCA. It seeks to present perspectives on the care of critically ill children in specialist paediatric units, general ICUs and one regional PHDU. Information from three discrete datasets is presented for three different reporting periods.

TABLE 3.1: OVERVIEW OF DATA QUALITY FOR THE IRISH PAEDIATRIC CRITICAL CARE AUDIT, 2019

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Relevance	Relevant data meet the current and potential future needs of users.	Relevance of the IPCCA data is assessed based on the following characteristics: • release and use of the data • value of the data • adaptability of the data source. **PICANet dataset** PICANet data are used for national and local audits, service planning, commissioning, and research, and to provide baseline information for clinical trials. PICANet is a powerful tool for supporting clinical governance in paediatric intensive care. The core dataset of demographic and clinical data on all admissions, collated by PICANet, allows for the comparison of PCCU activity at local level with national benchmarks. This dataset provides an important evidence base on outcomes, processes and structures that permits planning for future practice, audit and interventions. PICANet has also recently expanded its data collection to include the referral and transport of children who need paediatric intensive care. This will enable audit of these important aspects of care for these children. Additions to the dataset have been made in order to include data items that comprise the Paediatric Critical Care Minimum Data Set (PCCMDS). The primary purpose of the PCCMDS is to allow the operation of the UK's National Tariff Payment System within paediatric critical care. In addition to the core datasets, PICANet has a remit to support local audits. Using the PICANet web data collection tool, PICANet are able to develop customised data collections for a single PCCU or across any number of PCCUs. PICANet publishes an annual report, as well as all data and information requests, on its website (www.picanet.org.uk).

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Relevance *(Continued)*	Relevant data meet the current and potential future needs of users.	**INICUA dataset** The audit manager and clinical lead work in collaboration with data users to determine data relevance. Data users include local hospitals, Hospital Groups, local HIPE coders, the HSE Business Intelligence Unit, Organ Donation and Transplant Ireland, and NOCA for national reporting. The core dataset of demographic and clinical data on all admissions, collated by INICUA, allows comparison of ICU activity at local and national level with national benchmarks. The dataset provides an important evidence base that permits planning for future practice, audit and interventions. The data inform both the HSE and the Department of Health, and measure activity in order to inform the reconfiguration of critical care beds and resources. Participating Units receive a Quarterly Quality Report of ICNARC-reported data fields. INICUA publishes annual reports on the NOCA website (www.noca.ie/audits/irish-national-icu-audit). **PICANet dataset for the regional PHDU at UHL** Under the assessment of Relevance is the adaptability of the data source. The regional PHDU at UHL adapted the PICANet core dataset in order to meet the unit's requirements. The data can measure activity, interventions and outcomes on all admissions to the Unit in 2019 and inform the reconfiguration of paediatric critical care beds and resources, both locally and nationally. NOCA is seeking feedback on the use of the data and the dataset, which can potentially be adapted and applied to other units in the future.
Accuracy and reliability	The accuracy of data refers to how closely the data correctly describe what they were designed to measure. Reliability refers to whether those data consistently measure, over time, the reality of the metrics that they were designed to represent.	The accuracy and reliability of the IPCCA data is assessed based on the following characteristics: • coverage • data capture and collection • data processing • data completeness and validity. **PICANet dataset** This dataset covers the 3-year period from January 2017 to December 2019. The focus in this report is on admissions of children aged 0–15 years. Individual PCCUs submit data prospectively, using a secure web-based portal. Data submission can involve the direct entry of patient data or the upload of a data file from an existing CIS. PICANet provides documentation on data definitions and standardised data collection forms. There is also a data dictionary to support data entry. The process of data validation begins once the data are uploaded via the PICANet web portal; logic and range checks are used, and missing data items are flagged. The audit nurse also checks the PICANet data daily on the CIS and patient flow sheets in order to ensure their completeness and correctness. A research nurse also conducts a systematic monthly validation review. Every quarter, PICANet emails a validation report to each Unit.

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Accuracy and reliability *(Continued)*	The accuracy of data refers to how closely the data correctly describe what they were designed to measure. Reliability refers to whether those data consistently measure, over time, the reality of the metrics that they were designed to represent.	Each Unit will send a change file every time it updates any validation queries from PICANet. The validation process continues until the admission event is completed. PICANet carries out regular on-site validation visits. CHI at Crumlin and CHI at Temple Street had on-site visits from PICANet in 2019. During validation visits, the PICANet research nurse carries out a crosscheck against records held on locally in the PCCU (such as admission books, patient charts and in-house data collection systems) and PICANet web. On-site validation visits are a core element of data quality review. **Revision of data** PICANet freezes its database on 31 March annually. This frozen dataset is used to produce the PICANet annual report. PICANet will send any specific data queries to the Units. Units continue to work on live data. **INICUA dataset** The reference population for INICUA is live patients admitted to participating adult ICUs in 2019 only. Reporting is based on dates and times of Unit admission. Full coverage in each Unit is defined as entry of all admissions into the Info Flex system. *The Irish National ICU Audit Interim Report 2019* covers 23 participating Units across 19 hospitals. The INICUA dataset consists of the ICNARC dataset for Ireland (which makes up 45% of the INICUA dataset) and of data taken from the local NOCA dataset, which capture extended organ donation and infection data (which makes up 55% of the INICUA dataset). The ICNARC dataset is extracted and validated by ICNARC. Any errors are presented to the user and updated before the extraction is completed. Following receipt of extracted data, ICNARC sends a series of Data Validation Reports to Units. This validation process includes completeness, reliability and accuracy of the submitted data. A Data Validation Report is sent back to the Units identifying data validation questions requiring action by the Units. This process continues until ICNARC is satisfied with the data quality. When the data are clean, a QQR is issued to the Units. Data Validation Reports clearly document invalid and missing fields. These are corrected or deemed unavailable before data are reported. **PICANet dataset for regional PHDU at UHL** The reference population for the pilot audit carried out at UHL is all children admitted to its regional PHDU in 2019. The data were entered retrospectively by going through the clinical notes of all admissions for 2019. The Unit used the *PICANet Admission Dataset Definitions Manual* (Paediatric Intensive Care Audit Network, 2020) for completing a PICANet data collection form to capture the data. Data were collected in three core datasets: admission data, discharge data and daily intervention data.

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Timeliness and punctuality	**Timely data are collected within a reasonable agreed time period after the activity that they measure. Punctuality refers to whether data are delivered on the dates promised, advertised, or announced.**	**PICANet dataset** PICANet measures the timeliness of data collection and presents how many of the admission events have been completed on the PICANet database within 3 months of discharge. An admission record is defined as complete when all validation checks have been fulfilled. PICANet reports on five key metrics, one of which is case ascertainment and timeliness of data submission. Case ascertainment is a measure of the proportion of total admissions that are reported to PICANet and is one aspect of data quality; 100% ascertainment would mean that PICANet received information for all admissions. The completeness of patients' admission data within 3 months of their discharge from the Unit was 89% for the ROI for the 3-year period from 2017 to 2019. PICANet processes data in alignment with the General Data Protection Regulations (GDPR). Patient name and full address are not collected from Units in the ROI. **INICUA dataset** NOCA and ICNARC issue data collection targets for each Unit based on quarterly submissions in order to ensure timeliness and punctuality. The data are processed and reported to Units within 17 weeks of receipt of the data, early in the third month of the quarter following submission of the data. Reporting is with a provision that QQRs are only run when 50% of data are returned from all participating Units to allow for adequate data for benchmarking. When there is a delay in a target submission date, there is a delay in the release date of the QQR. NOCA monitors and documents the timeliness of data submission from the Units. National reports may be impacted if there are delays in reporting Q4 data. ICNARC issues an INICUA network quality report for each year. **PICANet dataset for regional PHDU at UHL** The completed Excel sheet with the data from the regional PHDU in UHL was received by NOCA in April 2020.

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Coherence and comparability	Coherent and comparable data are consistent over time and across providers and can be easily combined with other sources.	The coherence and comparability of data are assessed based on the following characteristics: standardisation, coherence and comparability. **PICANet dataset** PICANet is an international clinical audit of PCC activity in the UK and the ROI. The data collected are comparable across all the participating Units. PICANet provides manuals and guidance for core data collection in order to facilitate standardised data collection across Units in the UK and the ROI. Data sources for the PICANet audit include the patient chart and both the CIS and patient flow sheet at the patient's bedside. PICANet reviews its dataset regularly. Any changes are communicated with the participating Units and displayed on the PICANet website, and the data dictionary is updated. NOCA is currently developing a data dictionary for the IPCCA dataset. Each year, PICANet produces a full summary report and a more detailed report of tables and figures covering the whole of the UK and the ROI, which are published in autumn each year. Until 2019, PICANet produced separate national reports for jurisdictions outside the UK, including the ROI. In 2018, PICANet reviewed its reporting processes, along with the value of some of the separate annual reports produced. The figures in these separate reports were broadly similar to the main PICANet summary report. PICANet therefore agreed with all national funders and clinical leads that it would cease production of the separate national reports. This agreement was reached with NOCA and took effect from the 2018 PICANet annual report. **INICUA dataset** The ICNARC dataset for Ireland is linked to the ICNARC Case Mix Programme dataset, this enables the comparison of activity and outcome measures for all participating Units from the ROI and the UK. A *National ICU Audit data definition manual* (NOCA, 2017) is available to ICU audit coordinators on the NOCA website. ICU audit coordinators are trained using this manual so that definitions and coding are consistent. Data sources for the INICUA dataset include the patient chart and both the patient administration system and the CIS, where a Unit has a CIS. **PICANet dataset for regional PHDU at UHL** This adapted dataset used the PICANet data definitions. The regional PHDU in UHL used the *PICANet Admission Dataset Definitions Manual* for completing a PICANet data collection form for processing the data. Data were collected in three core datasets: admission data, discharge data and daily intervention data. The limitation of this pilot audit is that there is no way to compare the activity with similar Units.

Dimensions of data quality	Definition (HIQA, 2018)	Assessment of dimension
Accessibility and clarity	Data are easily obtainable and clearly presented in a way that can be understood.	**PICANet dataset** PICANet has a specific data access policy. A PICANet data request form is completed for all queries relating to data and information requests and is emailed to PICANet. PICANet only releases data from the reporting periods that have already been published in its annual reports. **INICUA dataset** NOCA has data access policies in place in order to access INICUA data from ICNARC. **PICANet dataset for the regional PHDU at UHL** Collection of data from the regional PHDU in UHL was carried out on a preliminary basis in order to assess feasibility. Information will be accessible by the participating Unit at the end of the reporting year. This feasibility project will be reviewed in 2021.

PICANet METRIC 1: CASE ASCERTAINMENT AND TIMELINESS OF DATA SUBMISSION

Case ascertainment: Case ascertainment is a measure of the proportion of total admissions that are reported to PICANet and is one aspect of data quality; 100% ascertainment would mean that data were submitted for all admissions. Among the 11 PCCUs that PICANet visited between 1 April 2019 and 31 December 2019, the number of PCCU admissions in 9 Units (82%) was independently validated. In these nine PCCUs, almost all admissions (at least 95% in each Unit) were reported to PICANet; five Units had reported more than 99% of admissions. A review of the PICANet database was undertaken following validation, resulting in the number of PCCUs reporting more than 99% of admissions increasing to six.

Timeliness of data submission: The timeliness of data submission is measured using the number of admission events that are completed on the PICANet database within 3 months of discharge – a requirement of the *Quality Standards for the Care of Critically ill Children* (Paediatric Intensive Care Society and West Midlands Quality Review Service, 2015). An admission record is defined as complete when all validation checks have been fulfilled. The completeness of patients' admission data within 3 months of their discharge from the Unit was 89% for the 3-year period from 2017 to 2019 for the ROI (Figure 3.1).
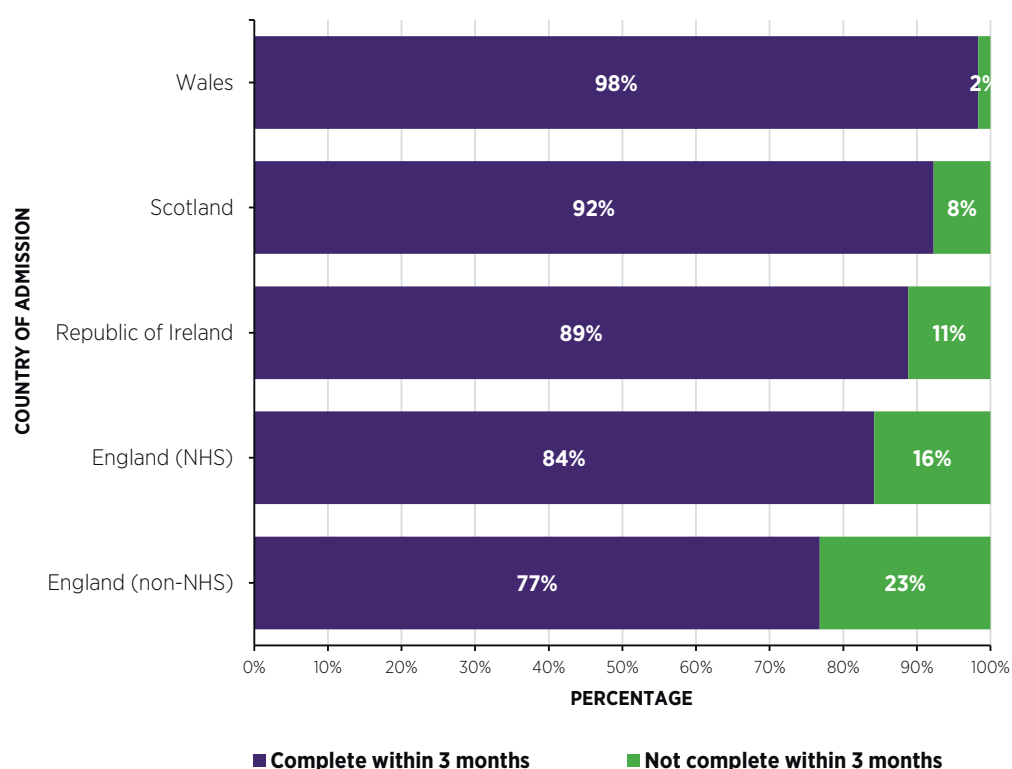
Complete within 3 months   **Not complete within 3 months**

FIGURE 3.1: PROPORTION OF ADMISSION RECORDS COMPLETED WITHIN 3 MONTHS OF DISCHARGE, BY COUNTRY OF ADMISSION, 2017–2019[1]

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[1] Data are not presented for Northern Ireland, as PCCUs were unable to submit data between May 2018 and January 2019 due to the introduction of the GDPR and associated clarifications required. This meant that these PCCUs were unable to provide data within the required timeframe of 3 months during this period.

Figure 3.2 provides a breakdown by Unit of the completeness of patients' admission data within 3 months of their discharge for the 2017–2019 reporting period. CHI at Crumlin achieved 87% completeness and CHI at Temple Street achieved 92% completeness. CHI at Crumlin is implementing changes and working with hospital management to improve the timeliness of data submission in the future.
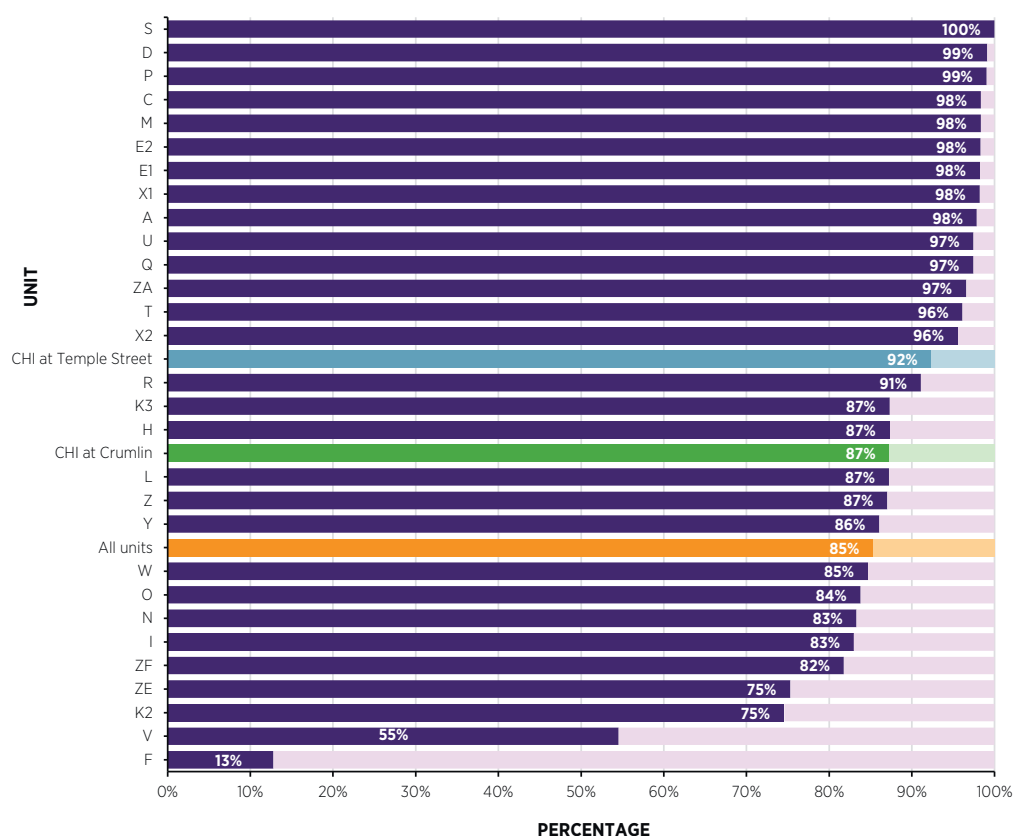
FIGURE 3.2: PROPORTION OF ADMISSION RECORDS COMPLETED WITHIN 3 MONTHS OF DISCHARGE, BY UNIT, 2017–2019[2]

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[2] ZB is not included in Figure 3.2, as this PCCU was unable to submit data between May 2018 and January 2019 due to the introduction of the GDPR and associated clarifications required.

ADMISSIONS AND PATIENT PROFILE IN PCCU
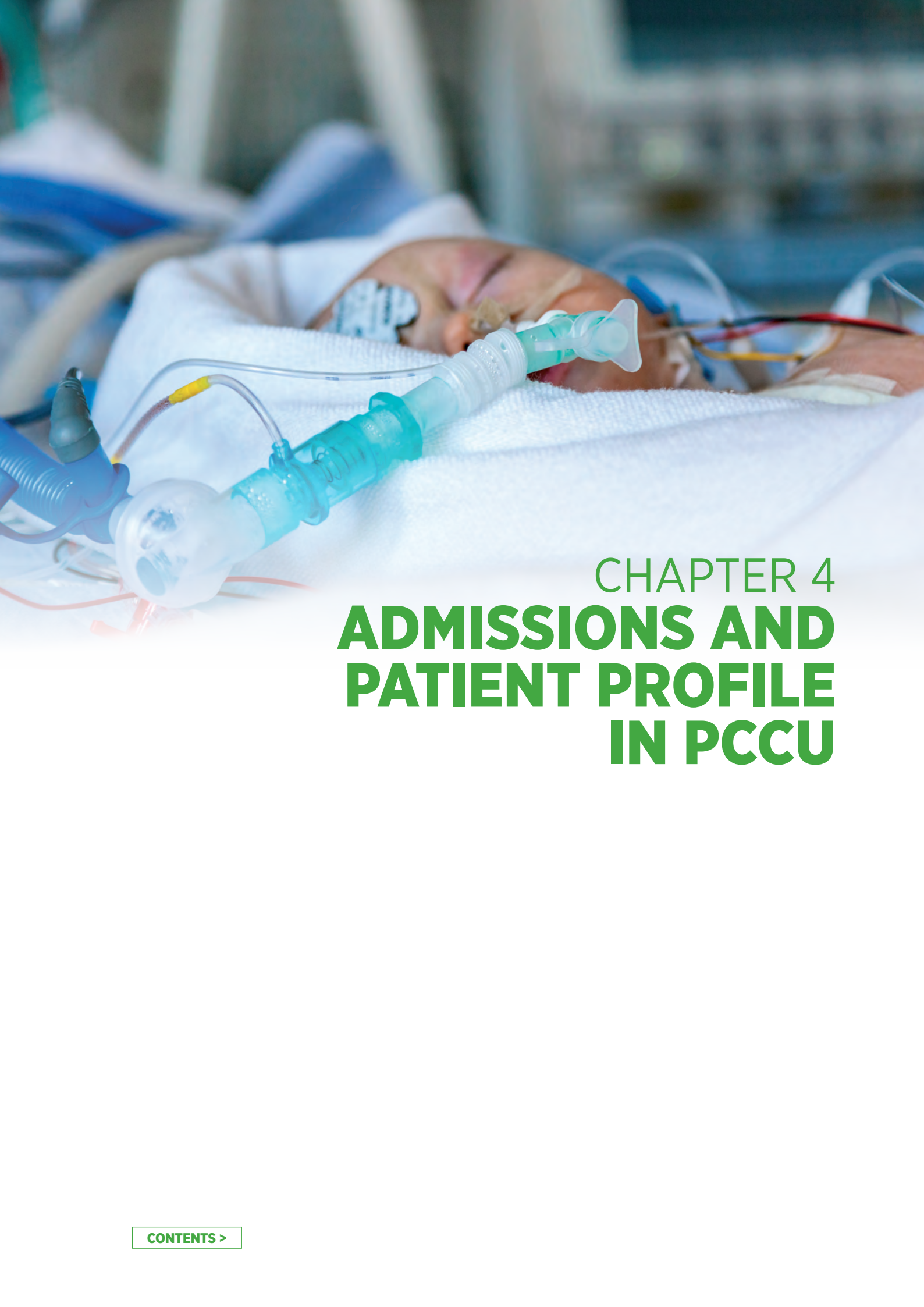
CHAPTER 4: ADMISSIONS AND PATIENT PROFILE IN PCCU

ADMISSIONS TO PCCU

Across the UK and the ROI (CHI at Crumlin and CHI at Temple Street), there were approximately 20,000 admissions to PCCUs in 2017, 2018 and 2019. The ROI Units accounted for 7% of all admissions. In the ROI, there were 4,407 admissions of patients aged under 16 years to PCCUs between 2017 and 2019. There were an additional 83 admissions of patients aged 16 years or over to PCCUs in the ROI during 2017–2019, bringing the total number of admissions to 4,490. The average annual number of admissions to Units in the ROI over the 3-year reporting period was 1,469 (Table 4.1). These patient numbers do not include paediatric patients in adult ICUs.

The number of admissions by country and age group are provided in Table 4.2. A total of 1,691 (3%) admissions to PCCUs during 2017, 2018 and 2019 were patients aged between 16 and 25 years. PCCUs in the ROI had 83 admissions (2% of all admissions in the ROI) within this age group, with 66 in CHI at Crumlin and 17 in CHI at Temple Street. Paediatric critical care may have been deemed the most clinically appropriate place for these patients, for example, as part of a long-term pathway of care for a complex chronic condition.

TABLE 4.1: NUMBER OF ADMISSIONS AGED <16 YEARS, BY COUNTRY AND YEAR, 2017–2019

Country	2017	2018	2019	Total
ENGLAND	16 001	16 380	16 191	48 572
SCOTLAND	1390	1351	1697	4438
NORTHERN IRELAND	522	501	492	1515
WALES	493	510	489	1492
ROI	1463	1430	1514	4407
TOTAL	**19 869**	**20 172**	**20 383**	**60 424**

TABLE 4.2: NUMBER OF ADMISSIONS AGED <26 YEARS, BY COUNTRY, 2017–2019

Country	Total 2017–2019				
	≤15 years of age		16–25 years of age		Total
	N	%	N	%	N
ENGLAND	48 572	97%	1461	3%	50 033
SCOTLAND	4438	97%	119	3%	4557
NORTHERN IRELAND	1515	99%	15	1%	1530
WALES	1492	99%	13	1%	1505
ROI	4407	98%	83	2%	4490
TOTAL	**60 424**	**97%**	**1691**	**3%**	**62 115**

PREVALENCE OF ADMISSION

The annual average rate of PCCU admissions recorded in the ROI for the 3 years from 2017 to 2019 was 132 per 100,000 children in the population. The highest average rate for the 3 years was recorded in Scotland, with Units collectively reaching 168 admissions for every 100,000 children, followed by Northern Ireland (NI; n=165 per 100,000 children), England (n=140 per 100,000 children) and Wales (n=139 per 100,000 children). The admission rate in the ROI for this period was 21% lower than that in Scotland. This may reflect a lack of capacity due to high bed occupancy and pressure on PCCU beds in the ROI. Rates of admission per 100,000 children are presented in Figure 4.1.
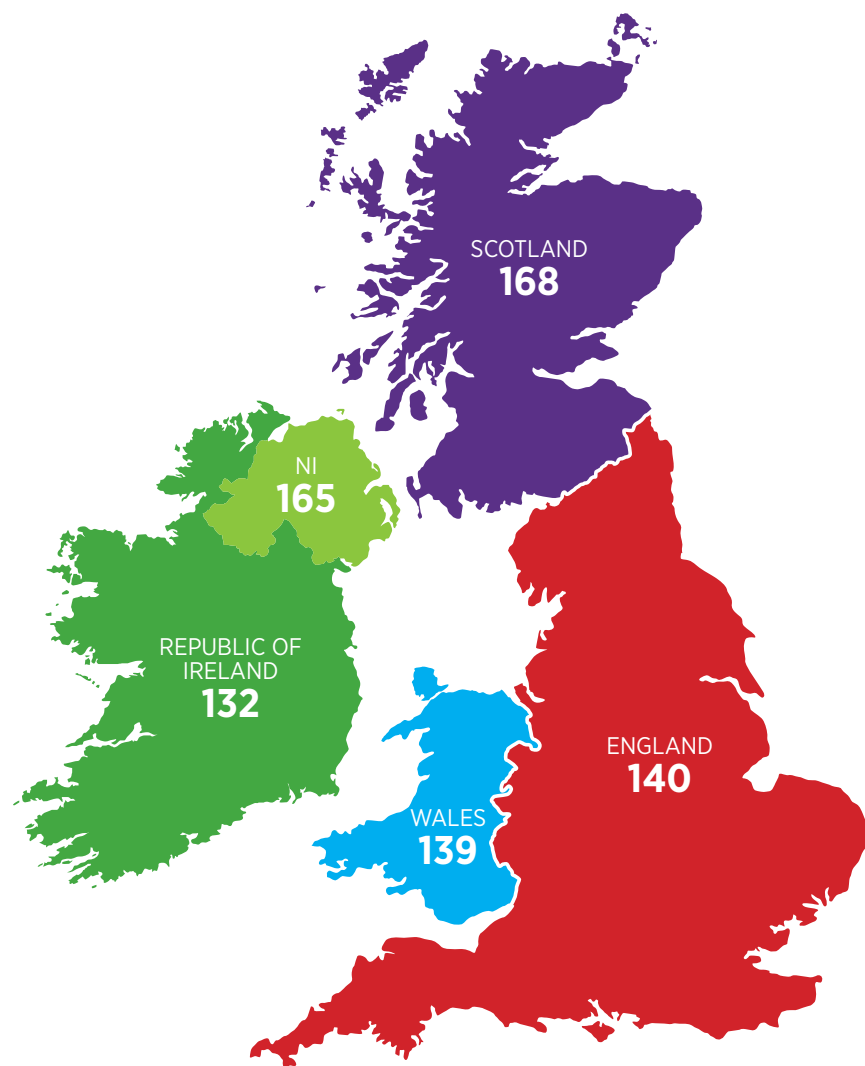
FIGURE 4.1: RATE OF ADMISSIONS PER 100,000 CHILDHOOD POPULATION, 2017 – 2019

The number of admissions to PCCUs in CHI at Crumlin and CHI at Temple Street by county of residence in 2019 is outlined in Figure 4.2. The highest number of admissions (n=491) were patients from Co Dublin, followed by counties Cork (n=130) and Kildare (n=102). Five percent of admissions (n=76) to Irish PCCUs were from NI.
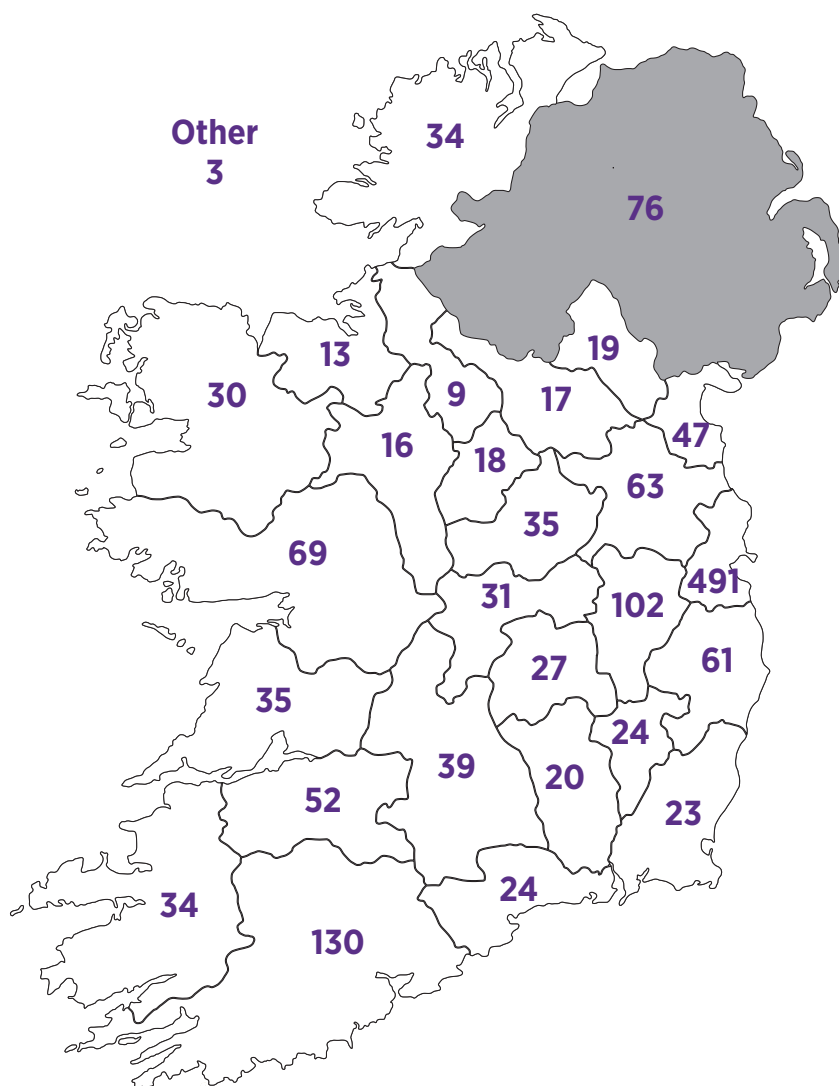
FIGURE 4.2: NUMBER OF ADMISSIONS TO CHILDREN'S HEALTH IRELAND PAEDIATRIC CRITICAL CARE UNITS, BY COUNTY OF RESIDENCE, 2019 (N=1542)[3]

3 Figure 4.2 includes all admissions to PCCUs in the ROI, including those aged 16 years or over.

The rate of admissions for children (aged under 16 years) from each county per 100,000 population for 2017–2019 is shown in Figure 4.2A. Co Longford (174.4), Co Kildare (168.1) and Dublin City (163.9) had the highest rates of admission, while counties Cavan (81.2), Cork (94.5) and Kilkenny (96.4) had the lowest rates of admission.
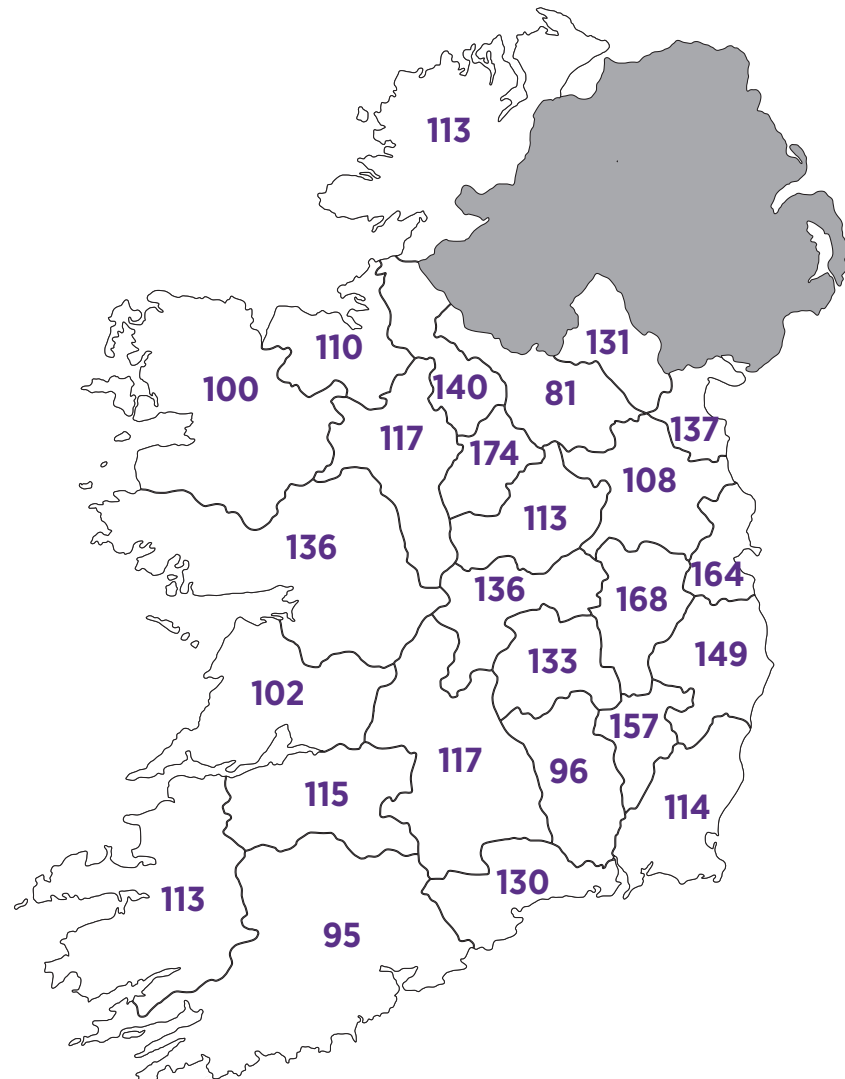
FIGURE 4.2A: RATES OF ADMISSION PER 100,000 CHILDHOOD POPULATION (AGED <16 YEARS), BY COUNTY, 2017–2019[4]

[4] Population estimates based on Central Statistics Office Census, 2016.

The total number of admissions per Unit for the 3-year period from 2017 to 2019 is illustrated in Figure 4.3. CHI at Crumlin had the third-highest number of PCCU admissions of all PICANet participating Units, at 3,074. There was negligible variation in the number of admissions to CHI at Crumlin over the 3-year reporting period, while admissions to the CHI at Temple Street PCCU increased by 20% between 2018 and 2019 (Figure 4.4).
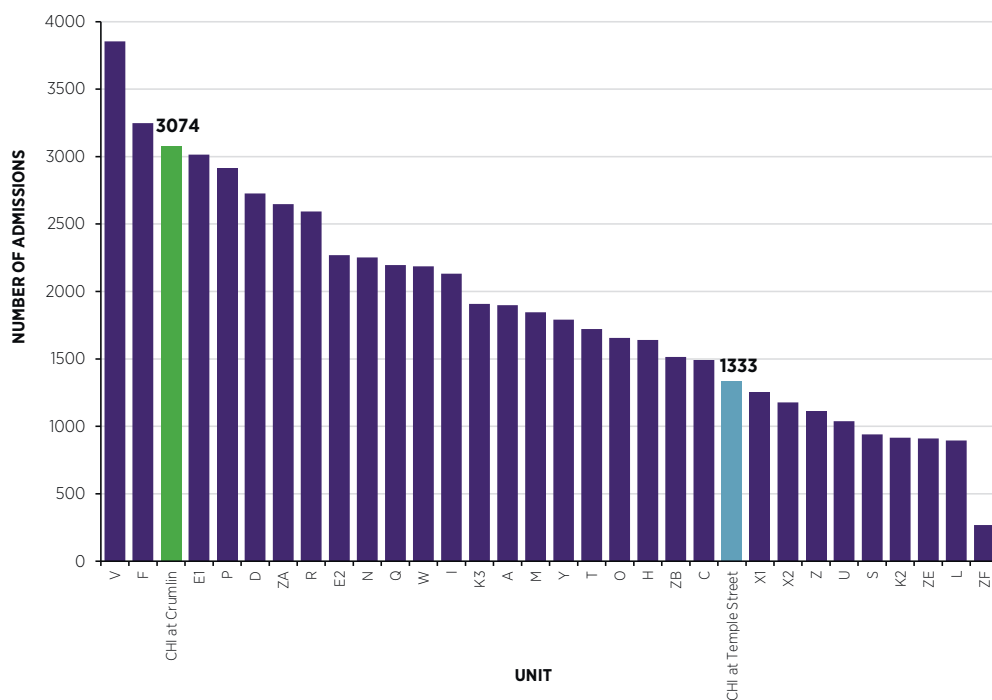
FIGURE 4.3: TOTAL NUMBER OF ADMISSIONS TO PICANET PARTICIPATING UNITS, BY UNIT, 2017–2019 (N=60424)
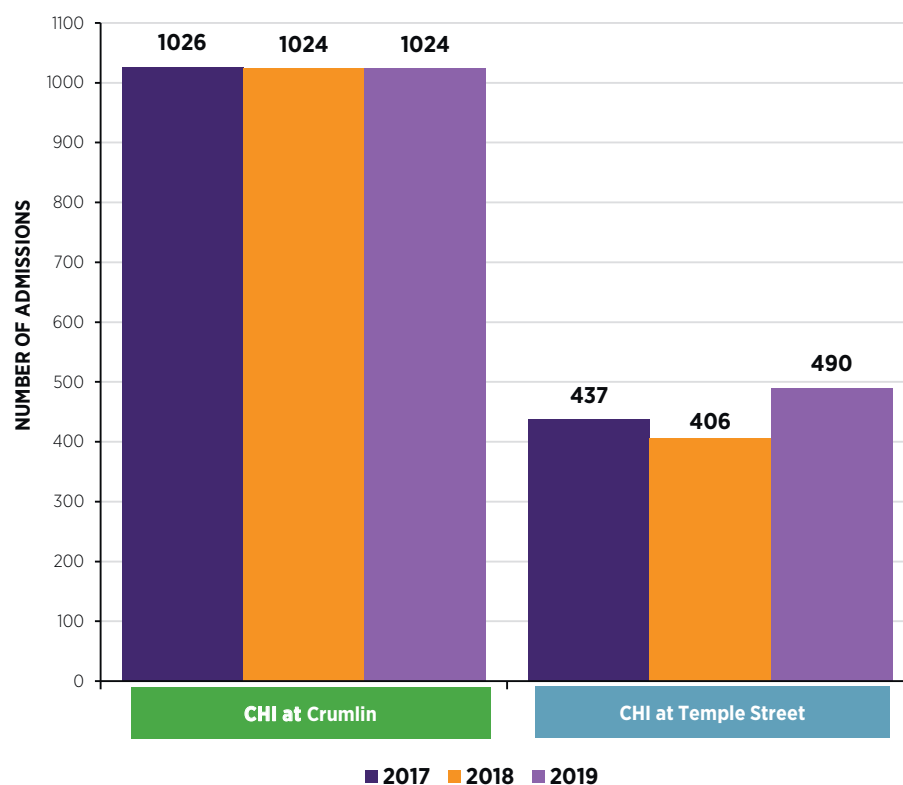
FIGURE 4.4: ADMISSIONS BY PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=4407)

ADMISSIONS BY TYPE AND SOURCE

Over the 3-year period from 2017 to 2019, 39% (n=1706) of admissions to PCCUs in the ROI were planned. The greatest proportion of admissions to PCCU, at 61% (n=2701), were unplanned (i.e. emergencies). There were differences between the two Units; slightly more than one-half of admissions to the CHI at Crumlin PCCU were unplanned (55%; n=1689), while for CHI at Temple Street, unplanned admissions accounted for three-quarters of admissions (76%; n=1012) (Figure 4.5). This can be explained by examining the overall occupancy rates for both Units: at 100% occupancy, CHI at Crumlin had no vacancies for accepting admissions from outside the hospital.
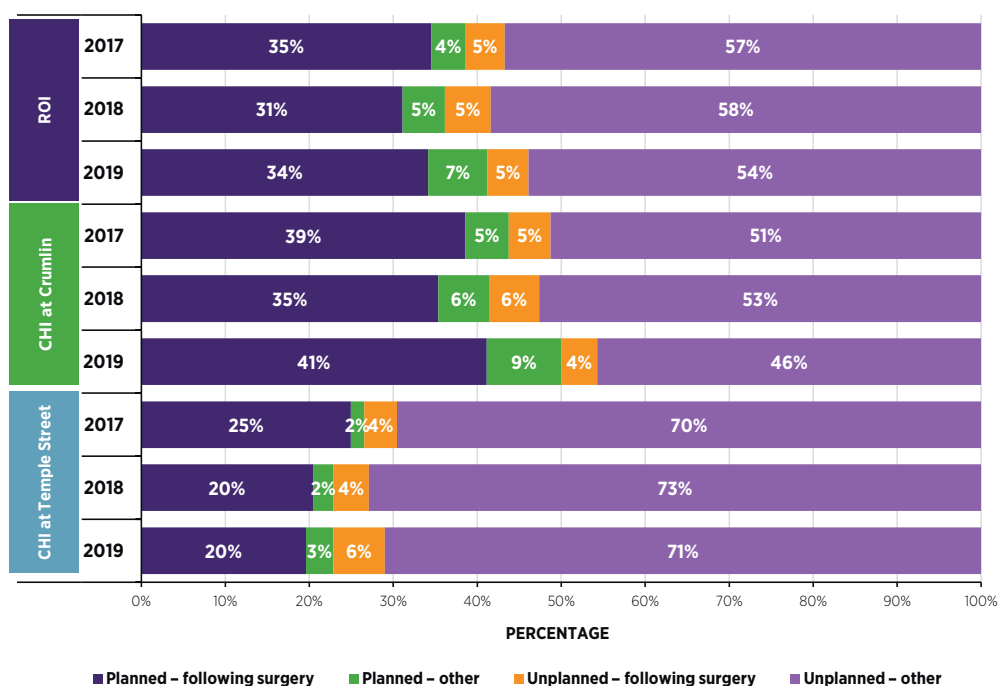
FIGURE 4.5: TYPES OF ADMISSION TO PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=4407)

SOURCE OF ADMISSION

The source of unplanned admissions varied between CHI at Crumlin and CHI at Temple Street. In CHI at Crumlin, a higher proportion of unplanned admissions were inpatients of the same hospital (Figure 4.6), whereas in CHI at Temple Street, a greater proportion of unplanned admissions to the PCCU were transfers from another hospital. The proportion of unplanned admissions from outside the hospital to the CHI at Crumlin PCCU declined from 41% (n=216) in 2017 to 31% (n=145) in 2019. This can be accounted for by the high number of in-house emergency admissions to the PCCU in CHI at Crumlin.

There was less variation in the ratio of transferred versus inpatient unplanned admissions in CHI at Temple Street (Figure 4.6).
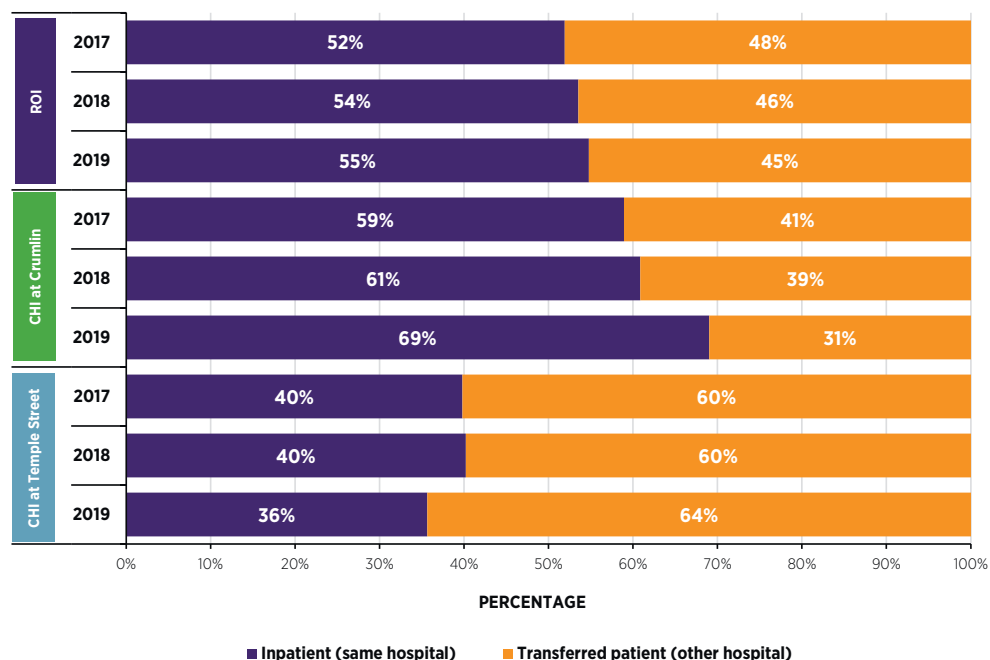
FIGURE 4.6: SOURCE OF 'UNPLANNED – OTHER' ADMISSIONS TO PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=2481)

AGE AND SEX PROFILE OF CHILDREN ADMITTED TO PCCUS

The age and sex distribution of children admitted to PCCUs in the ROI between 2017 and 2019 is provided in Figures 4.7 to 4.9. A higher proportion of children admitted to PCCUs in the ROI were male (55%; n=2420). This male predominance was evident across all age groups except for those aged 11–15 years, where the sex distribution was equal (Figure 4.7).
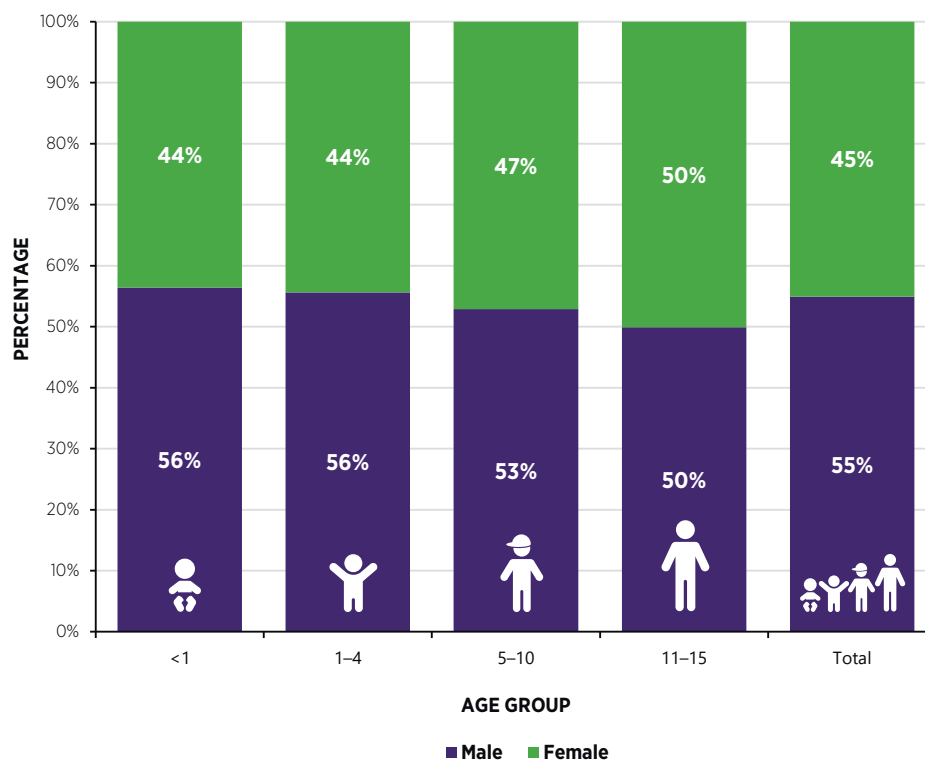
FIGURE 4.7: AGE AND SEX PROFILE OF CHILDREN IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=4407)

Just over one-half (52%; n=2285) of children admitted to PCCUs were infants aged under 1 year. The sex distribution of these infants by age in months is shown in Figure 4.8, and shows a male predominance of cases that varied only slightly with age.
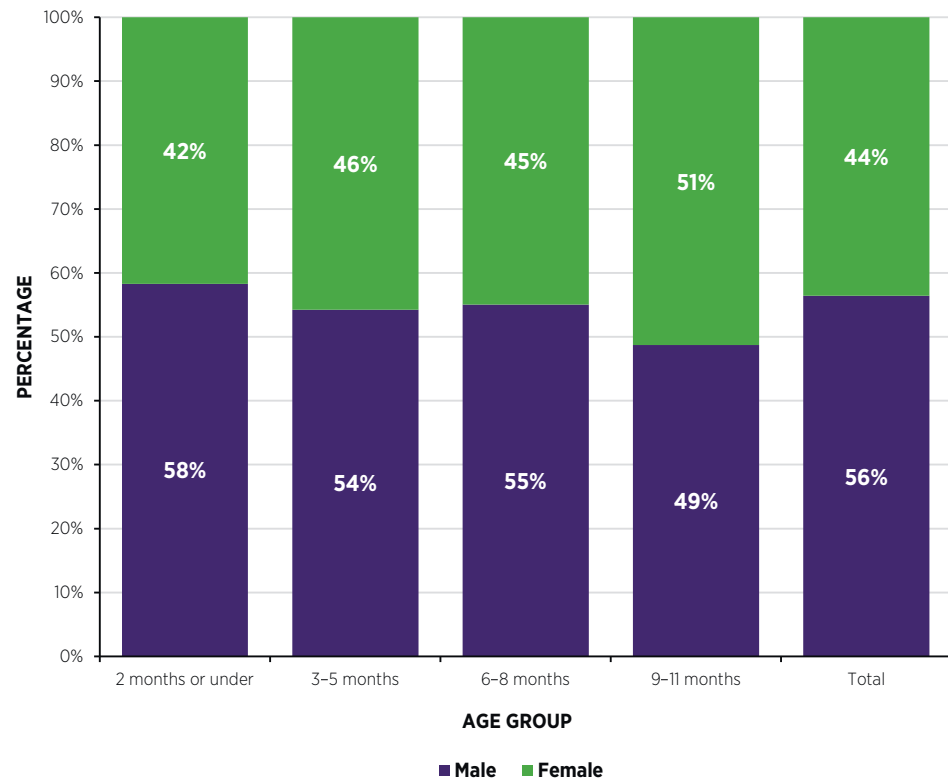
FIGURE 4.8: AGE AND SEX PROFILE OF CHILDREN AGED <1 YEAR IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=2285)

A breakdown of the age profile of children admitted to individual PCCUs in the ROI in 2019 is provided in Figure 4.9. Infants (aged under 1 year) accounted for more than one-half of all admissions (58%; n=592) to CHI at Crumlin and for 46% (n=224) of admissions to CHI at Temple Street. The number of admissions decreased with age. Overall, patients admitted to the PCCU in CHI at Temple Street were older than those admitted to CHI at Crumlin.
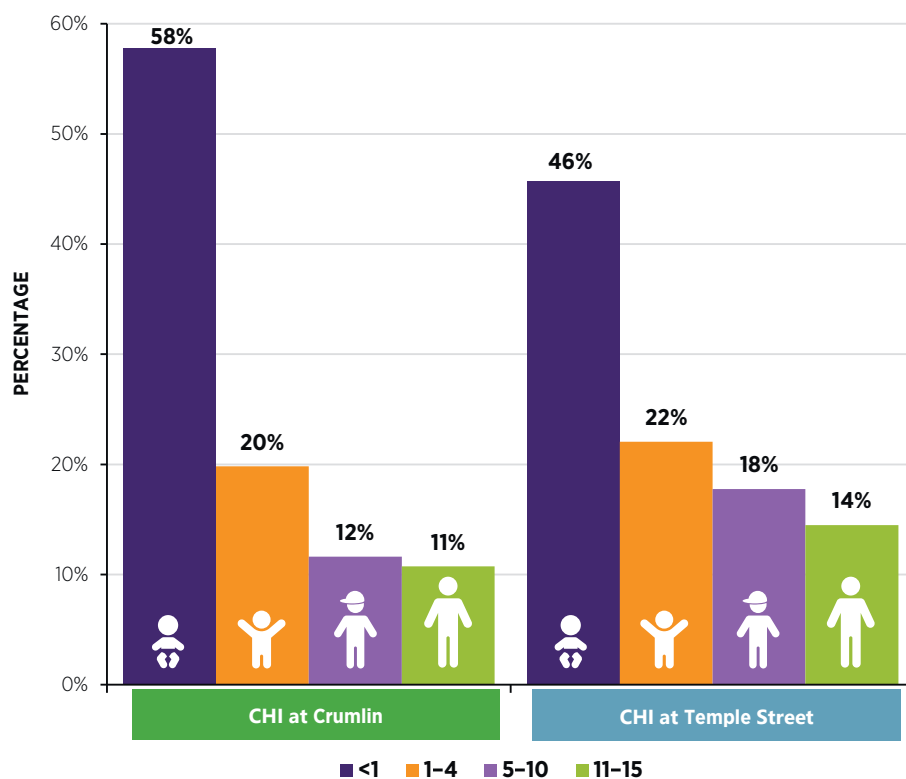
FIGURE 4.9: AGE PROFILE OF CHILDREN IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2019 (N=1514)

ADMISSIONS BY PRIMARY DIAGNOSIS GROUP

Admission by primary diagnosis group varied by Unit. The number of admissions to each Unit in 2017–2019, grouped by primary diagnosis, is outlined in Figures 4.10A and 4.10B. The largest proportion of patients admitted to the PCCU in CHI at Crumlin every year were those with cardiovascular diagnoses. This finding is not surprising, as CHI at Crumlin is the tertiary referral centre for paediatric cardiothoracic surgery and cardiology. Respiratory diagnoses accounted for between 22% and 25% of admissions in this Unit.

The pattern of admission differs for CHI at Temple Street, where the largest proportion of patients were admitted for respiratory diagnoses, followed by neurological diagnoses including all neurosurgical cases requiring PCCU care.

CHI at Crumlin
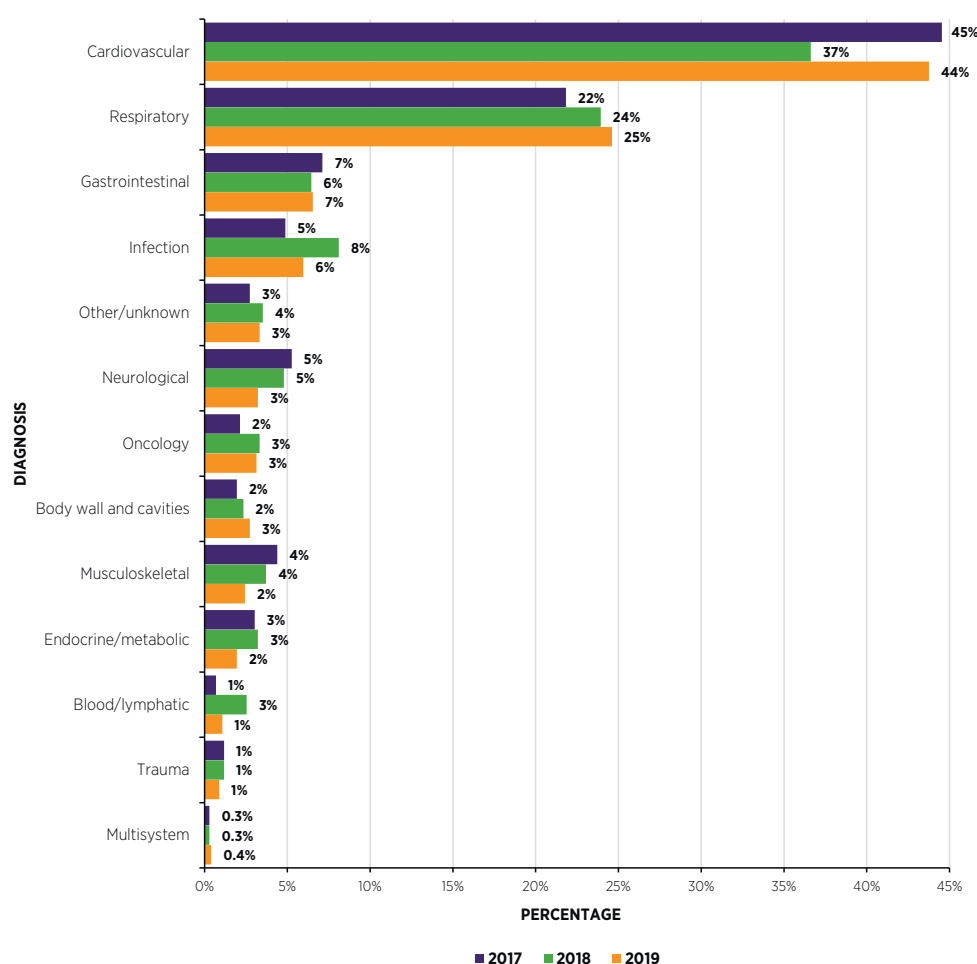
FIGURE 4.10A: ADMISSIONS TO CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, BY PRIMARY DIAGNOSIS AND YEAR, 2017–2019

CHI at Temple Street
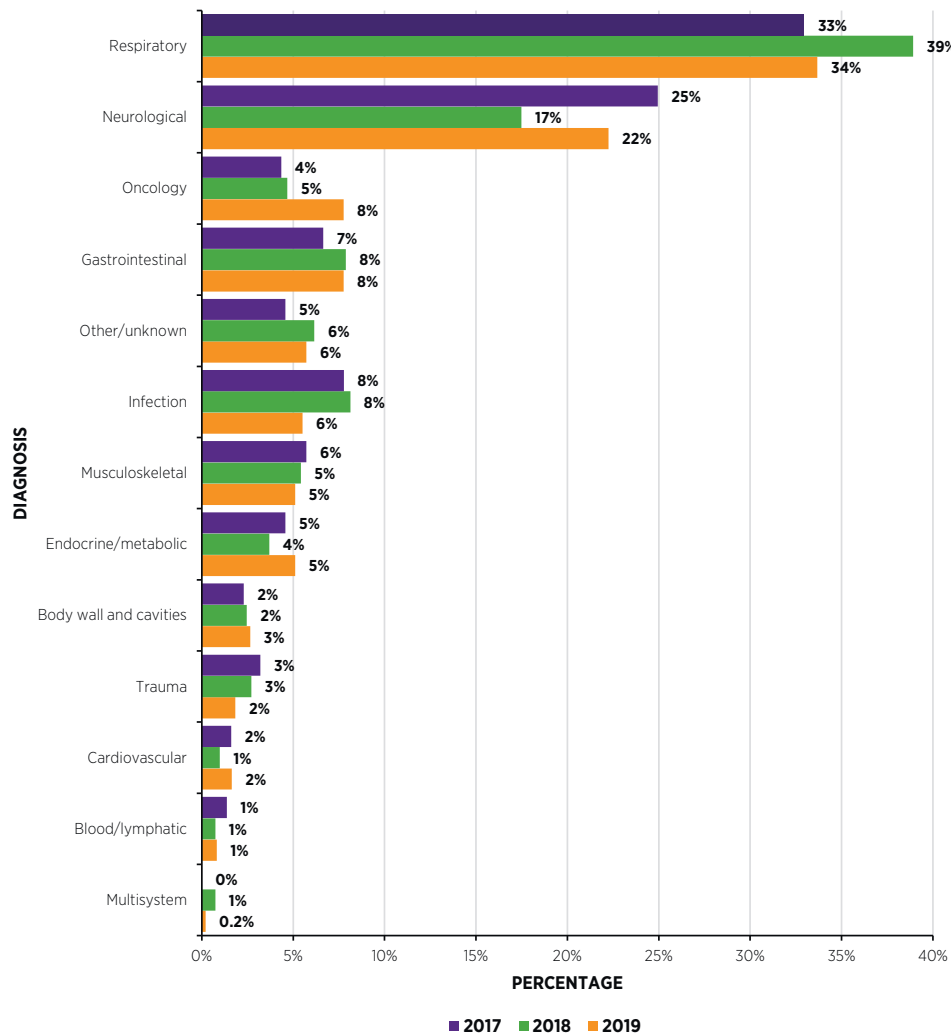
FIGURE 4.10B: ADMISSIONS TO CHILDREN'S HEALTH IRELAND AT TEMPLE STREET PAEDIATRIC CRITICAL CARE UNIT, BY PRIMARY DIAGNOSIS AND YEAR, 2017–2019

ADMISSIONS OF CHILDREN TO ADULT ICUS

Prior to 2019, there was no system in place to capture and collect validated data on children aged under 16 years who were cared for in hospitals without specialised PCCUs. However, with the introduction of the Intensive Care National Audit and Research Centre (ICNARC), and the collection of data from each adult Unit in the ROI, these data have now become available.

In 2019, 111 children aged under 16 years were admitted to adult ICUs in the ROI. Of these, 18 (16%) were aged under 1 year, and 44 (40%) were aged under 6 years. Of particular note, 20 (18%) of these patients required invasive ventilation. A description of these patients is provided in Table 4.3.

TABLE 4.3: DESCRIPTION OF CHILDREN AGED <16 YEARS ADMITTED TO ADULT INTENSIVE CARE UNITS IN 2019

Description Characteristic	n
Patients aged <16 years	111
Mean age (median; interquartile range (IQR))	7.5 (8; 2–13)
Aged <1 year	18 (16.2%)
Aged <6 years	44 (39.6%)
Admissions after surgery	34 (30.6%)
Admissions with sepsis	22 (19.8%)
Invasive ventilation	20 (18.0%)
Mean unit length of stay (LOS), in hours (median; IQR)	27 (18; 12–24)
Unit survival	110 (99.1%)
Hospital survival	107 (96.4%)

Table 4.4 outlines the number of children admitted to adult ICUs in 2019, by hospital. The Units with the largest number of children were Beaumont Hospital Richmond ICU (Neuro) (n=24) – which most likely reflects a requirement for specialist care – and University Hospital Galway (UHG) ICU (n=62).

In 2019, UHG ICU admitted 62 paediatric patients (56% of all paediatric patients admitted to adult ICUs in 2019), the majority of whom (65%; n=40) were aged under 6 years and 27% (n=17) of whom were aged under 1 year. UHG was the only adult ICU that regularly admitted children aged under 6 years. Mean LOS was very short in UHG (17 hours), most likely indicating rapid transfer to a PCCU if ICU care was going to be prolonged.

Children in adult ICUs present particular challenges with respect to staffing the Unit with nurses trained in paediatric critical care, as per national standards. *The Model of Care for Paediatric Critical Care* (National Clinical Programme for Critical Care and National Clinical Programme for Paediatrics, 2019) states that if a patient is ventilated or stays for longer than 24 hours, communication with a PCCU and transfer out is recommended. It is recognised that this may pose a difficulty for families where geographical distance is a factor, but adherence to national and international standards regarding the care of children in adult ICUs is recommended.

TABLE 4.4: NUMBERS OF PATIENTS IN ADULT INTENSIVE CARE UNITS, BY AGE, LENGTH OF STAY, AND NUMBERS VENTILATED

	<1 year (n)	1–6 years (n)	7–16 years (n)	Total (n)	Mean LOS (hours)	Ventilated (n)
Beaumont Hospital Richmond ICU (Neuro)	0	0	24	24	19	~
St James's Hospital General Intensive Care Unit (GICU)	0	0	~	~	226	~
University Hospital Galway ICU	17	23	22	62	17	8
University Hospital Limerick ICU	0	0	~	~	11	~
University Hospital Waterford ICU	0	0	~	~	16	~
Wexford General Hospital Intensive Care Unit	0	0	~	~	20	0
Midland Regional Hospital Tullamore ICU	0	0	~	~	53	0
St Vincent's University Hospital ICU	0	0	~	~	167	~
Cork University Hospital ICU	~	~	7	10	17	~
Letterkenny University Hospital ICU	0	~	~	~	14	~
South Tipperary General Hospital ICU	0	0	~	~	32	0
University Hospital Kerry ICU	0	0	~	~	24	0

~ Denotes five cases or fewer

KEY FINDINGS FROM CHAPTER 4

- The total number of admissions of patients aged under 16 years to PCCUs in the ROI in the period from 2017 to 2019 was 4,407, with an annual average of 1,469.

  The rate of admissions during this period, at 132 per 100,000 children in the population, is the lowest of all countries contributing data to the Paediatric Intensive Care Audit Network (PICANet) and is 21% lower than that of Scotland, the country with the highest rate of admissions. This may reflect a lack of capacity due to high bed occupancy and pressure on PCCU beds in the ROI. The availability of paediatric critical care beds during this period was 2.8 per 100,000 population aged under 16 years.

- The two PCCUs in Dublin accept patients from all counties in Ireland. The highest number of admissions to these PCCUs in 2019 were patients from Co Dublin (n=491), followed by counties Cork (n=130) and Kildare (n=102). The counties with the highest rates of admission per 100,000 population aged under 16 years were Co Longford (174.4), Co Kildare (168.1) and Dublin City (163.9).

- Five percent of admissions (n=76) to PCCUs in the ROI in 2019 were from Northern Ireland, all of which were patients with cardiovascular diagnoses admitted to the CHI at Crumlin PCCU, the National Centre for Paediatric Cardiology and Cardiothoracic surgery.

- CHI at Crumlin had the third-highest number of PCCU admissions (n=3074) of all Units in the UK and the ROI for 2017–2019. Admissions to the PCCU in CHI at Temple Street increased by 20% between 2018 and 2019.

- The greatest proportion of children admitted to both Irish PCCUs in 2017, 2018 and 2019 were unplanned (i.e. emergency) admissions. At CHI at Crumlin, this equated to 55% of admissions, and the majority of these were from within the same hospital (63%). In CHI at Temple Street, three-quarters of admissions to PCCU (76%) were unplanned, and the majority were transfers from another hospital (61%).

- More than one-half (52%; n=2285) of children admitted to PCCUs during the 3-year reporting period were infants aged under 1 year, and almost three-quarters (73%; n=3220) were aged under 5 years. A slightly greater proportion of patients across all age groups were male, with the exception of those aged 11–15 years.

  Eighty-three additional patients aged 16 years or over were admitted to PCCUs in the ROI during 2017–2019.

- The primary diagnosis of patients admitted to PCCUs varied by Unit; over the 3-year reporting period, the greatest proportion (42%; n=1280) of admissions to the CHI at Crumlin PCCU were patients with cardiovascular diagnoses, followed by respiratory diagnoses (23%; n=721). In the CHI at Temple Street PCCU, most admissions were patients with respiratory (35%; n=457) or neurological (22%; n=289) diagnoses. The pattern of admission by primary diagnosis did not change for either Unit over the 3-year reporting period.

- In 2019, 111 children aged under 16 years were admitted to adult ICUs in the ROI. The majority were admitted to Beaumont Hospital Richmond ICU (Neuro) (n=24) and UHG ICU (n=62), the only adult Unit that regularly admitted children aged under 6 years (n=40). Mean LOS was very short in UHG (17 hours), most likely indicating rapid transfer to a PCCU if ICU care was going to be prolonged.

CHAPTER 5
BED ACTIVITY AND OCCUPANCY

CHAPTER 5: BED ACTIVITY AND OCCUPANCY

NUMBER OF BED DAYS DELIVERED

The total number of bed days delivered is calculated as the sum of children receiving intensive care in a PCCU each day. A bed day is counted if a child is in a PCCU bed for part of any day during the reporting period. National figures of bed days delivered for individual countries are presented in Table 5.1, and total figures for individual Units during the 3-year reporting period are illustrated in Figure 5.1.

From PICANet data, the number of bed days provided fluctuated throughout the 3-year reporting period in all admitting countries. The average number of bed days delivered by the two PCCUs in the ROI within this reporting period was 10,059 annually, increasing slightly every year. More than three-quarters (77%) of the bed days per annum were provided in the Unit in CHI at Crumlin.

TABLE 5.1: NUMBER OF BED DAYS DELIVERED, BY COUNTRY OF ADMISSION AND YEAR[5]

Country	2017	2018	2019	Total
ENGLAND (NHS)	112 896	117 415	115 038	345 349
SCOTLAND	10 765	10 319	12 054	33 138
NORTHERN IRELAND	3695	3282	3422	10 399
WALES	2451	2509	2626	7586
ROI	9607	10 177	10 393	30 177
TOTAL	**139 414**	**143 702**	**143 533**	**426 649**

[5] Figures include children admitted prior to, but discharged during, the reporting period, counted from 12.00am on 1 January 2017 until discharge (or until 11.59pm on 31 December 2019 if not discharged during the reporting period). Children admitted during the reporting period but discharged in 2020 are counted from admission date until 11.59pm on 31 December 2019.

The total bed days delivered for each Unit during the time period of 2017–2019 is illustrated in Figure 5.1. Data for each PCCU in the ROI by year are provided in Figure 5.2. The number of bed days delivered showed a steady increase every year for both CHI at Crumlin and CHI at Temple Street. For the 3-year reporting period, CHI at Crumlin had the third-highest number of bed days of all PCCUs in the UK and the ROI.
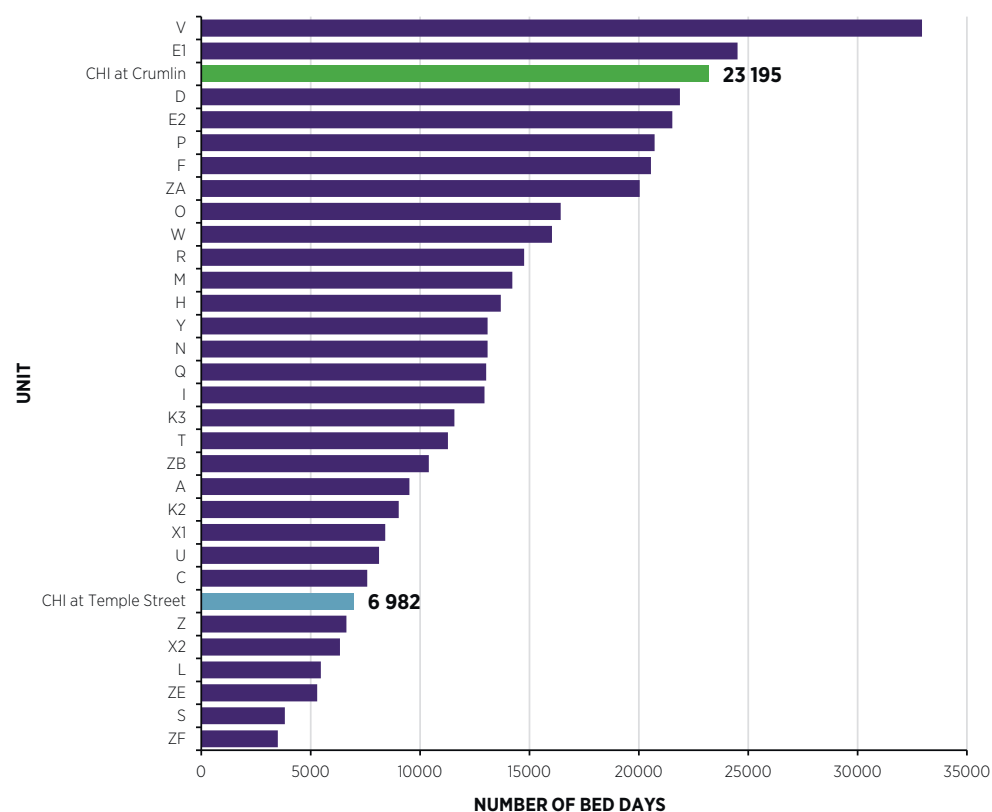
FIGURE 5.1: NUMBER OF BED DAYS DELIVERED BY EACH UNIT PARTICIPATING IN THE PAEDIATRIC INTENSIVE CARE AUDIT NETWORK, UK AND ROI, 2017–2019[6]

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[6] Figures include children admitted prior to, but discharged during, the reporting period, counted from 12.00am on 1 January 2017 until discharge (or until 11.59pm on 31 December 2019 if not discharged during the reporting period). Children admitted during the reporting period but discharged in 2020 are counted from admission date until 11.59pm on 31 December 2019.
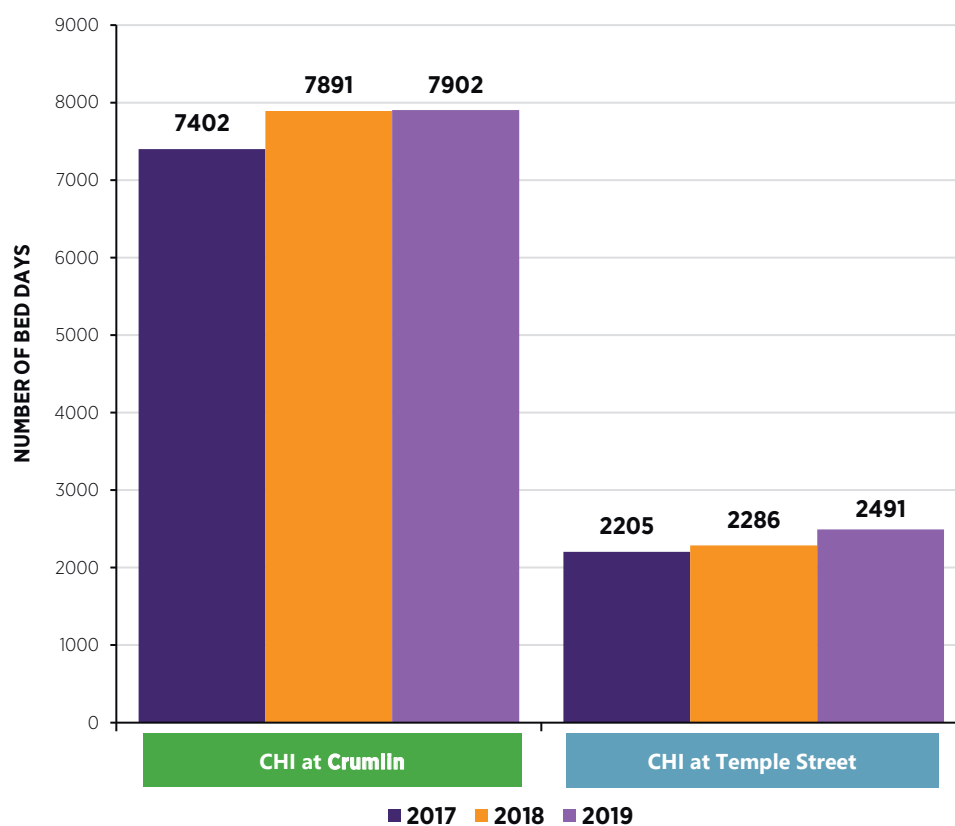
FIGURE 5.2: NUMBER OF BED DAYS DELIVERED IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, BY YEAR, 2017–2019[7]

[7] Figures include children admitted prior to, but discharged during, the reporting period, counted from 12.00am on 1 January 2017 until discharge (or until 11.59pm on 31 December 2019 if not discharged during the reporting period). Children admitted during the reporting period but discharged in 2020 are counted from admission date until 11.59pm on 31 December 2019.

BED OCCUPANCY IN PCCU IN THE ROI

Accurate daily bed occupancy data are required for the planning and delivery of PCCU services. These data should be collected twice daily in order to reflect changes in staffing during the twice-daily nursing shift system. The physical number of beds does not reflect bed availability, occupancy or issues with staffing. An actual PCCU bed should reflect national PCCU standards for medical and nursing staff cover.

For the period from 2017 to 2019, CHI at Crumlin had 25 PCCU bed spaces available, of which an average of 21 per year were open and staffed. Bed occupancy for each Unit, expressed as the percentage of bed days used out of total bed days available each year, is outlined in Figure 5.3. The proportion of bed occupancy for CHI at Crumlin has increased steadily over the reporting period, from 93% (n=7490) in 2017 to 95% (n=7969) in 2018 and 100% (n=8006) in 2019. These data do not reflect acuity, where one bed could require a nurse–patient ratio of 3:1 – for example, if the patient is on extracorporeal life support or continuous venovenous haemodialysis.

Detailed local data for daily bed availability in CHI at Temple Street were unavailable for 2017 and 2018. Recording has been updated and data are now available for 2019. These data indicate that bed occupancy in CHI at Temple Street was at 88% (n=2499) in 2019 (Figure 5.3). Bed occupancy figures for both Units exceeded the recommended limit of 85% each year (Joint Faculty of Intensive Care Medicine of Ireland, 2018).
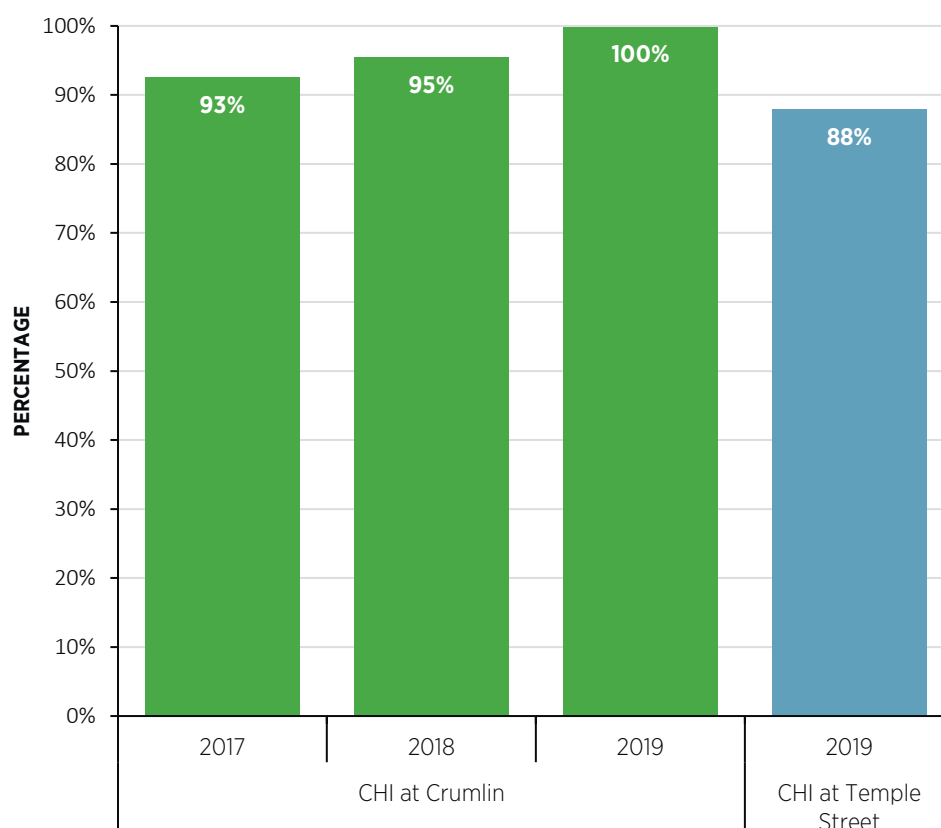
FIGURE 5.3: BED OCCUPANCY IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019[8]

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[8] Accurate data are not available for CHI at Temple Street for 2017 and 2018.

Distribution of bed occupancy figures for each Unit by month and year are outlined in Figures 5.4A, 5.4B, and 5.5. These data indicate that bed occupancy was lower in the spring and summer months, which was most evident in CHI at Temple Street, reflecting unplanned admissions from outside Dublin that are transferred due to bed availability. For CHI at Crumlin, this seasonal variation was less evident in 2019, reflecting more planned admissions due to scheduled cardiothoracic and other semi-elective surgery and a cohort of children with complex illnesses who require care throughout the year. Both PCCUs experienced occupancy levels of 110% or more in the winter months during 2019, a reflection of the seasonality of winter influenza, which resulted in the curtailment of planned surgeries for children on waiting lists.

CHI at Crumlin 2017
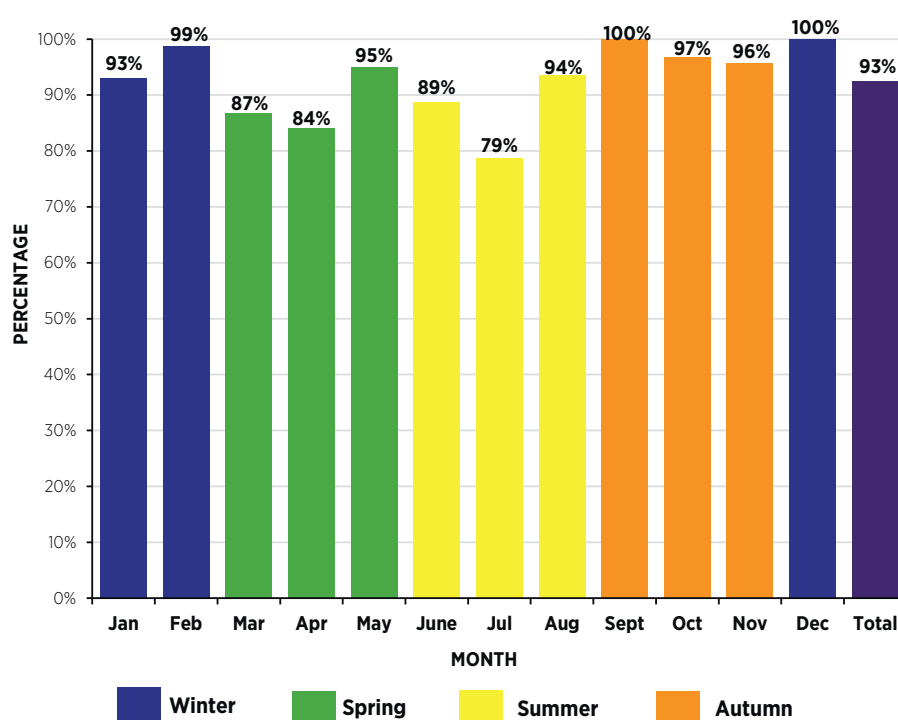
FIGURE 5.4A: BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, 2017 (N=7490 BED DAYS USED OF 8094 BED DAYS AVAILABLE)

CHI at Crumlin 2018
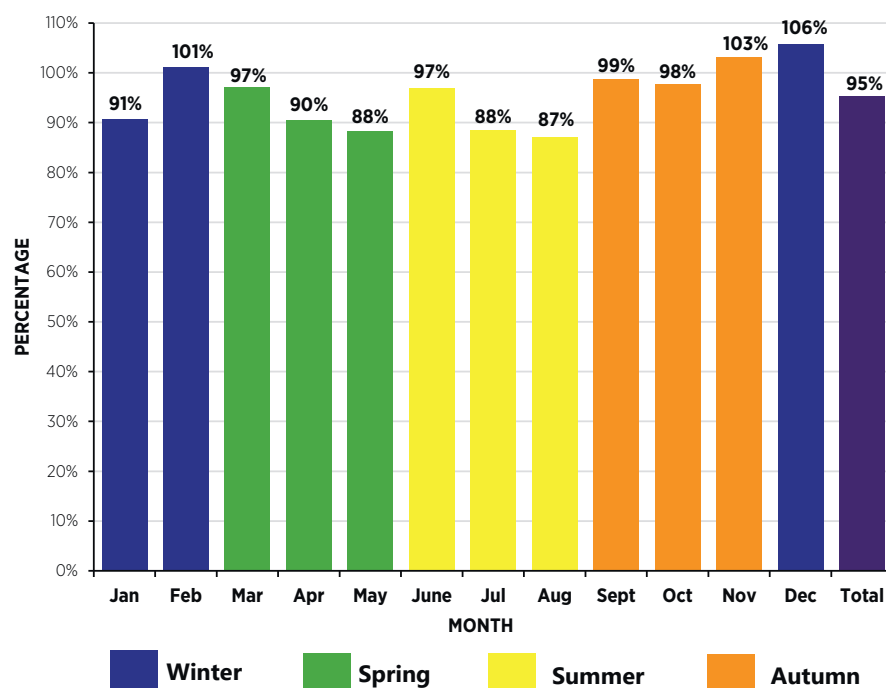
FIGURE 5.4B: BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, 2018 (N=7969 BED DAYS USED OF 8356 BED DAYS AVAILABLE)
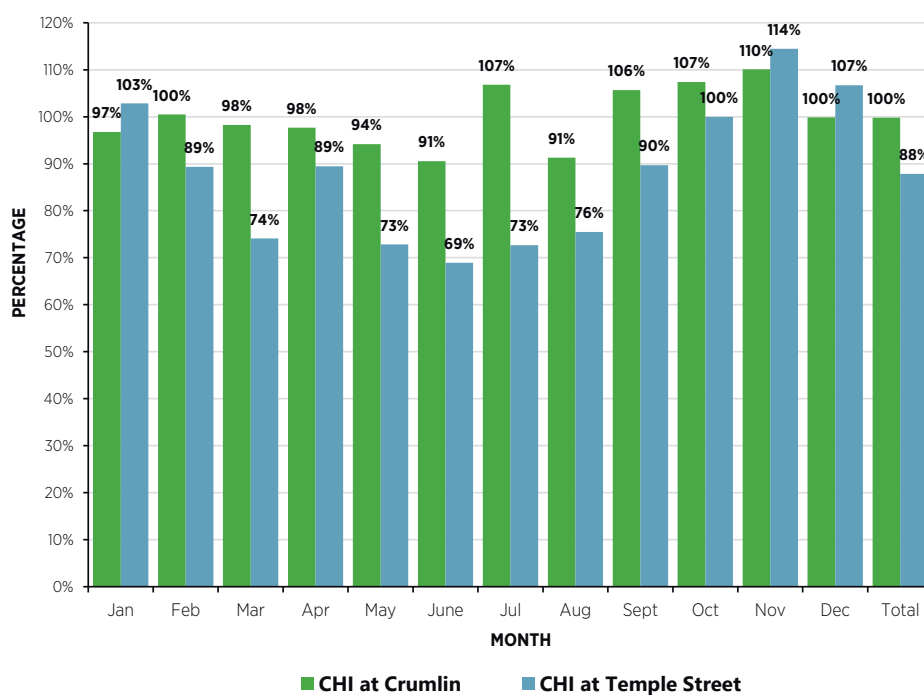
FIGURE 5.5: PAEDIATRIC CRITICAL CARE UNIT BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN (N=8006 BED DAYS USED OF 8021 BED DAYS AVAILABLE) AND CHILDREN'S HEALTH IRELAND AT TEMPLE STREET (N=2499 BED DAYS USED OF 2844 BED DAYS AVAILABLE), 2019

CRITICAL CARE BEDS OCCUPIED AT MIDDAY WEDNESDAY

In addition to detailed daily bed occupancy data, PICANet captures a snapshot in time of bed occupancy levels at a 'normal hours' census point (midday Wednesday) during a particular week in November. At this point in the week beginning 11 November in 2019, the proportion of critical care beds occupied in CHI PCCUs during normal hours was 89% (n=24), having increased gradually from 78% (n=21) in 2017 and 82% (n=22) in 2018 (Figure 5.6).

These data do not reflect the complexity of collecting data to determine overall bed availability, occupancy and staffing issues.
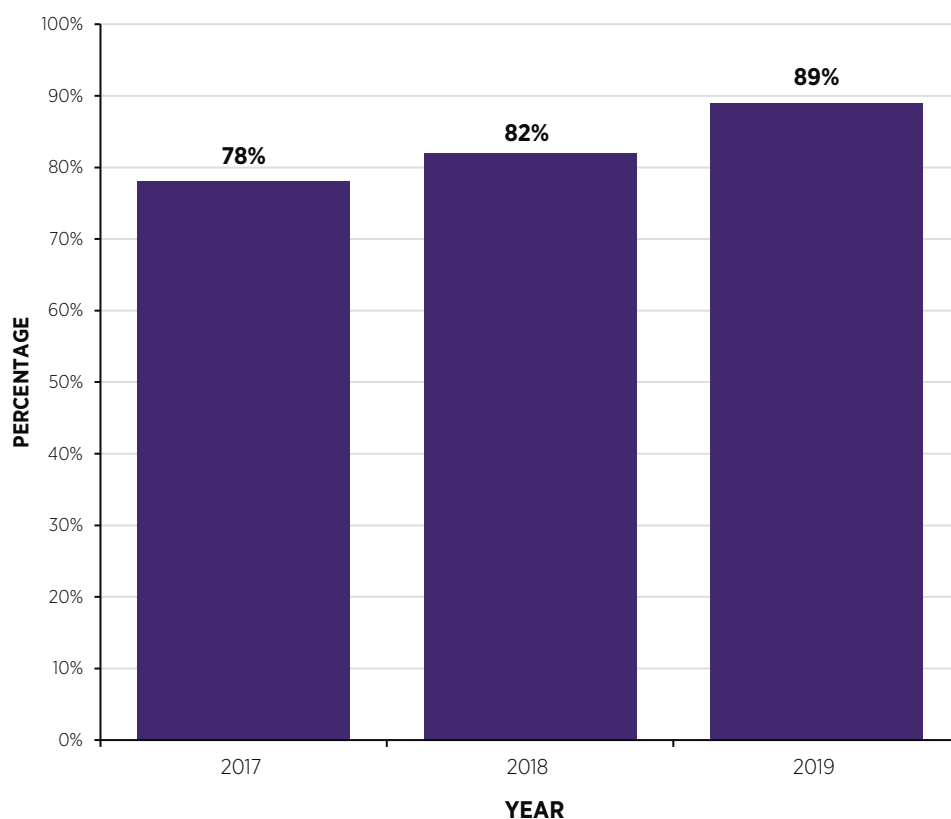
FIGURE 5.6: PERCENTAGE OF FUNDED CRITICAL CARE BEDS IN CHILDREN'S HEALTH IRELAND AT CRUMLIN AND CHILDREN'S HEALTH IRELAND AT TEMPLE STREET OCCUPIED AT A 'NORMAL HOURS' CENSUS POINT, BY YEAR, 2017–2019

PICANet METRIC 3: QUALIFIED NURSES PER BED

The *National Standards for Paediatric Critical Care Services Version 2.0* (Joint Faculty of Intensive Care Medicine of Ireland 2018) recommend that every critical care bed should be supported by a minimum of 5.5 whole-time equivalent (WTE) staff nurses. Open beds in CHI at Crumlin meet this nursing standard.

However, while a gradual improvement from 2017 to 2019 is evident, staffing levels in CHI at Temple Street were below the recommended standard for every year reported (Figure 5.7). The ROI standard of 5.5 WTE nurses per critical care bed pertains to the number of nurses required in direct patient care, which includes the numbers required for one-to-one direct patient care only and varies from that used in the UK, which includes nurse managers and other nursing support staff (Paediatric Intensive Care Society, 2015). *The Quality Standards for the Care of Critically ill Children* (Paediatric Intensive Care Society and West Midlands Quality Review Service, 2015) state that a minimum of 7.01 WTE qualified (registered) nurses are needed to staff one Level 3 critical care bed. It is important to note, however, that the existing standard used for PCCUs in the ROI is not adjusted for patient complexity – e.g. those who require more than one nurse – and uses a baseline that does not take account of maternity, mandatory or sick leave.

Retention of nursing staff is particularly problematic in ICUs for various reasons, including the higher nurse–patient ratios and specialised training required to enable working in a high-stress environment. The staffing shortages in CHI at Temple Street were due to multiple reasons, including staff retention, the ability to recruit suitable qualified staff, and maternity and sick leave. Staffing requirements may vary intermittently and are impacted by multiple factors, including case mix, outbreaks and the season.
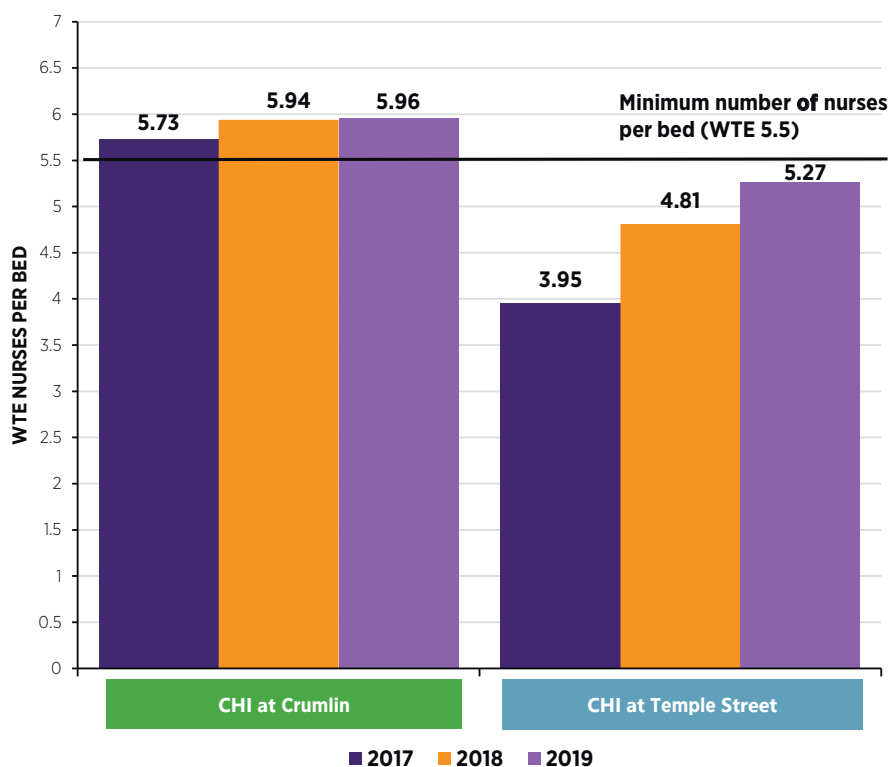
FIGURE 5.7: NUMBER OF CLINICALLY QUALIFIED WHOLE-TIME EQUIVALENT NURSING STAFF IN POST PER BED, 2017–2019

LENGTH OF STAY

Average length of stay (LOS) for each Unit is presented in Table 5.2 as the median number of days, along with the interquartile range (IQR), by age group and year. The median LOS for the 3-year reporting period was 3.0 days in CHI at Crumlin and 1.84 days at CHI Temple Street. In both PCCUs, the median LOS was highest for infants aged under 1 year, at 4.0 days for CHI at Crumlin and 2.4 days for CHI at Temple Street, and this pattern did not change over time. Median LOS for patients aged under 1 year in CHI at Crumlin was twice that of other age groups. LOS was higher for patients in CHI at Crumlin than for CHI at Temple Street for every age group and year examined. Variation in LOS between the two Units was greatest for the infant age group (aged under 1 year) and decreased over the reporting period for the 1–4 years category.

TABLE 5.2: LENGTH OF STAY BY AGE GROUP, 2017–2019 (MEDIAN DAYS AND INTERQUARTILE RANGE)

	2017		2018		2019	
	Median	IQR	Median	IQR	Median	IQR
CHI at Crumlin						
<1 YEAR	4.02	2.2–8.8	4.24	2.0–8.7	4.03	1.9–8.6
1–4 YEARS	2.35	1.3–4.0	2.17	1.0–4.6	1.96	1.0–4.5
5–10 YEARS	1.99	1.0–4.3	2.04	1.0–4.8	1.73	0.9–3.9
11–15 YEARS	1.74	0.9–3.9	2.07	1.0–4.6	2.38	1.0–4.1
ALL AGES	2.94	1.7–6.3	3.08	1.6–6.8	3.08	1.3–6.9
CHI at Temple Street						
<1 YEAR	2.50	1.0–4.7	2.60	1.3–5.6	2.08	0.9–4.8
1–4 YEARS	1.83	0.8–3.9	1.71	0.8–5.1	1.42	0.8–3.5
5–10 YEARS	1.65	0.8–4.0	1.55	0.8–3.9	1.05	0.7–3.2
11–15 YEARS	1.56	0.9–3.9	1.78	1.0–6.8	1.65	0.7–4.3
ALL AGES	1.90	0.9–4.2	1.92	0.9–5.6	1.70	0.8–4.1

The median LOS and the IQR for patients by principal diagnosis group and by PCCU is presented in days in Table 5.3. The highest median LOS in CHI at Crumlin was for patients in the diagnosis group 'body wall and cavities' (6.01 days), that represent 2% (n=72) of total primary diagnoses, followed by 'infection', with a median LOS of 4.09 days and represent 6% (n=194) of all primary diagnoses. This is a reduction from previous years (2015–2017), when the median LOS for the 'body wall and cavities' diagnosis group was 9.4 days. This diagnosis group included surgical patients with gastroschisis and exomphalos and represents a small subgroup of patients admitted to the PCCU.

In CHI at Temple Street, the highest LOS figure was for patients in the 'multisystem diagnosis' group (5.2 days), that represent 0.3% (n=<5) of total primary diagnoses. The corresponding figure for 2015–2017 was 14.1 days (NOCA, 2017). It is important to note that the diagnosis groups with the highest LOS figures represented only a small proportion (5–6% CHI at Crumlin and 1% CHI at Temple Street) of overall admissions (see Figure 4.10).

TABLE 5.3: MEDIAN LENGTH OF STAY (DAYS) IN PAEDIATRIC CRITICAL CARE UNITS BY PRIMARY DIAGNOSIS AND UNIT, 2017–2019[9,10]

	CHI at Crumlin			CHI at Temple Street		
	N	Median	IQR	N	Median	IQR
Blood/lymphatic	44	2.16	1.2–10.2	*	4.46	0.6–6.0
Body wall and cavities	72	6.01	2.0–19.0	33	2.35	0.9–5.5
Cardio - vascular	1280	3.04	1.8–6.8	19	0.62	0.4–1.2
Endocrine/ metabolic	84	3.06	1.8–7.7	60	1.41	0.7–2.8
Gastrointestinal	206	3.03	1.6–7.7	99	2.54	1.0–6.0
Infection	194	4.09	2.2–7.0	94	3.56	1.6–6.3
Multisystem	10	3.03	1.9–12.8	~	5.21	1.5–15.9
Musculoskeletal	108	1.02	0.8–2.0	72	1.02	0.8–1.3
Neurological	136	2.34	1.2–5.2	289	1.58	0.8–3.2
Oncology	88	2.9	1.1–5.1	76	0.95	0.8–1.8
Respiratory	721	3.7	1.7–7.1	467	2.88	1.2–5.7
Trauma	33	2.56	1.3–4.3	34	1.07	0.6–3.8
Other	97	1.73	0.8–4.2	73	1.21	0.7–2.8

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

[9] Primary diagnosis group classification is based on CT3 (The Read Codes).

[10] 'Other' includes a mixture of diagnoses, as well as some coding where a non-diagnostic Read Code was given (e.g. 'post-surgical wound care'); this practice varies by organisation.

KEY FINDINGS FROM CHAPTER 5

- The average number of bed days delivered in PCCUs in the ROI within the 3-year reporting period from 2017 to 2019 was 10,059 annually, increasing slightly every year.

- CHI at Crumlin provided an average of 7,732 bed days annually, which is the third-highest number of bed days provided compared with all PCCUs in the UK and the ROI during this period. CHI at Temple Street provided an average of 2,327 bed days annually.

- Detailed bed activity data show that both PCCUs in the ROI exceeded the recommended occupancy limit of 85% each year during the reporting period from 2017 to 2019. The average bed occupancy over the 3-year reporting period was 96% in the CHI at Crumlin PCCU, and averaged 100% in 2019. Bed occupancy data for the CHI at Temple Street PCCU were only available for 2019 and showed 88% occupancy. Bed occupancy levels have increased every year over the reporting period.

- PICANet census snapshot data show that the proportion of critical care beds occupied in both CHI PCCUs during normal hours in 2019 was 89% (n=24), having increased gradually from 78% (n=21) in 2017 and 82% (n=22) in 2018.

- **PICANet Metric 3:** Nurse staffing levels in CHI at Crumlin met the recommended standard (Joint Faculty of Intensive Care Medicine of Ireland, 2018) of 5.5 WTE staff nurses per critical care bed for every year during the reporting period (average: 5.9 WTE).

  Nurse staffing levels in CHI at Temple Street remained below this recommended standard each year (averaging 4.7 WTE). This has implications for the ability to open staffed PCCU beds on a continuous basis without fluctuations in bed numbers. Consistency in staffing allows the beds to remain open.

- Median LOS in PCCUs in the ROI varied by Unit, age and primary diagnosis on admission, but was highest for infants aged under 1 year in both Units. The median LOS for the 3-year reporting period was 3.0 days for patients in CHI at Crumlin versus 1.84 days for patients in CHI at Temple Street.

INTERVENTIONS IN PAEDIATRIC CRITICAL CARE UNITS IN IRELAND

CHAPTER 6: INTERVENTIONS IN PAEDIATRIC CRITICAL CARE UNITS IN IRELAND

DAILY ACTIVITY DATA – PAEDIATRIC CRITICAL CARE MINIMUM DATA SET

PICANet received daily activity data from 32 organisations over the 2017–2019 reporting period. These data cover paediatric patients of all age groups.

The purpose of the Paediatric Critical Care Minimum Data Set (PCCMDS) is to provide the basis for payment by results through the establishment of UK Healthcare Resource Groups (HRGs). HRGs were specified to take into account differing levels of activity in PCCUs. The data received by PICANet have been grouped into these HRGs using the *HRG4+ 2018/2019 Reference Costs Grouper* (National Casemix Office, NHS UK 2019). New HRG definitions highlight differences in the intensity and complexity of support provided in PCCUs. This is important in terms of bed days used, staffing and bed availability (Table 6.1). Definitions for the levels of paediatric critical care (PCC) used in the ROI are detailed in Appendix 3.

TABLE 6.1: DESCRIPTION OF THE HEALTHCARE RESOURCE GROUP DEFINITIONS USED IN THIS ANALYSIS

HRG definitions (used in this analysis)	Current HRG definition	Description
PCC High Dependency	Basic critical care	Monitoring and interventions
PCC High Dependency Advanced	Intermediate critical care	Monitoring and interventions
PCC Intensive Care Basic	Advanced critical care 1	Invasive ventilatory support and/or support for two or more organ systems
PCC Intensive Care Basic Advanced	Advanced critical care 2	Invasive ventilatory support and/or support for two or more organ systems
PCC Intensive Care Advanced	Advanced critical care 3	Complex interventions/organ support
PCC Intensive Care Advanced enhanced	Advanced critical care 4	Complex interventions/organ support
PCC Intensive Care ECMO/ECLS	Advanced critical care 5	ECMO

There is still wide variation in the level of intensive care activity delivered in different PCCUs (Figure 6.1). Some of this variation may reflect differences in practice between cardiac and non-cardiac PCCUs that make like-for-like comparisons less clear.
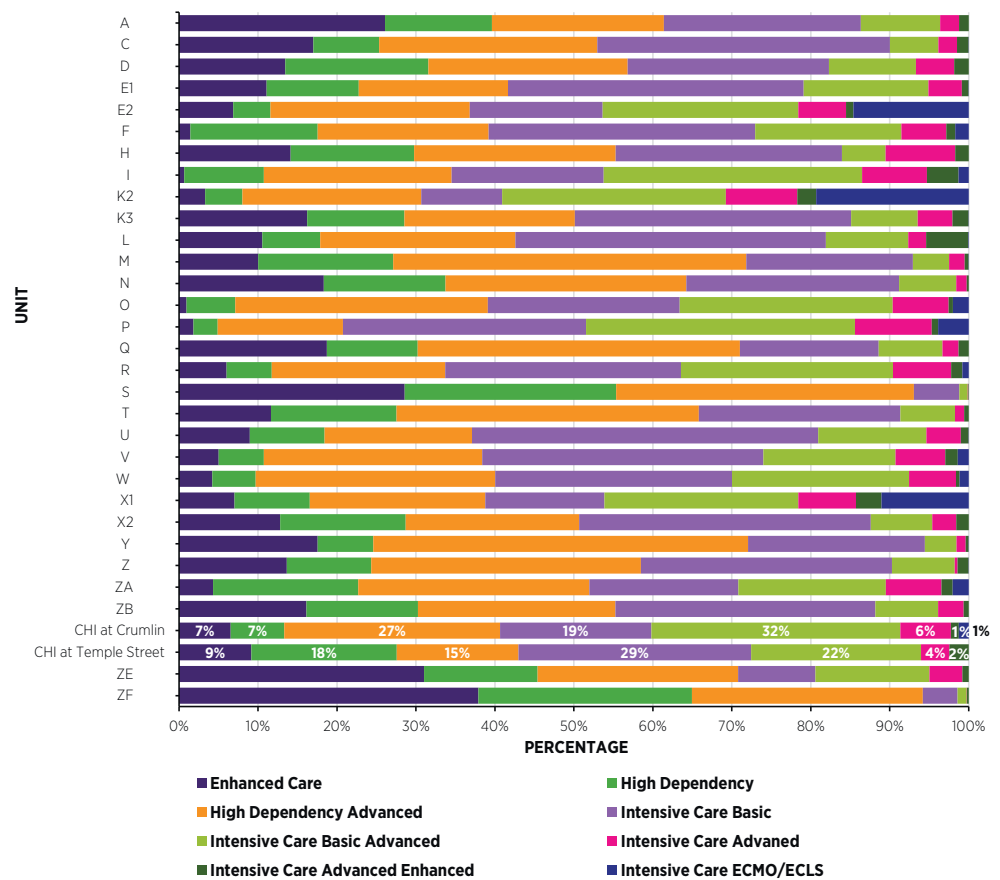
FIGURE 6.1: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL, BY UNIT, 2017–2019

The proportion of days of care delivered over the 2017–2019 reporting period at each HRG level in the CHI at Crumlin and CHI at Temple Street PCCUs is illustrated in Figures 6.2 and 6.3.

The levels of care most frequently delivered to patients in CHI at Crumlin were Intensive Care Basic Advanced (n=7400; 32%), High Dependency Advanced (n=6413; 27%) and Intensive Care Basic (n=4490; 19%) (Figure 6.2).

The levels of care most frequently delivered to patients in CHI at Temple Street were Intensive Care Basic (n=2138; 29%), Intensive Care Basic Advanced (n=1560; 22%) and High Dependency (n=1336; 18%) (Figure 6.3).

Of note, 40% of activity in CHI at Crumlin and 28% in CHI at Temple Street is at (or above) the level of Intensive Care Basic Advanced and above; this higher-intensity complex care requires an increased nurse–patient ratio at the bedside of 2:1. This is reflective of the higher proportion of cardiac cases treated in CHI at Crumlin compared with CHI at Temple Street.

CHI at Crumlin
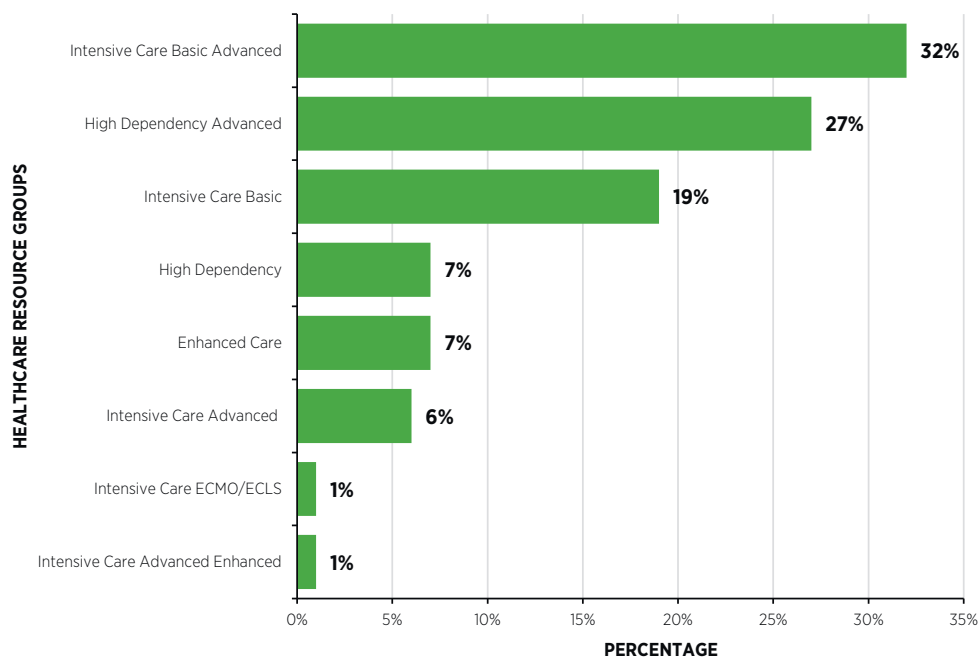
FIGURE 6.2: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, 2017–2019 (N=23460 DAYS)

CHI at Temple Street
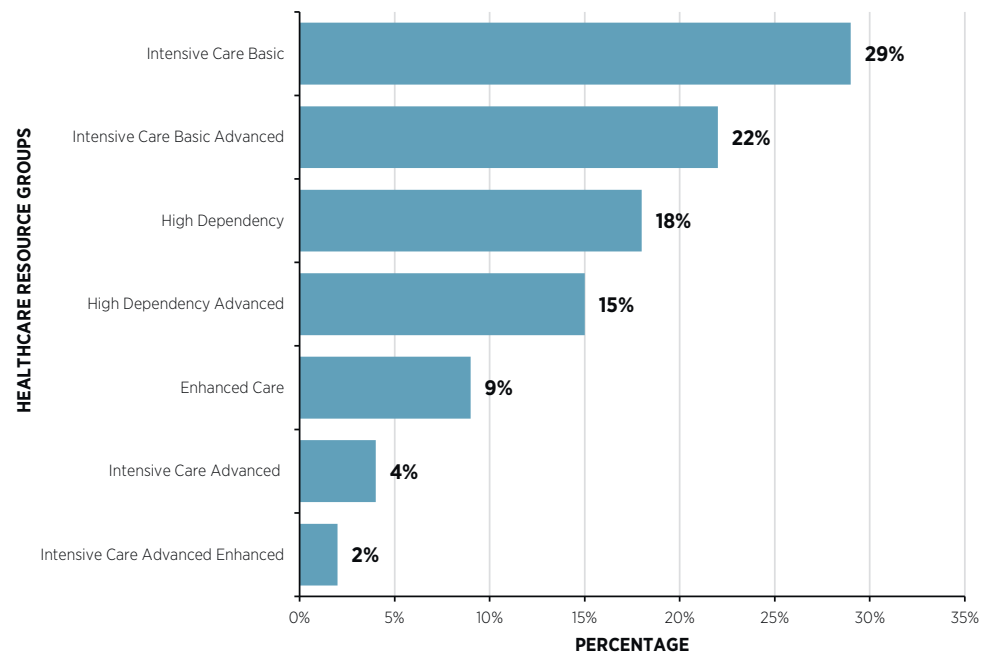
FIGURE 6.3: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, 2017–2019 (N=7250 DAYS)

INTERVENTIONS IN PCCUS IN IRELAND

Figures 6.4A and 6.4B illustrate the patient interventions carried out in the PCCUs in CHI at Crumlin and CHI at Temple Street from 2017 to 2019.

The most frequently used intervention for patients in both PCCUs over the 3-year reporting period was ventilation, with an average of 62% (n=2738) of patients receiving invasive ventilation (e.g. an endotracheal tube) and 23% (n=1009) receiving non-invasive ventilation (e.g. a nasal prong or continuous positive airway pressure (CPAP)). Only a small number of patients underwent a tracheostomy (n=35; 1%).

There was a much greater use of vasoactive medication to support the patient's cardiovascular system in CHI at Crumlin, compared with CHI at Temple Street, which is reflected in the daily activity data in Figure 6.2. Over the 3-year reporting period, 7% (n=93) of patients in CHI at Temple Street had an intracranial pressure (ICP) device placed due to the proportion of neurosurgery patients in that PCCU. The percentage of patients requiring renal support was broadly similar in both Units (average: 3%).

Over the 3-year reporting period, 2% of patients (n=47) received ECMO in CHI at Crumlin.

CHI at Crumlin
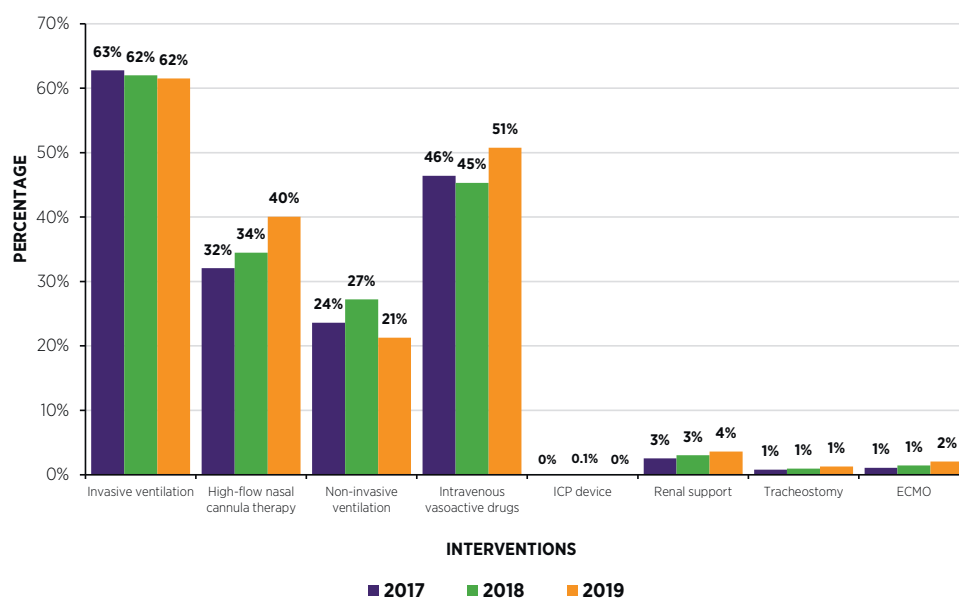
FIGURE 6.4A: DAILY INTERVENTIONS WHILE IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, BY YEAR, 2017–2019

CHI at Temple Street
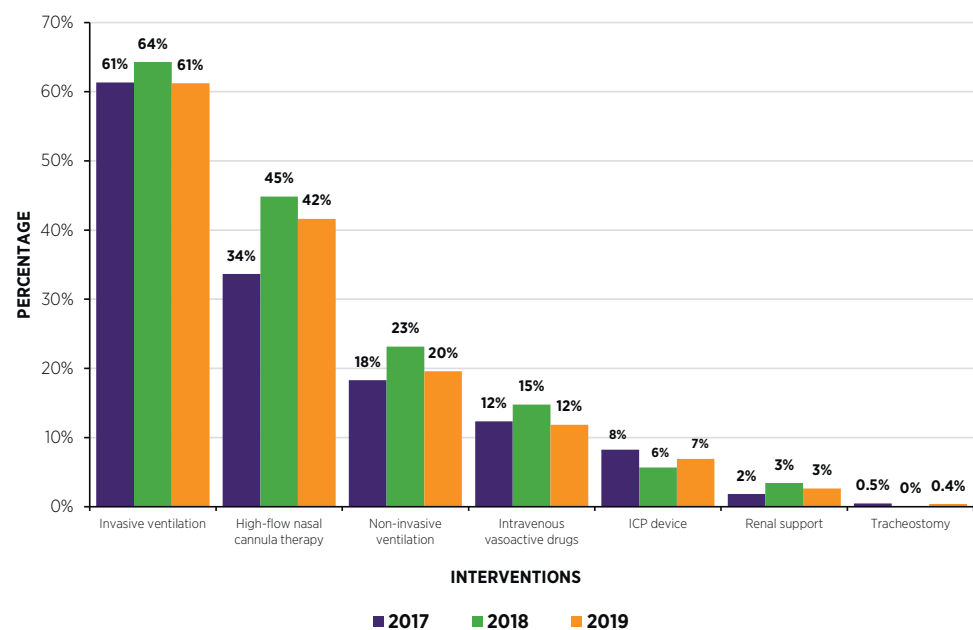
FIGURE 6.4B: DAILY INTERVENTIONS WHILE IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, BY YEAR, 2017–2019

TYPE OF VENTILATION

More than 40% of children admitted to each PCCU in the ROI underwent invasive ventilation, with a small additional percentage receiving non-invasive ventilation (Figures 6.5A and 6.5B).

CHI at Crumlin
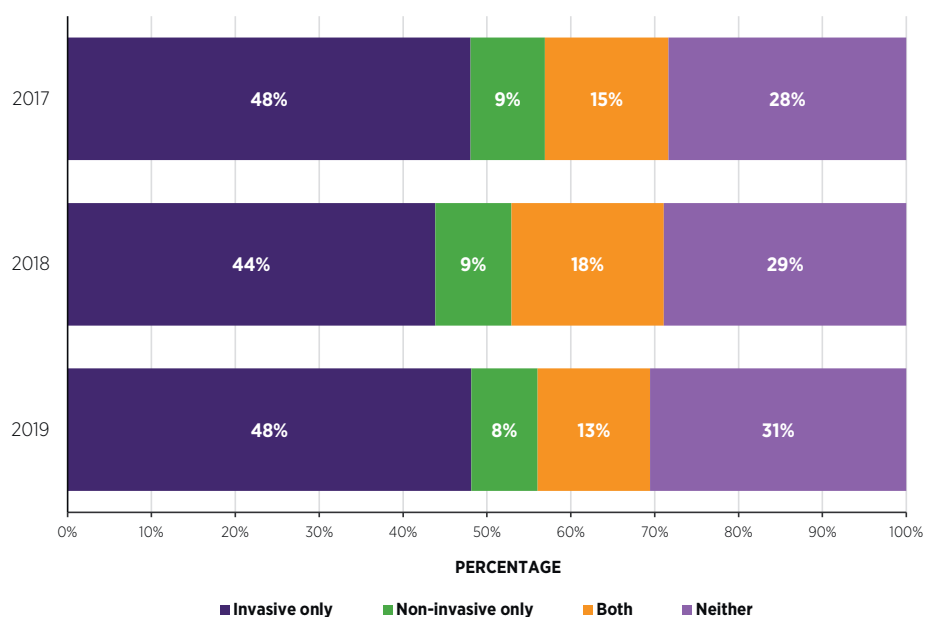
FIGURE 6.5A: TYPE OF VENTILATION IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, BY YEAR, 2017–2019

CHI at Temple Street
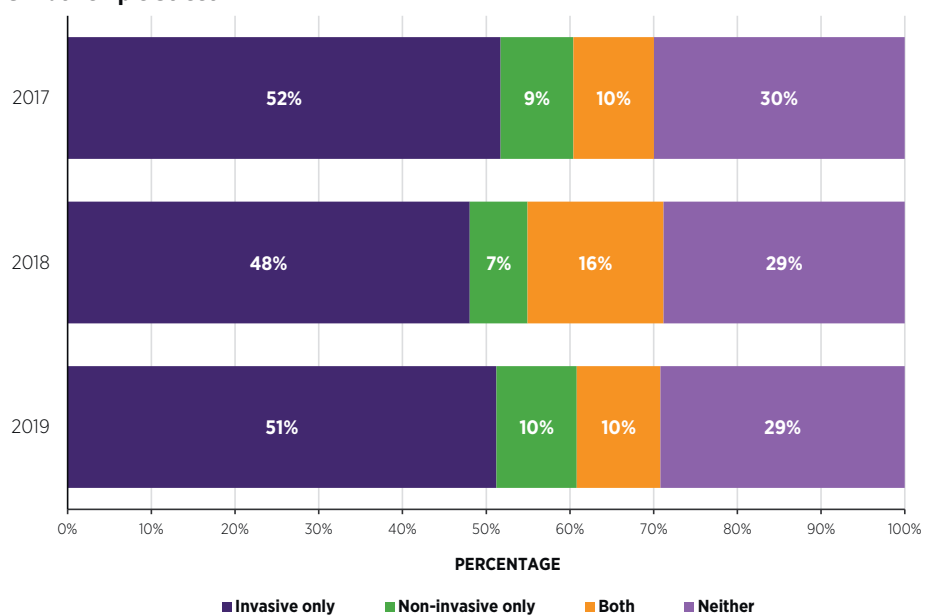
FIGURE 6.5B: TYPE OF VENTILATION IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, BY YEAR, 2017–2019

ADMISSIONS BY VENTILATION STATUS AND AGE GROUP

A breakdown of the ventilation status of patients by age group is shown in Figure 6.6.

From 2017 to 2019, infants (aged under 1 year) accounted for the greatest proportion of patients admitted to PCCUs in the ROI who received assisted ventilation. This was true for all categories of ventilation: invasive, non-invasive, and both.
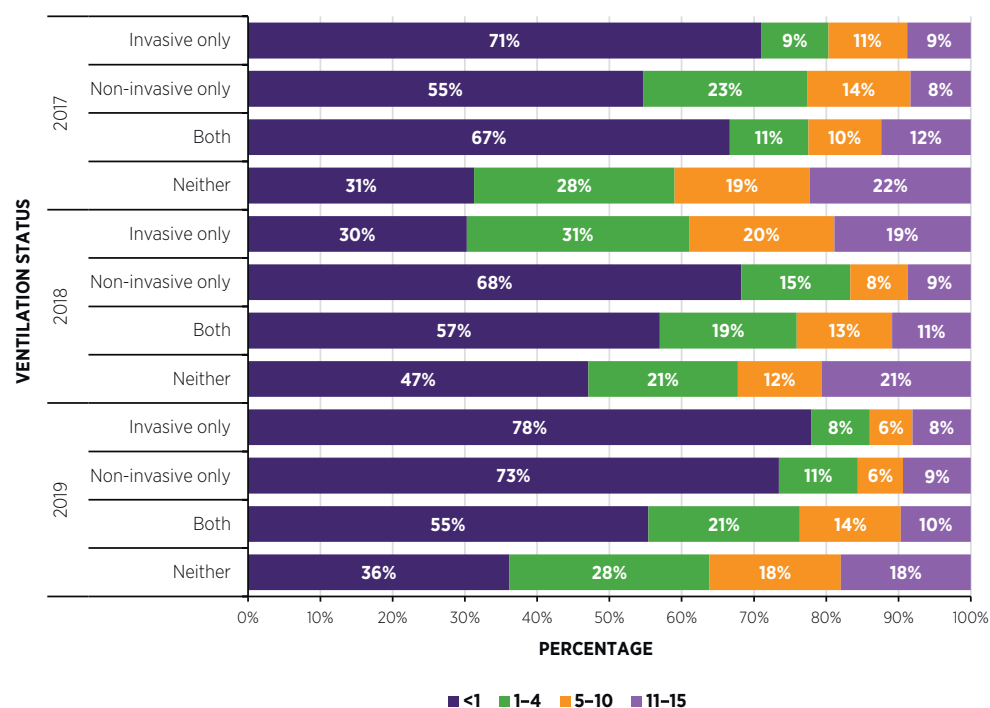
FIGURE 6.6: ADMISSIONS BY VENTILATION STATUS AND AGE GROUP IN THE REPUBLIC OF IRELAND, BY YEAR, 2017–2019 (N=4407)

ECLS AT CHI

ECLS Coordinator: Sunimol Joseph
ECLS Deputy Coordinator: Mochana Joseph

The ECLS cardiac programme at CHI at Crumlin commenced in 2005 and is recognised as a centre of excellence by the Extracorporeal Life Support Organization (ELSO). The CHI at Crumlin PCCU had 52 ECLS runs for the period 2017–2019 (Table 6.2). A large number of these (n=30) were cardiac surgical patients. However, nine ECLS runs were required for respiratory patients in CHI at Crumlin, a number of whom were transferred abroad for treatment, as there is no formally funded and resourced paediatric respiratory ECMO programme in the ROI. Respiratory ECMO provides life-saving treatment for infants and children with very severe lung failure. Data from the Health Service Executive (HSE) Treatment Abroad Scheme indicate that a total of 21 patients in the ROI were transferred abroad for respiratory ECMO over the 3-year reporting period.

A number of these patients had an LOS greater than 70 days in another European country, which has both financial and social implications for the HSE and for the families of these patients. Although survival rates were favourable, a small number of patients died while undergoing treatment abroad. The equipment and expertise required to provide respiratory ECMO is similar to that required for cardiac ECMO. It would be preferable if respiratory ECMO patients could remain in the ROI for treatment under a national cardiac and respiratory paediatric ECMO programme in CHI supported by CHI management and the HSE.

TABLE 6.2: TOTAL EXTRACORPOREAL MEMBRANE OXYGENATION RUN IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, 2017–2019 (N=52)[11]

	2017	2018	2019	TOTAL
Cardiac ECMO	11 runs: • extracorporeal cardiopulmonary resuscitation (ECPR) • cardiology • cardiac surgery	13 runs: • ECPR • cardiac surgery	19 runs: • ECPR • cardiology • cardiac surgery	43
Respiratory ECMO	Run: Venovenous ECMO	Runs: • airway repair • congenital diaphragmatic hernia (CDH) and persistent pulmonary hypertension of the newborn (PPHN) transferred to Sweden	Runs: • CDH transferred to Sweden • CDH and tetralogy of Fallot – ECMO in CHI at Crumlin	9
Total ECMO: Cardiac and respiratory	12	18	22	52
Total ECMO days in CHI at Crumlin	85	92	118	295
Total ECMO days in Sweden	0	40	37	77
Total bed stay in Sweden	0	72 days	43 days	115
Survival to decannulation	75%	89%	91%	
Survival to discharge	50%	78%	82%	

[11] Total of 49 patients; 2 patients had 2 runs of ECMO.

HIGH-FLOW NASAL CANNULA THERAPY

The intervention of high-flow nasal cannula therapy (HFNCT) has been recorded by PICANet since 2015. Usage is documented for both PCCUs in the ROI in Table 6.3. There has been a steady increase in children receiving HFNCT in both PCCUs as this intervention has become more commonplace.

TABLE 6.3: ADMISSIONS RECEIVING HIGH-FLOW NASAL CANNULA THERAPY, BY PAEDIATRIC CRITICAL CARE UNIT, 2017–2019

	CHI at Crumlin			CHI at Temple Street		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**
Number of events where HFNCT was provided	339	353	404	152	182	202
Total number of days	1324	1457	1623	423	502	492

KEY FINDINGS FROM CHAPTER 6

- Daily activity data show the different levels of critical care provided during the reporting period. Care at (or above) the level of Intensive Care Basic Advanced accounted for 40% of activity in CHI at Crumlin and 28% in CHI at Temple Street; this higher-intensity complex care requires an increased nurse–patient ratio at the bedside of 2:1. This is reflective of the higher proportion of cardiac cases treated in CHI at Crumlin compared with CHI at Temple Street.

- Over the 3-year reporting period, 85% of patients admitted to PCCUs in the ROI required respiratory support: 62% (n=2738) received invasive ventilation (e.g. an endotracheal tube) and 23% (n=1009) received non-invasive ventilation (e.g. a nasal prong or CPAP).

- In CHI at Crumlin, 47% (n=1460) of patients admitted from 2017 to 2019 received vasoactive medication, and this is reflected in the daily activity data. Seven percent (n=93) of patients in CHI at Temple Street, the national centre for paediatric neurosurgery, had an ICP device placed, due to the higher proportion of neurosurgery patients admitted to this PCCU.

- Each year from 2017 to 2019, infants aged under 1 year accounted for the greatest proportion of patients admitted to PCCUs in the ROI who received assisted ventilation (whether invasive, non-invasive, or both).

- From 2017 to 2019, a small number of patients (n=47) received ECMO in CHI at Crumlin; the majority of these had cardiac diagnoses (n=30). Nine respiratory ECLS runs were required by patients in CHI at Crumlin, a number of whom were transferred abroad.

  In total, 21 patients nationally over the 3-year reporting period were referred abroad to international ECLS centres for respiratory ECMO, as there is no formally funded and resourced paediatric ECMO programme in the ROI.

- There has been a steady increase in children receiving high-flow nasal cannula therapy in both PCCUs in the ROI as this intervention has become more commonplace.

CHAPTER 7: **RETRIEVALS AND TRANSPORT**

PAEDIATRIC TRANSPORT MEDICINE SERVICES IN THE ROI

The National Ambulance Service – Critical Care & Retrieval Services (NAS-CCRS) was established in 2018 and incorporated the adult and paediatric transport medicine services in Ireland. Within NAS-CCRS, there are two retrieval services for infants and children aged under 16 years:

- The National Neonatal Transport Programme (NNTP) is a 24/7 retrieval service for the stabilisation and transportation of premature and sick neonates aged 6 weeks and under who require transfer for specialist care within the ROI and abroad. Clinical teams from the three Dublin maternity hospitals (Coombe Women and Infants University Hospital, National Maternity Hospital and Rotunda Hospital) and an ambulance crew from the National Ambulance Service (NAS) staff the NNTP.

- The Irish Paediatric Acute Transport Service (IPATS) supports the transfer of critically ill infants and children (aged 4 weeks to 16 years) from a referring hospital to the PCCU in CHI at Crumlin or CHI at Temple Street. Dedicated specialised doctors and nurses, in collaboration with the NAS, staff the service. IPATS operates 5 days per week (Monday to Friday) between 10.00am and 4.00pm.
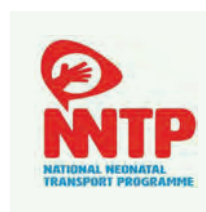
Non-specialist teams from the referring regional hospital carry out paediatric critical care transfers outside of IPATS' hours of activation. Through active education and outreach programmes, both the NNTP and IPATS support and enable the delivery of high-quality intensive care by other specialist teams and non-specialist local transport teams when required.

RETRIEVALS

Table 7.1 outlines IPATS activity from 2017 to 2019. Referrals and retrievals carried out by IPATS have remained stable each year. The majority of transports are non-elective urgent retrievals of children who are acutely unwell and have been accepted for admission by a PCCU.

TABLE 7.1: IRISH PAEDIATRIC ACUTE TRANSPORT SERVICE: ELECTIVE AND NON-ELECTIVE TRANSPORT, 2017–2019

	Total referred	Completed non-elective	Completed elective	Deferred
2017	117	93	7	17
2018	106	85	7	14
2019	115	91	9	15

Table 7.2 outlines IPATS elective/ 'B' team transports from 2017 to 2019. These transports are scheduled, planned transfers of children requiring High Dependency Unit or PCCU care. The majority of transfers to the UK are for children requiring specialist cardiac or hepatology services including transplantation assessment or completion. In the ROI, a small number of children who are dependent on specialised technology are transferred out of the PCCU to LauraLynn – Ireland's Children's Hospice, to a regional centre, or to the family home in order to facilitate end-of-life care in a location aligned with patient and family wishes.

TABLE 7.2: IRISH PAEDIATRIC ACUTE TRANSPORT SERVICE: ELECTIVE/'B' TEAM TRANSPORTS, 2017–2019

	Total referred	End-of-life care/ repatriation	Overseas	Overseas repatriation
2017	7	~	5	0
2018	7	~	~	~
2019	9	~	~	~

~ Denotes five cases or fewer

Table 7.3 displays NNTP transfers into CHI at Crumlin and CHI at Temple Street between 2017 and 2019. These numbers have also remained quite static over the 3-year reporting period. NNTP transfers the vast majority of infants requiring PCCU admission 24/7.

TABLE 7.3: TOTAL TRANSPORTS COMPLETED BY THE NATIONAL NEONATAL TRANSPORT PROGRAMME, 2017–2019[12]

	Total transports	Transports to CHI at Crumlin	Transports to CHI at Temple Street
2017	177	127	50
2018	211	139	72
2019	199	127	72

[12] Data were provided by the NNTP Co-ordinator.

IPATS DEFERRALS

Each year, a small proportion of referrals that fall within the acceptance criteria are deferred by the IPATS team. Table 7.4 outlines the number of retrievals that were received but not completed for each year of the reporting period. A proportion of referrals are cancelled following advice from the PCCU of a clinical improvement in the child such that they no longer require PCCU admission. There is a single team on service each shift and if that team is already tasked elsewhere, it must defer. If two patients require transport at the same time this is termed a 'double activation', in this case a risk assessment of need is undertaken in order to ensure that the team transports the child who is most likely to benefit from the transport team completing the retrieval. Phone support is provided to the referring team that is deferred. A small proportion of children each year will have a 'time-critical' diagnosis whereby the priority is rapid access to CHI for definitive care, and the delay incurred by sending a team from Dublin to retrieve the patient outweighs the benefit of using that team. This decision is made between the accepting PCCU intensivist and the IPATS consultant, and remote support is provided by phone to the referring team. On rare occasions, usually due to staff on unplanned sick leave, IPATS are unable to facilitate a team. For the period 2017–2019, there was one retrieval per year where IPATS was unable to facilitate a team.

TABLE 7.4: IRISH PAEDIATRIC ACUTE TRANSPORT SERVICE: RECEIVED RETRIEVALS NOT COMPLETED, 2017–2019

	Total	Stood down/ Cancelled	IPATS on another call	Time-critical	No IPATS team
2017	17	6	7	~	~
2018	14	~	9	~	~
2019	15	~	10	0	~

~ Denotes five cases or fewer

PICANET METRIC 2: RETRIEVAL MOBILISATION TIMES

Figure 7.1 shows the time taken to mobilise a team following a clinical decision that urgent (non-elective) transport is required in the UK and the ROI (i.e. IPATS) in 2019. Of the 12 transport organisations, 7 (T001, T002, T003, T004, T005, T008 and T024) mobilised within 30 minutes for more than one-half of the transports completed. IPATS mobilised within 60 minutes for 72% of transports in 2019. Once a team has agreed to transport a child, the UK Care Quality Commission recommends that the journey be commenced within 1 hour (Paediatric Intensive Care Audit Network, 2018). The time required for a retrieval team to mobilise depends on the model used by each team. Many high-volume teams are situated at bespoke bases awaiting activation and thus can achieve rapid deployment. Due to IPATS' relatively low volume of calls, both the IPATS registrar and nurse provide support to the PCCU during their shifts. Following activation, the IPATS team must assemble along with the IPATS consultant and the NAS ambulance, which are frequently not co-located.
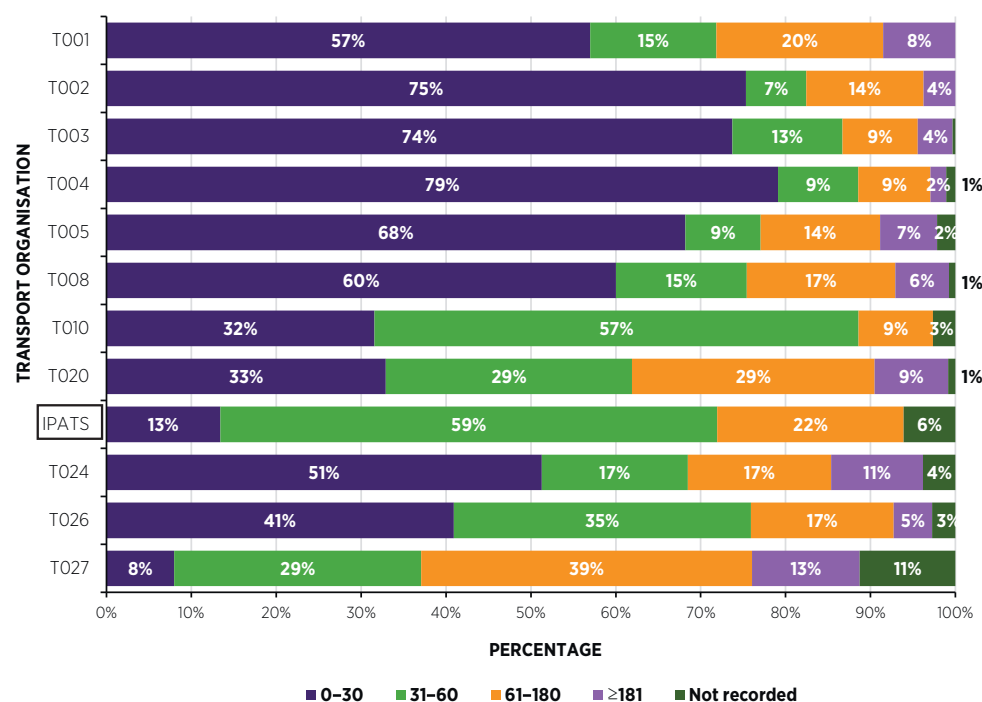
FIGURE 7.1: NON-ELECTIVE TRANSPORTS BY MOBILISATION TIMES (IN MINUTES), UNITED KINGDOM AND REPUBLIC OF IRELAND, 2019

Figure 7.2 illustrates mobilisation times for the ROI (IPATS) only. Journey commencement in less than 1 hour was achieved in the majority of cases each year: 71% in 2017 (n=58), 67% in 2018 (n=56) and 72% in 2019 (n=59). There were no cases recorded where the time taken for mobilisation exceeded 180 minutes in 2018 or 2019. There was an improvement in timeliness throughout the 3 years of the reporting period, with an average of 70% of cases commencing journeys within 1 hour, which is a clear improvement on 2015 and 2016, when this was achieved in about 40% of cases.
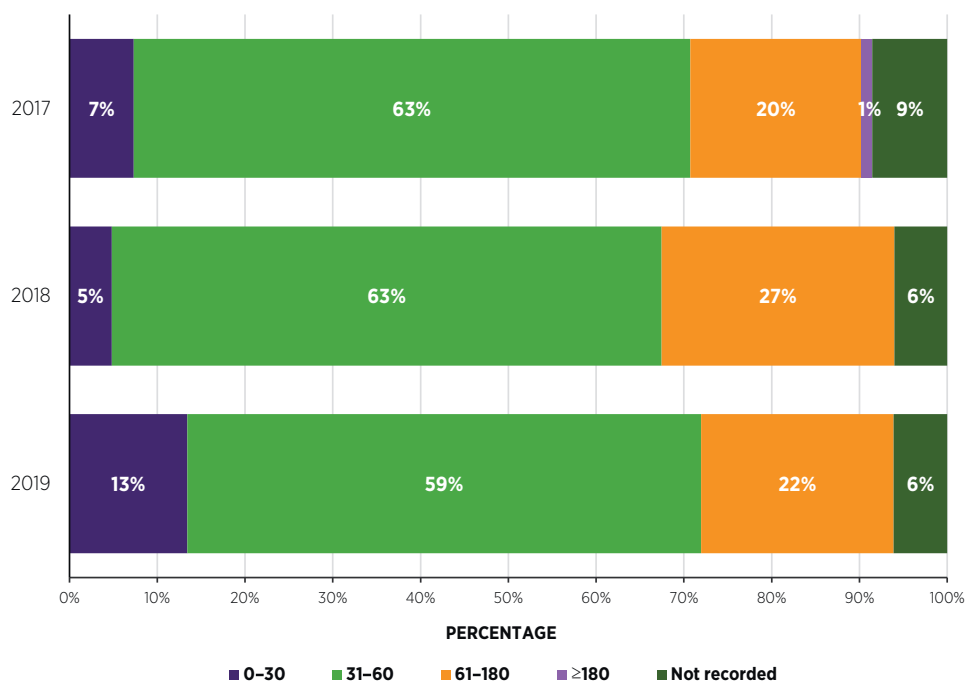
FIGURE 7.2: NON-ELECTIVE TRANSPORTS BY MOBILISATION TIMES (IN MINUTES) IN THE REPUBLIC OF IRELAND, 2017–2019 (N=247)

NON-ELECTIVE TRANSPORTS AND GRADE OF CLINICAL TRANSPORT TEAM LEADER

Figure 7.3 presents the distribution of the grade of the clinical transport team leader for non-elective transports by transport organisation in the UK and the ROI. In 2019, the grade of the clinical transport team leader varied across organisations; in 6 (T003, T10, T20, IPATS, T024 and T026) of the 12 transport organisations, a consultant was the team leader for more than one-half of transfers. In the ROI (IPATS), the team leader was a consultant in 90% (n=74) of transfers.
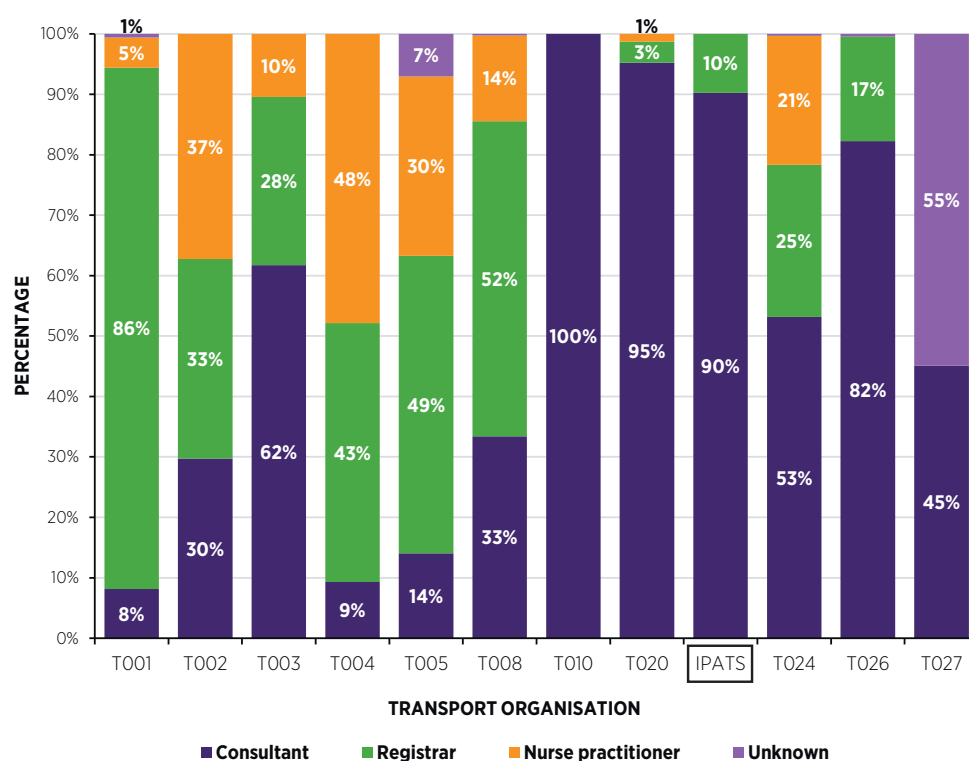
FIGURE 7.3: NON-ELECTIVE TRANSPORTS IN THE UNITED KINGDOM AND REPUBLIC OF IRELAND, BY TRANSPORT ORGANISATION AND GRADE OF CLINICAL TRANSPORT TEAM LEADER, 2019[13]

[13] The UK classifications of ST1–3 (specialty trainee years 1–3) and ST4–8 (specialty trainee years 4–8) were combined and recoded to 'Registrar' to correspond to the classification used in the ROI.

The grade of the IPATS clinical transport team leader for the period from 2017 to 2019 is outlined in Figure 7.4. There was an increase in the number of consultants as clinical team leaders over the reporting period, from 59 (72%) in 2017 to 75 (90%) in 2018 and 74 (90%) in 2019. The IPATS consultant-led model reflects the high acuity of the patients transported, the high frequency of intensive care interventions required during stabilisation at the regional centres, and the desire to fully support the IPATS registrars who are typically in their first 6 months of paediatric critical care training. The introduction of a new post in 2021 for a fellowship in critical care retrieval medicine is likely to alter the proportion of consultant-delivered transports in the future.
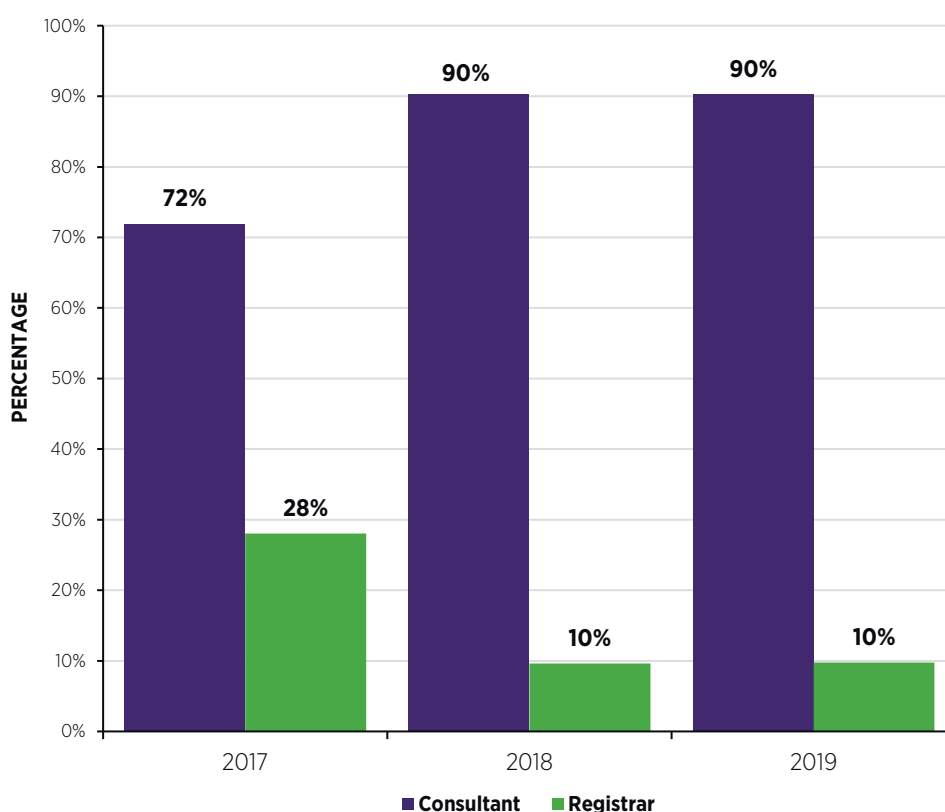
FIGURE 7.4: NON-ELECTIVE TRANSPORTS BY GRADE OF CLINICAL TRANSPORT TEAM LEADER IN THE REPUBLIC OF IRELAND, BY YEAR, 2017–2019 (N=247)

KEY FINDINGS FROM CHAPTER 7

- Transport was successfully arranged for all children accepted to a PCCU bed by one of a variety of transport teams throughout the 2017–2019 reporting period. IPATS transfers the majority of children referred within its current hours of activation.

- **PICANet Metric 2:** Retrieval mobilisation times of less than 1 hour were achieved in the majority of urgent transfers by IPATS each year: 71% (n=58) in 2017, 67% (n=56) in 2018 and 72% (n=59) in 2019.

  An overall improvement in mobilisation times is evident compared to 2015 and 2016, with all teams mobilised within 180 minutes in 2018 and 2019. IPATS mobilisation times are improving each year, but ultimately remain constrained by the team's lack of co-location.

- IPATS provides a predominantly consultant-delivered service, although this may change with the development of clinical fellowship and advanced nurse practitioner roles in 2021 and beyond.

CHAPTER 8: **OUTCOMES**

PICANet METRIC 4: **EMERGENCY READMISSIONS WITHIN 48 HOURS**

Emergency readmissions to the PCCU within 48 hours of discharge from the same PCCU may mean that a child was discharged too early or into the wrong care environment, or that the need for future intensive care was not predicted. There is no standard acceptable rate of emergency readmissions to PCCU within 48 hours. Low readmission rates are generally accepted as an indicator of a good quality of care.

Table 8.1 displays the number and percentage of admissions where the child was readmitted to PCCU within 48 hours of discharge, by country, for each year of the reporting period. For the 2017–2019 reporting period, Scotland had the highest readmission rate (2.0%; n=90), and the ROI had the lowest emergency readmission rate (1.5%; n=68).

TABLE 8.1: EMERGENCY READMISSIONS WITHIN 48 HOURS OF DISCHARGE, 2017–2019[14]

Country	2017		2018		2019		2017-2019	
	N	%	N	%	N	%	N	%
ENGLAND (NHS AND NON-NHS)	270	1.7%	272	1.7%	251	1.6%	793	1.6%
WALES	~	*	16	3.1%	*	*	29	1.9%
SCOTLAND	32	2.3%	26	1.9%	32	1.9%	90	2.0%
NORTHERN IRELAND	~	*	14	2.8%	*	*	27	1.8%
ROI	24	1.6%	18	1.3%	26	1.7%	68	1.5%
TOTAL	**336**	**1.7%**	**346**	**1.7%**	**325**	**1.6%**	**1007**	**1.7%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

Of note, the ROI readmission rate within 48 hours is 1.5%, and this is lower than that for other participating Units. This may reflect a lack of availability of beds on the ward, resulting in a prolongation of PCCU stay and in PCCU occupancy rates in excess of 85%. These data should be communicated to hospital management and taken into account when planning ward bed numbers, as this lack of available beds may contribute to the cancellation of elective surgeries.

[14] Due to small numbers, data for non-NHS and NHS organisations in England are presented together.

UNPLANNED EXTUBATION

Children who need help breathing may require a flexible plastic tube to be placed in their throat and connected to a machine; this is called invasive ventilation. If the tube is accidentally dislodged or removed by the patient, this is referred to as unplanned extubation. Unplanned extubation remains a relatively rare event in PCCUs. It is the most common adverse event related to airway management in intensive care and can result in clinical complications such as hypoxaemia (very low blood oxygen), hypercarbia (high blood carbon dioxide) and sometimes, but very rarely, death (Kanthimathinathan *et al.,* 2015). A single-cohort study using routine clinical data from 12,533 admissions to a single PCCU between 2010 and 2013 identified an acceptable threshold rate of unplanned extubations of less than 10 per 1,000 invasive ventilation days (Kanthimathinathan *et al.,* 2015).

Rates of unplanned extubation per 1,000 intubated days by country of admission are shown in Table 8.2. In 2019, all Units reported unplanned extubation rates below 7 per 1,000 intubated days. For the 2017–2019 reporting period, the ROI had an unplanned extubation rate of 4.0 per 1,000 intubated days (n=65).

TABLE 8.2: RATE OF UNPLANNED EXTUBATIONS PER 1000 DAYS OF INVASIVE VENTILATION, BY COUNTRY OF ADMISSION, 2017–2019

Country	2017	2018	2019	2017-2019
ENGLAND (NHS)	3.7 (n=206)	5.2 (n=287)	4.5 (n=247)	4.4 (n=740)
ENGLAND (NON-NHS)	0.0 (n=0)	0.0 (n=0)	1.8 (n=1)	0.6 (n=1)
WALES	2.9 (n=3)	2.4 (n=3)	1.8 (n=2)	2.3 (n=8)
SCOTLAND	4.8 (n=20)	6.0 (n=24)	6.0 (n=25)	5.6 (n=69)
NORTHERN IRELAND	3.2 (n=5)	2.8 (n=4)	6.5 (n=9)	4.1 (n=18)
ROI	4.0 (n=20)	3.8 (n=21)	4.2 (n=24)	4.0 (n=65)
Total	**3.7 (n=254)**	**5.0 (n=339)**	**4.6 (n=308)**	**4.4 (n=901)**

Figure 8.1 illustrates rates of unplanned extubation across all participating PCCUs in the UK and the ROI in 2017, 2018 and 2019. There was an increase in the unplanned extubation rate in CHI at Temple Street in 2018 (7.8) and 2019 (7.6) compared with that in 2017 (3.6). CHI at Crumlin had a slight decrease in the unplanned extubation rate per 1,000 intubated days in 2019 (3.0) compared with 2017 (4.1). Both PCCUs in the ROI fell well below the acceptable threshold rate of 10 unplanned extubations per 1,000 invasive ventilation days.
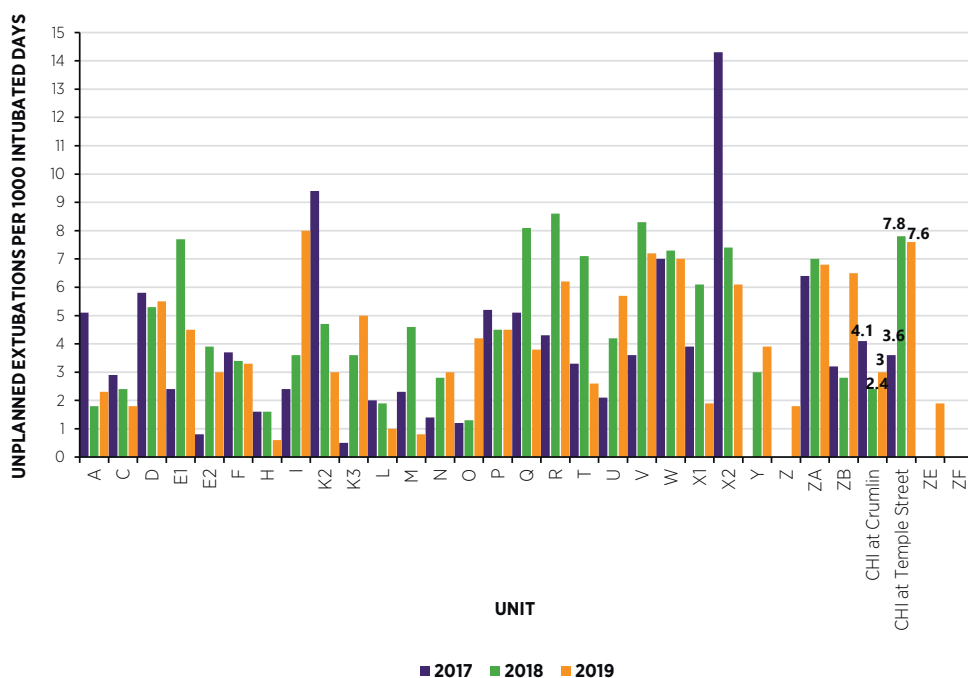
FIGURE 8.1: RATES OF UNPLANNED EXTUBATIONS AT PAEDIATRIC CRITICAL CARE UNITS, BY YEAR, 2017–2019[15]

Unplanned extubation is still a relatively new data item, as Units have only recently been required to report this metric. Changes in the rates of unplanned extubation should be carefully monitored over time to identify when changes in practices occur.

[15] Unit "S" had no unplanned extubations for 2017 to 2019 years

CLINICAL COMMENTARY

CHI AT CRUMLIN

By continuously monitoring unplanned extubation rates, it was possible to show the effect of a change in practice. Of note, the unplanned extubation rate in CHI at Crumlin was higher than average in 2015 and 2016. PICANet highlighted this to CHI at Crumlin, which warned us that the rate was above the acceptable range. As a result, we instituted a number of measures, including bedside teaching, the evaluation of endotracheal taping, and a change in practice when re-taping was complete. This resulted in a reduction in the number of unplanned extubations. We continue to monitor our data with regard to unplanned extubations and, if an increase is noted, we reiterate bedside teaching and the evaluation of endotracheal taping and re-taping in order to ensure that our rate of unplanned extubation remains low.

Dr Martina Healy, Clinical Lead Paediatric Critical Care Unit, CHI at Crumlin

CHI AT TEMPLE STREET

During 2017, event surveillance identified an unexpected exponential increase in the unplanned extubation rate in CHI at Temple Street. We quickly undertook a root cause analysis of each event. Staff were actively encouraged to record every unplanned extubation and our audit nurse was actively seeking to identify unplanned extubations, which probably led to an increase in recorded unplanned extubations compared with previous years. Working closely with all staff involved, we identified multiple areas of improvement, and specific training in taping and monitoring of tapes – including review at ward round times – led to improved numbers in subsequent years, showing the value of surveillance and audit. Simultaneously, discussions have started with PICANet, uncovering that there is no consensus regarding the definition of what is counted as an unplanned extubation, possibly leading to the wide variety in occurrences throughout the PICANet community. For the future, having a common definition will help accurately compare Units. Given the ongoing occurrence of unplanned extubations, continuous monitoring is advisable.

Dr Heike Bruell, Consultant Paediatric Intensivist, PCCU CHI at Temple Street

PICANet METRIC 5: MORTALITY IN PCCU

The Paediatric Index of Mortality (PIM) is a severity scoring system for predicting the risk of mortality among patients admitted to PCCUs based on data collected within the first hour following admission. The PIM was updated (PIM3) in 2013 in order to provide better estimates of mortality risk among children admitted to intensive care in the UK, the ROI, Australia and New Zealand. When estimating risk, the model adjusts for case mix, including factors such as diagnosis, post-procedure recovery, type of admission, and mechanical ventilation, as well as physiological variables, such as systolic blood pressure and pupillary reaction (Straney *et al.,* 2013).

The PIM3 risk grouping of children admitted to PCCUs in both CHI at Crumlin and CHI at Temple Street in 2017, 2018 and 2019 is presented in Table 8.3 and shows an overall improvement in the mortality risk of patients admitted to these PCCUs in 2019 compared to the previous 2 years.

TABLE 8.3: ADMISSIONS BY PAEDIATRIC INDEX OF MORTALITY 3 RISK GROUP FOR EACH UNIT, 2017–2019[16]

PIM3 risk group	2017		2018		2019	
	N	%	N	%	N	%
CHI at Crumlin						
<1%	375	37%	354	35%	393	38%
1 to <5%	459	45%	474	46%	472	46%
5 to <15%	156	15%	156	15%	138	13%
15 to <30%	25	2%	34	3%	11	1%
≥30%+	11	1%	6	1%	10	1%
Total	1026	100%	1024	100%	1024	100%
CHI at Temple Street						
<1%	211	48%	189	47%	230	47%
1 to <5%	151	35%	158	39%	192	39%
5 to <15%	54	12%	40	10%	52	11%
15 to <30%	12	3%	15	4%	12	2%
≥30%+	9	2%	4	1%	4	1%
Total	437	100%	406	100%	490	100%

Figures 8.2 and 8.3 show the distribution of PIM3 risk groups for PCCUs in the ROI for the years 2017 to 2019 combined. Of the children admitted to CHI at Crumlin, those in the 1% to <5% PIM3 risk group made up the largest share (46%; n=1405), whereas in CHI at Temple Street, admissions in the <1% PIM3 risk group were the largest group (47%; n=630).

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[16] Children aged under 16 years only.

CHI at Crumlin
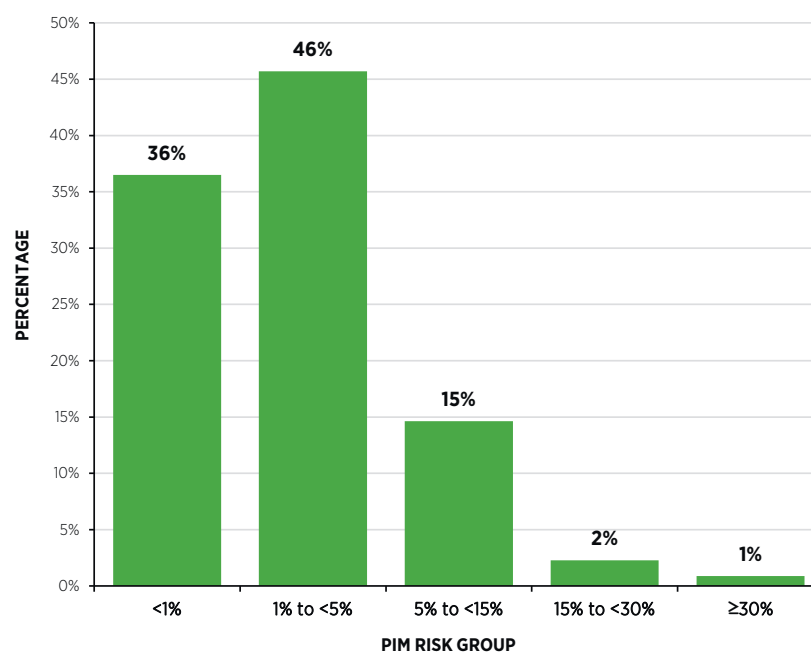
FIGURE 8.2: ADMISSIONS BY PAEDIATRIC INDEX OF MORTALITY 3 RISK GROUP, CHILDREN'S HEALTH IRELAND AT CRUMLIN, 2017–2019 (N=3074)[17]

CHI at Temple Street
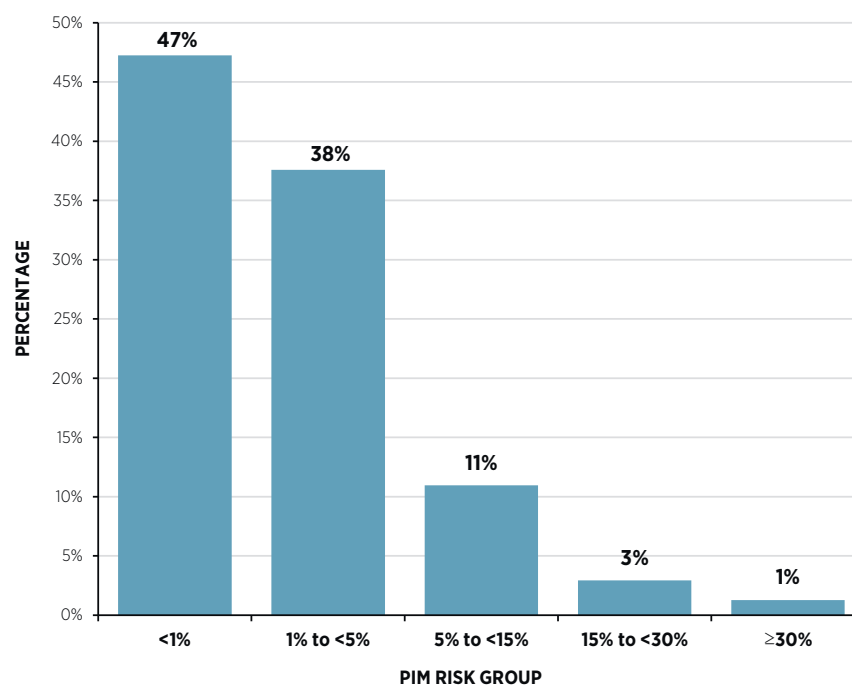
FIGURE 8.3: ADMISSIONS BY PAEDIATRIC INDEX OF MORTALITY 3 RISK GROUP, CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, 2017–2019 (N=1333)[18]

[17] Children aged under 16 years only.
[18] Children aged under 16 years only.

NUMBER OF DEATHS IN PCCU IN 2019

The number of deaths that occur after admission to but prior to discharge from PCCUs included in PICANet is shown in Figure 8.4. Estimates for each Unit are based on the total number of admissions to that Unit for 2019.

In 2019, CHI at Crumlin had a crude mortality rate of 4% (n=45) and CHI at Temple Street had a crude mortality rate of 3% (n=15). The mortality rate for CHI at Temple Street dropped from 4% (n=18) in 2017 to 3% in both 2018 (n=14) and 2019 (n=15).

PCCU deaths in the ROI accounted for 4% (n=179) of admissions to PCCUs in 2017–2019 (Table 8.4). This indicates that risk of death in PCCU is low, with 95.9% of patients discharged alive. Of all childhood deaths that occurred in Ireland during the reporting period, 21–22% died in PCCU each year (Table 8.5). Deaths in PCCU account for one in five deaths in the childhood population in the ROI in any given year.
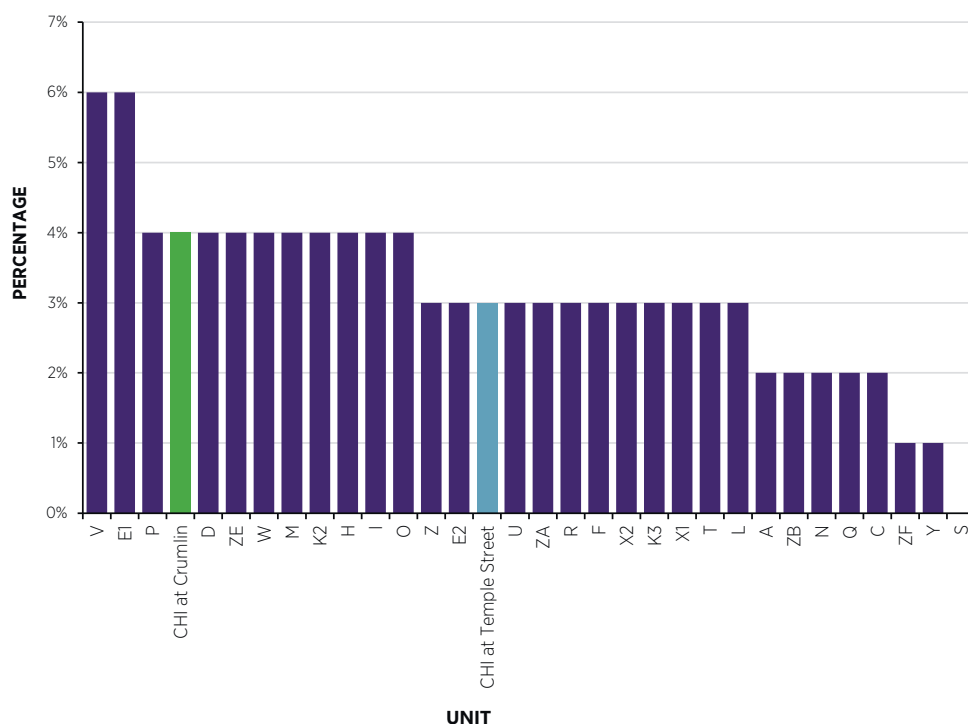
FIGURE 8.4: PROPORTION OF DEATHS IN PAEDIATRIC CRITICAL CARE UNITS, BY UNIT, 2019 (N=20383)

TABLE 8.4: DEATHS IN PAEDIATRIC CRITICAL CARE UNITS, BY COUNTRY OF ADMISSION, 2017–2019

Country	2017			2018			2019			2017-2019		
	Admissions	Deaths		Admissions	Deaths		Admissions	Deaths		Admissions	Deaths	
	N	N	%	N	N	%	N	N	%	N	N	%
ENGLAND	16 001	604	4%	16 380	562	3%	16 191	575	4%	48 572	1741	4%
WALES	493	10	2%	510	22	4%	489	10	2%	1492	42	3%
SCOTLAND	1390	35	3%	1351	33	2%	1697	33	2%	4438	101	2%
NORTHERN IRELAND	522	18	3%	501	12	2%	492	11	2%	1515	41	3%
ROI	1463	60	4%	1430	59	4%	1514	60	4%	4407	179	4%
Total	**19 869**	**727**	**4%**	**20 172**	**688**	**3%**	**20 383**	**689**	**3%**	**60 424**	**2104**	**3%**

TABLE 8.5: DEATHS IN PAEDIATRIC CRITICAL CARE UNITS AS A PROPORTION OF ALL CHILDHOOD DEATHS, BY COUNTRY OF ADMISSION, 2017–2019

Country	2017			2018			2019		
	Deaths in population	Deaths in PCCU		Deaths in population	Deaths in PCCU		Deaths in population	Deaths in PCCU	
	N	N	%	N	N	%	N	N	%
UK	4133	667	16.1%	4028	629	15.6%	3962	629	15.9%
ROI	273	60	22.0%	279	59	21.1%	272	60	22.1%
Total	**4406**	**727**	**16.5%**	**4307**	**688**	**16.0%**	**4234**	**689**	**16.3%**

STANDARDISED MORTALITY RATIOS FOR PCCUS IN CHI AT CRUMLIN AND CHI AT TEMPLE STREET

Mortality rates are assessed for each PCCU based on a statistical approach that takes into account the severity of the child's illness at the time of admission. The risk-adjustment method used is PIM3. The number of children predicted to die is calculated and then compared to the number of children who actually die in order to derive the risk-adjusted standardised mortality ratio (SMR) (Paediatric Intensive Care Audit Network, 2020).

The risk-adjusted SMR for each PCCU in the UK and the ROI is displayed in a funnel plot (plotted against the number of admissions) for the period 2017–2019 in Figure 8.5. In this reporting period, after allowing for level of illness at time of admission, no PCCU in the ROI had a mortality rate that was higher than expected. Risk-adjusted mortality is an important high-level quality indictor. Transparent presentation of this information is important to assure the public, parents and the health service at large that hospitals are continuously monitoring important outcomes and that there are systems in place to review any areas of concern.
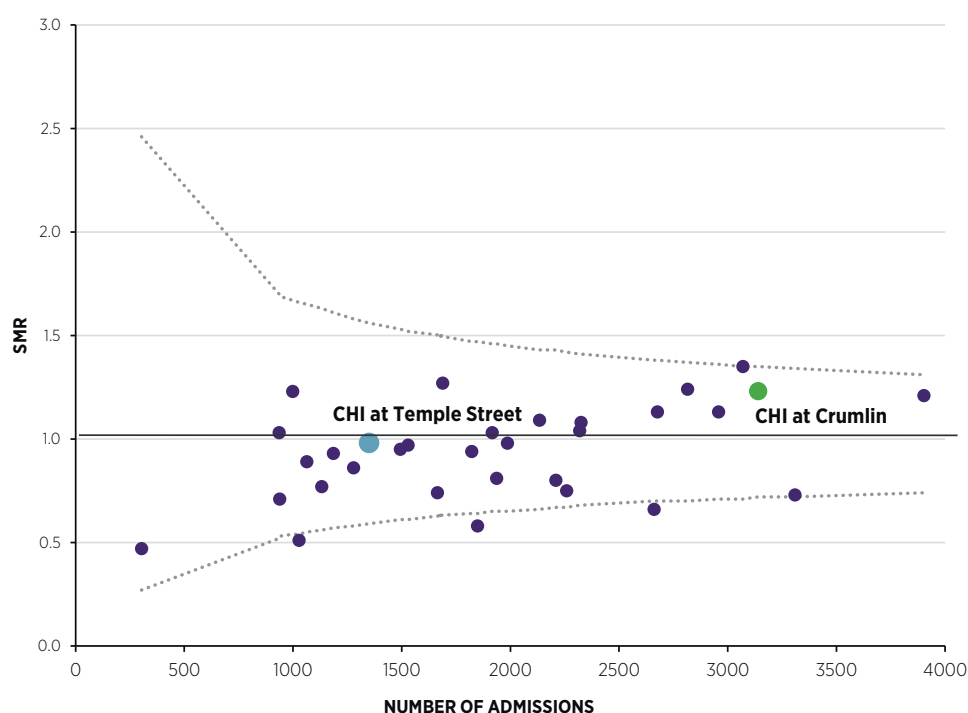
FIGURE 8.5: RISK-ADJUSTED STANDARDISED MORTALITY RATIO, BY PARTICIPATING PAEDIATRIC CRITICAL CARE UNIT, 2017–2019

KEY FINDINGS FROM CHAPTER 8

- **PICANet Metric 4:** Of all Units participating in PICANet, those in the ROI had the lowest rate of emergency readmissions within 48 hours of discharge from the same PCCU for the reporting period, at 1.5% (n=68).

- The annual average rate of unplanned extubations per 1,000 intubated days in PCCUs in the ROI was 4.0 compared with an average of 4.4 across all participating PCCUs. Both Units in the ROI fell below the acceptable threshold rate of 10 unplanned extubations per 1,000 invasive ventilation days.

- In 2019, CHI at Temple Street audited the rate of unplanned extubations per 1,000 intubated days and found that the rates in 2018 (7.8) and 2019 (7.6) were twice the rate reported in 2017 (3.6). Areas of improvement were identified and changes implemented, leading to a decrease in the unplanned extubation rate in 2020. In CHI at Crumlin, a gradual reduction in unplanned extubation rates was observed over the reporting period, from 4.1 per 1,000 intubated days in 2017 to 2.4 in 2018 and 3.0 in 2019.

- **PICANet Metric 5:** The mortality rate in PCCUs in the ROI is low, with 96% of patients discharged alive. Deaths in PCCU account for one in five deaths in the childhood population in the ROI in any given year. Risk-adjusted SMRs for both PCCUs in the ROI over the 3-year reporting period indicate that neither Unit had a mortality rate that was higher than expected.

REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK

CHAPTER 9: REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK

ADMISSIONS BY AGE AND SEX

The regional Paediatric High Dependency Unit (PHDU) in University Hospital Limerick (UHL) has two beds for children who need high-dependency nursing and medical care (level 1; see Appendix 3). The UHL Unit is the only dedicated PHDU in the ROI that is operational outside Dublin.

In 2019, the total number of admissions to the regional PHDU at UHL was 126. The mean age of patients admitted was 4 years, and the median age was 2 years. Younger children aged 0–4 years represented the majority of the admissions to the PHDU, at 71% (n=89). A higher proportion of all children admitted were male (56%; n=71) (Figure 9.1).
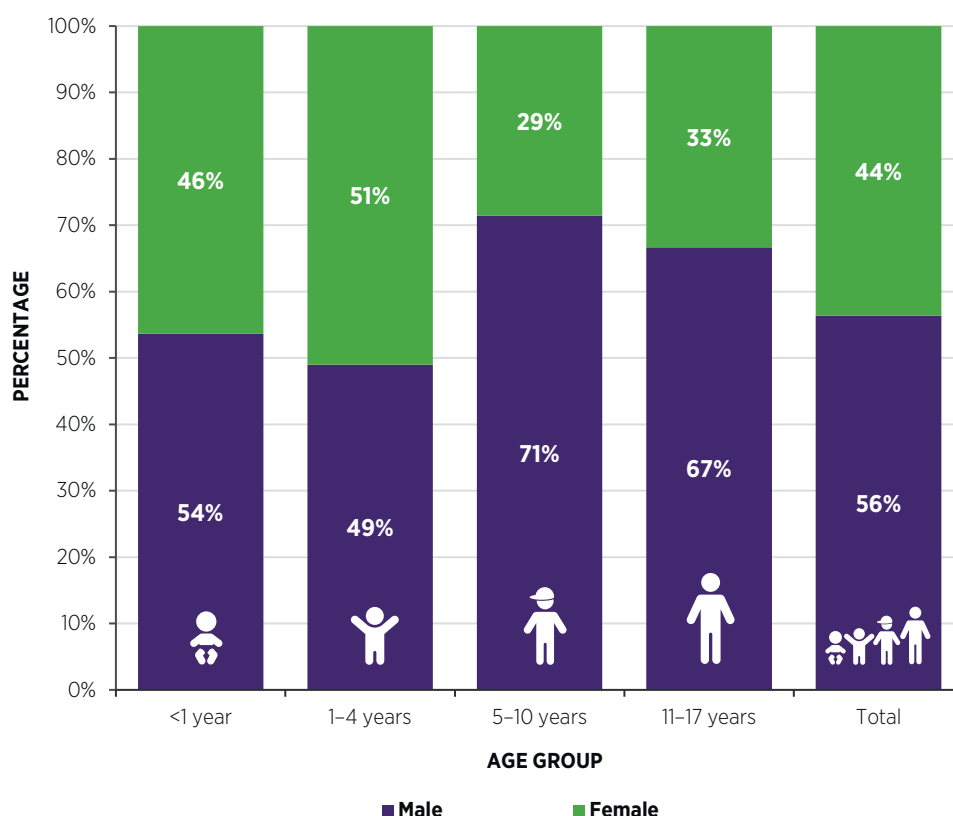
FIGURE 9.1: ADMISSIONS TO REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, BY SEX AND AGE GROUP (N=126)

ADMISSIONS BY TYPE AND SOURCE

The majority (n=119; 94%) of children admitted to the regional PHDU in UHL were unplanned admissions (i.e. emergencies) (Table 9.1). Only 5% of children admitted were unplanned admissions following surgery for post-appendectomy and post-tonsillectomy bleeding. In 2019, the majority (n=126; 96%) of PHDU patients were inpatients admitted from within the same hospital. Out of those who were transferred either within the same hospital or from another hospital, 73% (n=90) were admitted from the Emergency Department (ED), 22% (n=27) were admitted from the ward and 5% (n=6) were admitted from theatre and recovery.

TABLE 9.1: ADMISSIONS TO REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, BY TYPE AND SOURCE, 2019

		N	%
TYPE OF ADMISSION	Planned	~	*
	Unplanned	119	94%
	Unplanned – following surgery	~	5%
	Total	**126**	
SOURCE OF ADMISSION	Same hospital	121	96%
	Other hospital/clinic	~	*
	Home	~	*
	Total	**126**	
CARE AREA OF ADMISSION	ED	90	73%
	Ward	27	22%
	Theatre and recovery	6	5%
	Total	**123**	

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

LENGTH OF STAY

The average length of stay (LOS) in the regional PRHDU UHL was 3.8 days, and the median LOS was 2.0 days. The majority of patients (60%; n=75) stayed between 2 and 7 days. Figure 9.2 shows the distribution of LOS in the PHDU by age group. Almost three-quarters (74%; n=29) of patients aged under 1 year stayed in the PHDU for between 2 and 7 days. The LOS in PHDU for all patients aged 5–10 years was less than 8 days.
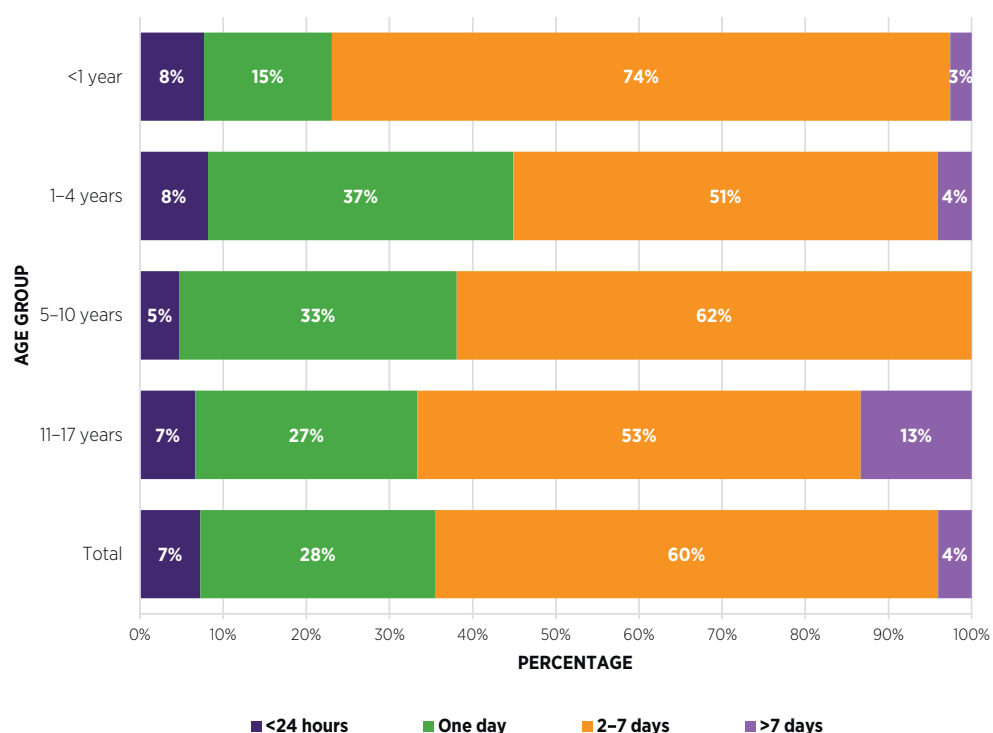
FIGURE 9.2: LENGTH OF STAY IN REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, BY AGE GROUP (N=124)[19,20]

[19] Cases that had time recorded incorrectly were excluded from Figure 9.2.
[20] Please note: Percentages may not sum to 100% due to rounding.

ADMISSIONS BY PRIMARY DIAGNOSIS GROUP

The number of admissions to the regional PHDU UHL during 2019, grouped by primary diagnosis, is outlined in Figure 9.3. The largest proportion of patients admitted to the PHDU were those presenting with a respiratory diagnosis (55%; n=69), followed by a neurological diagnosis (16%; n=20).
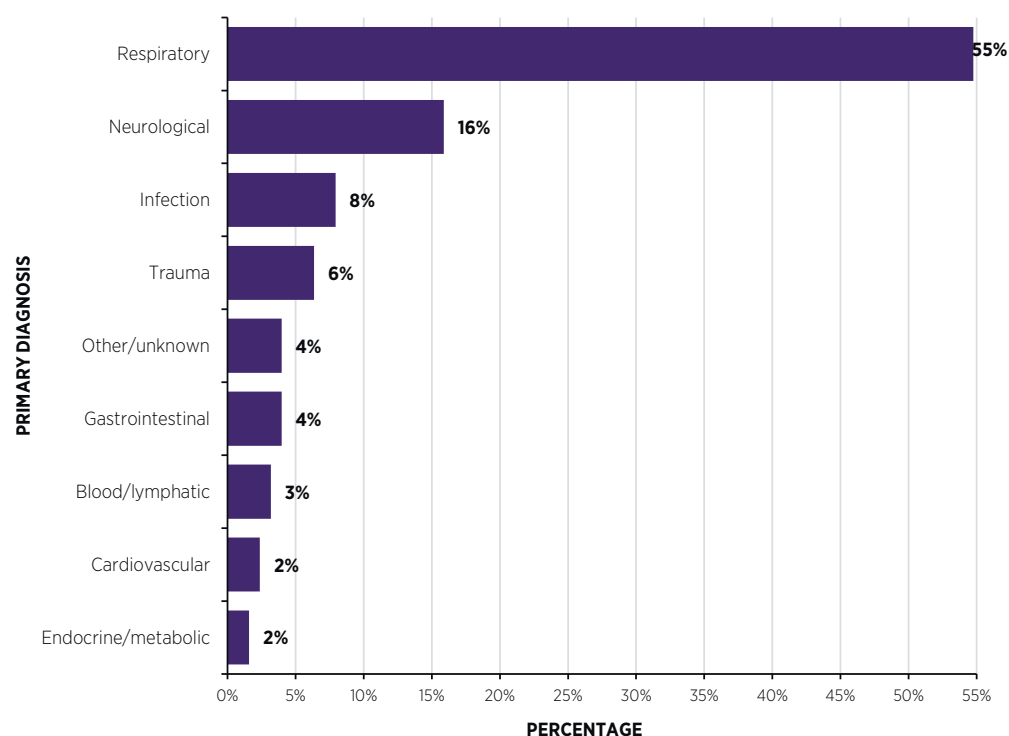
FIGURE 9.3: ADMISSIONS TO REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, BY PRIMARY DIAGNOSIS, 2019 (N=126)[21]

[21] Please note: Percentages may not sum to 100% due to rounding.

The majority of patients (63%; n=79) admitted to the Unit did not have any pre-existing comorbidities, while 37% (n=47) had a pre-existing comorbidity. The most prevalent pre-existing comorbidities were neurological (13%; n=16) and genetic (11%; n=14) (Table 9.2).

TABLE 9.2: COMORBIDITIES OF PATIENTS IN REGIONAL PHDU (N=126)

	N	%
Neurological	16	13%
Genetic	14	11%
Other*	17	13%
None	79	63%
Total	**126**	**100%**

* Other includes Respiratory, Infectious, ENT, Endocrine

INTERVENTIONS

The majority (64%; n=81) of children admitted to the PHDU required respiratory support (Table 9.3). Sixty-five percent (n=82) of patients had one or more interventions performed while in the PHDU. Table 9.3 shows the distribution of these interventions, with oxygen treatment being the most used intervention (n=81; 64%).

TABLE 9.3: INTERVENTIONS IN REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, 2019			
		N	%
SYSTEM REQUIRING SUPPORT	Respiratory	81	64%
	Neurological	24	19%
	Circulatory	~	13%
	Cardiovascular	~	*
	Total	**126**	**100%**

INTERVENTION PERFORMED	Oxygen treatment	81	64%
	High-flow nasal cannula	31	25%
	Continuous positive airway pressure	26	21%
	Total number of patients	126	100%
	Total procedures	**138**	

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

DISCHARGES

Ninety-eight percent (n=124) of paediatric patients were alive on discharge from the regional PHDU UHL. Seventy-three percent (n=91) were discharged to the same hospital and 16% (n=20) were discharged to their normal residence (Table 9.4). Of those who were discharged for further care (to the same or another hospital) (n=104), the vast majority (89%; n=93) were discharged to the ward. Ten percent (n=10) were transferred for PCCU care (critical care Levels 2–3; see Appendix 3) to a tertiary paediatric centre; most paediatric patients were transferred in order to escalate their respiratory support.

TABLE 9.4: DISCHARGE FROM REGIONAL PAEDIATRIC HIGH DEPENDENCY UNIT UNIVERSITY HOSPITAL LIMERICK, 2019

		N	%
DISCHARGE DESTINATION	Home	20	16%
	Same hospital	91	73%
	Other hospital	13	10%
	Total	**124**	

		N	%
CARE AREA DISCHARGED TO	Ward	93	89%
	PCCU	10	10%
	Unknown	1	1%
	Total	**104**	

KEY FINDINGS FROM CHAPTER 9

- The only dedicated regional PHDU that is operational outside Dublin is in UHL, which had 2 available beds and 126 admissions in 2019. The majority (94%; n=119) were unplanned admissions presenting with respiratory (55%; n=69) or neurological (16%; n=20) complaints, and 10% (n=10) were transferred for PCCU care (Levels 2–3) to a tertiary paediatric centre, mostly for escalation of respiratory support.

CHAPTER 10: **AUDIT UPDATE**

UPDATE ON AUDIT RECOMMENDATIONS FOR ICU PAEDIATRIC UNITS
FROM IRISH NATIONAL ICU AUDIT ANNUAL REPORT 2017

Recommendation	Update
The paediatric hospitals should increase bed capacity in PCCUs, as evidenced by the 94% bed occupancy across both Units in 2017. Increased bed capacity could be achieved by retention and recruitment of staff in order to open all available Intensive Care Unit (ICU) capacity (32 beds), avoiding the need for an increase in structural bed capacity.	**In 2019, the bed occupancy rate was 100% in Children's Health Ireland (CHI) at Crumlin and 88% in CHI at Temple Street.**
The Health Service Executive (HSE) should prioritise the expansion of the Irish Paediatric Acute Transport Service (IPATS) to a 24-hour, 7-day-per-week centralised transport service (CTS) in order to ensure safe transfer of all children to specialist PCCU care in a timely manner; this requires investment in recruitment and retention of nurses and doctors.	**The process of extending IPATS was initiated and, as of 19 April 2021, the service now operates 6 days per week.**
Prioritise a national database for audit of adult ICUs, which will facilitate data collection and reporting on all children who are cared for in adult critical care. This information is critical to the health service for future planning of paediatric bed capacity and transport services.	**NOCA made a submission for HSE funding to set up an Irish National Intensive Care Unit Audit database, which has been approved and is due to commence in 2021.**
Consider developing a dataset for rates of medical staffing per ICU bed for the ROI in consultation with PICANet.	**Development of this dataset remains a future consideration.**

AUDIT ACTIVITY

- An Irish Paediatric Critical Care Audit (IPCCA) audit manager was appointed in September 2019.
- The audit manager conducted site visits to both paediatric hospitals in order to view data and PICANet data portals.
- The audit manager attended the PICANet Annual Meeting 2019 in the UK.
- The data manager from CHI at Crumlin joined the Irish National ICU Audit Governance Committee in order to represent paediatrics.
- A new Public and Patient Interest (PPI) representative joined the Irish National ICU Audit Governance Committee in order to represent paediatrics.

AUDIT DEVELOPMENTS

- Hospital Activity Dashboards were planned, but have been deferred due to the COVID-19 pandemic.
- The rollout of the National ICU database will capture data on all children who are cared for in adult ICUs.

CHAPTER 11: **RECOMMENDATIONS**

RECOMMENDATIONS FOR IMPROVING SERVICE DELIVERY

RECOMMENDATION 1

Children's Health Ireland (CHI) should use the data in this report to work with the Health Service Executive (HSE) in order to inform the planning and implementation of adequate measures for optimising bed capacity in the Paediatric Critical Care Units (PCCUs) in the Republic of Ireland (ROI). Providing the resources adequate to maintain a bed occupancy of 85% would provide flexibility in order to cover surges such as flu pandemics and the winter surge, and avoid the late cancellation of semi-elective surgeries.

Rationale

The Model of Care for Paediatric Critical Care (National Clinical Programme for Critical Care and National Clinical Programme for Paediatrics, 2019) outlines the requirements for safe and effective care for all children requiring paediatric critical care medicine in the ROI and incorporates the minimum standards of care outlined in the *National Standards for Paediatric Critical Care Services Version 2.0* (Joint Faculty of Intensive Care Medicine Ireland, 2018). Part of the remit of this model of care is capacity planning, which indicates recommended bed occupancy and staffing levels, which are especially pertinent due to a predicted increase in the number of children requiring critical care in the future (Department of Health, 2018). The data presented in this report demonstrate bed occupancy figures that exceed the recommended limit of 85% for both Units during the reporting period from 2017 to 2019. While this is a reflection of increased demand for PCCU beds, it also reflects the insufficient numbers of suitably qualified staff and that not all funded PCCU beds were open and staffed during the reporting period. High occupancy levels may result in sudden, unexpected cancellations of semi-elective congenital, cancer or scoliosis surgeries, with unexpected deferrals resulting in anxiety and upset for families.

Nurse staffing levels in CHI at Temple Street are below the recommended standard of 5.5 whole-time equivalent (WTE) staff nurses per critical care bed.

What evidence is there to show that this action will be effective?

The UK Paediatric Intensive Care Society recommends that average PCCU bed occupancy exceeding 85% for more than 2 successive months should be specifically escalated to hospital management and specifically reviewed. Various large observational studies have demonstrated that hospitals or Units with higher nurse staffing rates have lower rates of mortality (Hamilton et al., 2007; Tourangeau et al., 2006; Lang et al., 2004; Aiken et al., 2002). Staff shortages occur because of multiple factors associated with recruitment and retention of suitably qualified staff. Retention of nursing staff is particularly problematic in ICUs for a number of reasons, including the higher nurse–patient ratios and specialised training required to enable working in a high-stress environment. Staffing requirements may vary intermittently, influenced by multiple factors including case mix, outbreaks, the season, etc.

What action should be taken?
The ultimate aim is to have all 32 beds over the 2 sites – 23 beds in CHI at Crumlin and 9 in CHI at Temple Street – open and staffed 24 hours per day, 7 days per week. Addressing staff retention, particularly with regard to nursing, and allowing flexibility for sick and maternity leave would ensure consistency in bed availability. This will facilitate peaks and troughs in bed availability and allow for a recommended occupancy rate of 85%. Difficulties with the recruitment of suitably qualified staff in PCCUs in the ROI must also be addressed in order to raise levels to the recommended standard of 5.5 WTE staff per bed (Joint Faculty of Intensive Care Medicine of Ireland, 2018). Sustained, consistent, increased bed usage can be achieved by both the retention and recruitment of additional staff in order to open all available PCCU capacity (32 beds), thus avoiding the need to increase structural bed capacity. Ensuring adequate planning for availability of ward beds for discharges from PCCUs will prevent cancellations of planned procedures that require care in PCCUs.

Who will benefit from this recommendation?
• Recommended staffing levels will reduce stress and burnout among staff and result in improved quality of care for patients admitted to PCCUs in the ROI.
• CHI sites will benefit from the capacity to open all available PCCU beds, reducing cancellations of surgeries, etc.
• Annual monitoring and review of staffing needs in PCCUs will determine optimal requirements for each Unit and ensure that quality of care is not compromised.

Who is responsible for implementing this recommendation?
CHI management is responsible for addressing staff shortages in CHI Units.

When should this be implemented?
The priority is to improve patient care. The information in this report will support immediate consultation with HSE and hospital management in order to assist in planning for staffing needs for the critical care of patients in the National Children's Hospital (NCH). Future reports will provide data for annual review and will highlight any improvement or deterioration in a timely manner.

RECOMMENDATION 2

CHI and the National Ambulance Service – Critical Care & Retrieval Services (NAS-CCRS) should operationally enable the extension and development of the Irish Paediatric Acute Transport Service to a 24-hour-per-day, 7-day-per-week centralised transport service (CTS). This will help to ensure that a specialised paediatrics retrieval team transfers all critically ill children.

Rationale
The Irish Paediatric Acute Transport Service (IPATS) supports the transfer of critically ill infants and children (aged 4 weeks to 16 years) from a referring hospital to the PCCU in CHI at Crumlin or CHI at Temple Street. IPATS operates 5 days per week (Monday to Friday) between 10.00am and 4.00pm. IPATS transfers the majority of children who are referred during its current hours of activation. A significant number of paediatric critical care transfers continue to be carried out by non-specialist teams from the referring regional hospital outside of IPATS' hours of activation.

What evidence is there to show that this action will be effective?
The Association of Anaesthetists of Great Britain and Ireland's Safety Guideline, *Care of the Critically Ill Child in Irish Hospitals 2015* (AAGBI, 2015), states that there is a need for national 24-hour-per-day, 7-day-per-week neonatal and paediatric retrieval services in order to ensure the prompt and safe transfer of critically ill children and newborns. Use of specialist retrieval teams for transfer is associated with improved outcomes for patients (Ramnarayan *et al.,* 2010). The unavailability of IPATS outside of regular working hours means that a large number of transfers to PCCUs are carried out by the National Neonatal Transport Programme or by non-specialist transfer teams.

What action should be taken?
• IPATS should develop a 7-day-per-week service, and then extend this to a 24-hour service. This requires additional resources that will be supported by the development of a senior tier of trainee which will facilitate more remote consultant supervision that can thus be provided over a greater period of time per WTE staff member.
• IPATS should continue to progress and develop its outreach and education programme and support the development of paediatric critical care transport standards at a national level.
• Future development of a NAS-CCRS base of operations would facilitate a more rapid deployment time and potentially allow acceptance of time-critical transfers.

Who will benefit from this recommendation?
All children who require transfer to a PCCU will benefit from increased availability of IPATS, and this will reduce demand on the National Neonatal Transport Programme and other non-specialist transport services.

Who is responsible for implementing this recommendation?
CHI and the NAS-CCRS have a shared responsibility to operationally enable the extension of IPATS.

When should this be implemented?
The additional resources required to enable the extension of IPATS should be identified and implemented as a matter of priority.

RECOMMENDATIONS FOR DEVELOPING THE IRISH PAEDIATRIC CRITICAL CARE AUDIT

RECOMMENDATION 3

Procedures for recording, collecting and reporting data included in the Irish Paediatric Critical Care Audit (IPCCA), and submitted to the Paediatric Intensive Care Audit Network (PICANet) dataset, should be reviewed by the National Office of Clinical Audit (NOCA) and PICANet.

Rationale
Analysis of the data included in this report highlighted difficulties arising from variations in the definitions and practices for recording data relevant to critical care; for example, admissions data of patients who were transported by transfer and retrievals teams vary between hospitals, transfer teams, and Units in the UK, and there are differences between the UK and the ROI in the recommended standards for nurse staffing per PCCU bed. This prevents accurate and comparative reporting of detailed descriptions of these services in the ROI as well as meaningful comparisons with international Units. Variations in practices and criteria for transfers between Units in the ROI and their UK counterparts lead to inaccuracies in the number of IPATS refusals reported by PICANet.

There is also no consensus regarding the definition of what is/should be regarded as an unplanned extubation, contributing to wide variation in rates across Units participating in PICANet. Such issues limit the information that can be derived from the data.

What evidence is there to show that this action will be effective?
The Health Information and Quality Authority's *Information management standards for national health and social care data collections* (Health Information and Quality Authority, 2017) and National Standards for Safer Better Healthcare (Health Information and Quality Authority, 2012) outline key principles for health information and seven dimensions contributing to data quality. Complete, high-quality data are required in order to provide an accurate picture of care delivery, including identifying areas with high standards of care as well as providing opportunities for informing and implementing health service improvements. Conversely, poor-quality data have a substantial impact on the safety of service users.

What action should be taken?
1. NOCA will work with PICANet to review definitions and criteria for variables submitted to the PICANet dataset in order to ensure that they meet the definitions specified in the PICANet data dictionary, and that comparison with international Units are meaningful.
2. Additional steps should be included to verify numbers prior to submitting the data to PICANet, including services involved in transfers and retrievals.
3. Consideration should be given to education and training in order to improve data entry – specifically the recording of patient details – across Units. This is particularly pertinent in relation to the initial designation of ward or Unit on admission in the case of transferred patients, and to the identity of the transfer team involved.

Who will benefit from this recommendation?
Standardisation of protocols for documenting data relating to admission of transferred patients across all hospitals and Units will provide accurate activity data for various transport and retrieval systems. It will also lead to improvements in the accuracy of data submitted to PICANet and to the IPCCA, optimising the potential of the audit to identify areas for improvement in standards of care for patients.

Who is responsible for implementing this recommendation?
NOCA will work with PICANet to review protocols for recording admission data relevant to critical care and will provide training to data coordinators where necessary. NOCA and PICANet are responsible for carrying out this review and any actions arising from it.

When should this be implemented?
These measures will be included in the work plan for the next IPCCA report.

RECOMMENDATION 4

Future development of the IPCCA should be guided by a review of the scope and governance of the national clinical audit and should include additional detailed data, which will greatly add to the national overview of paediatric critical care.

Rationale

This is the first standalone national report from the IPCCA. It provides information on activity related to the care of critically ill children across the healthcare system in the ROI, and includes information from a number of datasets, as follows:

- the PICANet dataset on PCCUs and paediatric retrieval and transport medicine
- the Intensive Care National Audit and Research Centre (ICNARC) dataset on adult ICUs
- an adapted PICANet dataset on the regional Paediatric High Dependency Unit University Hospital Limerick.

This report highlights where delivery of care is excellent, as well as areas where improvements are necessary. There are also gaps in information. Bringing together all of this information under the IPCCA will provide a more complete picture of the care of children in PCCUs in order to inform care delivery and national policy. Future audit should include additional details, which would greatly add to a national overview of PCCUs.

What evidence is there to show that this action will be effective?

The *Model of Care for Paediatric Critical Care* (HSE, 2019) highlights the need for audit wherever paediatric critical care services are delivered. Children in adult ICUs present particular challenges with respect to staffing these Units with nurses trained in paediatric critical care, as per national standards. The *Model of Care for Paediatric Critical Care* (HSE, 2019) recommendations state that if a patient is ventilated or stays for longer than 24 hours, communication with a PCCU and transfer out is recommended. Notwithstanding the difficulty for families where geographical distance is a factor, adherence to national and international standards regarding the care of children in adult ICUs is recommended. Data on the provision of critical care for paediatric patients in adult ICUs are currently collected via the ICNARC.

A robust database of information that prioritises paediatric patients and captures details of activity and outcomes specific to all paediatric patients requiring critical care in the ROI is required in order to maximise the opportunities for improvements in standards of care. In order to fully evaluate the service provided, a detailed Unit report on patient case mix and on Unit and operational activity is required across the system.

What action should be taken?

A feasibility study is recommended in order to analyse the scope of audit and the requirements to support prioritisation and collation of data on activity relating to the provision of critical care for children across the healthcare system in the ROI.

Who will benefit from this recommendation?

Continuous monitoring of clinical and administrative data relevant to the provision of critical care for paediatric patients will provide timely information on activity and maximise the potential to identify areas for improvement that will benefit patients and their families, staff, and the healthcare system in the ROI.

Who is responsible for implementing this recommendation?

NOCA is responsible for leading the feasibility study, working with stakeholders such as PICANet and the HSE National Clinical Programme for Critical Care.

When should this be implemented?

With the approval of this report, NOCA will seek to include this recommendation in the NOCA work plan for the next IPCCA report.

CHAPTER 12
CONCLUSION

CHAPTER 12: **CONCLUSION**

This is the first independent national report from the IPCCA. It provides a complete account of activity and outcomes in all Units providing critical care to children in the ROI during the period from 2017 to 2019. In addition to data from specialised paediatric critical care units and from transfer and retrieval services that traditionally provide data to PICANet (based in the UK), this report also includes data from adult ICUs and the regional Paediatric High Dependency Unit in University Hospital Limerick, giving a more complete description of national activity.

The data demonstrate the excellent care provided to sick children across both PCCU sites in CHI, which is safe and comparable to international standards. Areas for improving the standard of care are also highlighted, such as optimising bed capacity in PCCUs, extending transfer and retrieval services and extending extracorporeal life support to patients in the respiratory patient group.

The information in this report will be important for informing the planning of critical care services in the short and medium term. Of particular importance will be its usefulness in highlighting deficits and benchmarking against international PCCUs.

Audit will be an important part of ensuring that standards of care are maintained in the existing paediatric hospitals as well as in the new children's hospital in the future. This is dependent on complete, accurate and good-quality data. Continuation and further development of the IPCCA will contribute to the information available for driving quality improvements in paediatric critical care medicine.

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APPENDICES

APPENDIX 1: GOVERNANCE OF ICU AUDIT, 2019

IRISH NATIONAL ICU AUDIT GOVERNANCE COMMITTEE MEMBERSHIP AND MEETING ATTENDANCE, 2019

Organisation	Name	6.3.19	12.6.19	11.9.19	31.10.19	12.12.19
Clinical Lead, INICUA Audit	Dr Rory Dwyer	✓	✓	✓	✓	✓
Chair/Joint Faculty of Intensive Care Medicine of Ireland	Dr Brian Marsh	✓	✓	✓	✓	✗
Clinical Lead, Paediatric ICU Audit	Dr Martina Healy	✗	✗	✗	✓	✗
Intensive Care Society of Ireland	Dr Catherine Motherway	✓	✓	✗	✓	✓
HSE Office of the Nursing and Midwifery Services Director	Derek Cribbin	✓	✓	✓	✓	✓
Public and Patient Interest Representative	Barbara Egan	✓	✓	✓	✓	✓
Public and Patient Interest Representative	Damien Nee	✓	✓	✓	✗	✓
Irish Association of Directors of Nursing and Midwifery	Eileen Whelan	✓	✓	✓	✓	✗
ICU Audit Nurse Representative	Magdalena Helen Pecak	✓	✓	✓	✓	✗
Royal College of Surgeons in Ireland	Prof. David Healy	✓	✓	✗	✗	✗
College of Anaesthesiologists of Ireland	Prof. Gerry Fitzpatrick	✗	✗	✗	✗	✗
Royal College of Physicians of Ireland	Prof. Tim McDonnell	✗	✗	✗	✗	✗
Irish National ICU Audit Manager	Mary Baggot	✓	✓	✓	✓	✓
Irish National ICU Audit Assistant Manager	Fionnuala Treanor	✓	✓	✓	✓	✓
NOCA Executive Director	Collette Tully	✓	✓	✓	✗	✗

APPENDIX 2: INICUA – PARTICIPATING ICUS, 2019

Organisation	Name	Q1	Q2	Q3	Q4
Beaumont Hospital	Beaumont Hospital General ICU	✓	✓	✓	✓
Beaumont Hospital	Beaumont Hospital Richmond ICU (Neuro)	✓	✓	✓	✓
Mater Misericordiae University Hospital	Mater Misericordiae University Hospital HDU	✓	✓	✓	✓
Mater Misericordiae University Hospital	Mater Misericordiae University Hospital ICU	✓	✓	✓	✓
Our Lady of Lourdes Hospital Drogheda	Our Lady of Lourdes Hospital Drogheda ICU	✓	✓	✓	✓
St James's Hospital	St James's Hospital Keith Shaw Unit (Cardiothoracic ICU)	✓	✓	✓	✓
St James's Hospital	St James's Hospital GICU	✓	✓	✓	✓
Tallaght University Hospital	Tallaght University Hospital ICU	✗	✗	✗	✓
University Hospital Galway	University Hospital Galway ICU	✓	✓	✓	✓
University Hospital Limerick	University Hospital Limerick ICU	✓	✓	✓	✓
University Hospital Waterford	University Hospital Waterford ICU	✓	✓	✓	✓
Regional Hospital Mullingar	Regional Hospital Mullingar ICU	✓	✓	✓	✓
Wexford General Hospital	Wexford General Hospital Intensive Care Unit	✓	✓	✓	✓
Connolly Hospital	Connolly Hospital ICU	✓	✓	✓	✓
Midland Regional Hospital Tullamore	Midland Regional Hospital Tullamore ICU	✓	✓	✓	✓
Naas General Hospital	Naas General Hospital ICU	✓	✓	✓	✓
St Luke's General Hospital, Carlow/Kilkenny	St Luke's General Hospital Kilkenny ICU	✗	✗	✗	✗
St Vincent's University Hospital	St Vincent's University Hospital ICU	✓	✓	✓	✓
Cork University Hospital	Cork University Hospital Cardiothoracic ICU	✓	✓	✓	✓
Cork University Hospital	Cork University Hospital ICU	✓	✓	✓	✓
Letterkenny University Hospital	Letterkenny University Hospital ICU	✗	✗	✗	✓
South Tipperary General Hospital	South Tipperary General Hospital ICU	✗	✗	✓	✓
University Hospital Kerry	University Hospital Kerry ICU	✗	✗	✓	✓

✓ Included in Audit   ✗ Data Not Collected   ✗ Unit Not Participating

APPENDIX 3: DEFINITION OF PAEDIATRIC CRITICAL CARE LEVELS IN IRELAND

LEVEL 0: WARD-BASED CARE

Hospital ward clinical management.

LEVEL 1: HIGH-DEPENDENCY CARE REQUIRING A NURSE–PATIENT RATIO 0.5:1

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

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

LEVEL 1: HDU: REGIONAL HDU CARE

In addition to providing enhanced observation and basic system supports, regional level 1 HDUs due to availability of subspecialist 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–PATIENT RATIO OF 1:1

The child who is receiving advanced respiratory support (complex non invasive or invasive ventilation) and who requires continuous nursing supervision. Level 2 also pertains to the unstable, non-intubated child, e.g. the haemodynamically unstable patient who requires invasive cardiovascular monitoring, frequent fluid challenges and vasoactive drug infusions. The child meeting Level 2 criteria should be treated at a paediatric critical care medicine lead centre, except in a case where the regional and lead centre consultants agree that the child can be safely cared for locally.

LEVEL 3: CRITICAL CARE REQUIRING A NURSE–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 multi-organ failure requiring vasoactive and inotropic medications, and postoperative patients requiring ventilation and vasoactive medications, such as those who have had major abdominal surgery or paediatric scoliosis surgery.

LEVEL 3S: CRITICAL CARE REQUIRING A NURSE–PATIENT RATIO OF 2:1

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

Source: Joint Faculty of Intensive Care Medicine of Ireland, 2018.

APPENDIX 4: FREQUENCY TABLES

FIGURE 3.1: PROPORTION OF ADMISSION RECORDS COMPLETED WITHIN 3 MONTHS OF DISCHARGE, BY COUNTRY OF ADMISSION, 2017–2019

	Complete within 3 months		Not complete within 3 months		Total completed admission records
	N	**%**	**N**	**%**	**N**
England (NHS)	41 033	84%	7694	16%	48 727
England (non-NHS)	1001	77%	302	23%	1303
Wales	1482	98%	25	2%	1507
Scotland	4193	92%	351	8%	4544
ROI	3991	89%	502	11%	4493
Total	51 700	85%	8874	15%	60 574
	5302	**60%**	**3580**	**40%**	**8882**

FIGURE 3.2: PROPORTION OF ADMISSION RECORDS COMPLETED WITHIN 3 MONTHS OF DISCHARGE, BY UNIT, 2017–2019

	Complete within 3 months		Not complete within 3 months		Total completed admission records
	N	**%**	**N**	**%**	**N**
CHI at Crumlin	2743	87%	399	13%	3142
CHI at Temple Street	1248	92%	103	8%	1351

FIGURE 4.3: TOTAL NUMBER OF ADMISSIONS TO PARTICIPATING UNITS, BY UNIT, 2017–2019 (N=60424)

	2017	**2018**	**2019**	**Total**
CHI at Crumlin	1026	1024	1024	3074
CHI at Temple Street	437	406	490	1333

FIGURE 4.5: TYPES OF ADMISSION TO PARTICIPATING PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=4407)

| | CHI at Crumlin | | | | | |
| | 2017 | | 2018 | | 2019 | |
	N	%	N	%	N	%
Planned – following surgery	396	39%	362	35%	421	41%
Unplanned – following surgery	51	5%	61	6%	44	4%
Planned – other	53	5%	62	6%	91	9%
Unplanned – other	526	51%	539	53%	468	46%
Total	**1026**	**100%**	**1024**	**100%**	**1024**	**100%**
	CHI at Temple Street					
	2017		2018		2019	
	N	%	N	%	N	%
Planned – following surgery	109	25%	83	20%	96	20%
Unplanned – following surgery	17	4%	17	4%	30	6%
Planned – other	7	2%	10	2%	16	3%
Unplanned – other	304	70%	296	73%	348	71%
Total	**437**	**100%**	**406**	**100%**	**490**	**100%**
	ROI total					
	2017		2018		2019	
	N	%	N	%	N	%
Planned – following surgery	505	35%	445	31%	517	34%
Unplanned – following surgery	68	5%	78	5%	74	5%
Planned – other	60	4%	72	5%	107	7%
Unplanned – other	830	57%	835	58%	816	54%
Total	**1463**	**100%**	**1430**	**100%**	**1514**	**100%**

FIGURE 4.6 SOURCE OF 'UNPLANNED – OTHER' ADMISSIONS TO PARTICIPATING PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=2481)

| | CHI at Crumlin | | | | | |
| | 2017 | | 2018 | | 2019 | |
	N	%	N	%	N	%
Inpatient (same hospital)	310	59%	328	61%	323	69%
Transferred patient (other hospital)	216	41%	211	39%	145	31%
Total	**526**	**100%**	**539**	**100%**	**468**	**100%**
	CHI at Temple Street					
	2017		2018		2019	
	N	%	N	%	N	%
Inpatient (same hospital)	121	40%	119	40%	124	36%
Transferred patient (other hospital)	183	60%	177	60%	224	64%
Total	**304**	**100%**	**296**	**100%**	**348**	**100%**
	ROI total					
	2017		2018		2019	
	N	%	N	%	N	%
Inpatient (same hospital)	431	52%	447	54%	447	55%
Transferred patient (other hospital)	399	48%	388	46%	369	45%
Total	**830**	**100%**	**835**	**100%**	**816**	**100%**

FIGURE 4.7: AGE AND SEX PROFILE OF CHILDREN IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=4407)

	Male		Female		Total
	N	%	N	%	N
<1	1289	56%	996	44%	2285
1–4	520	56%	415	44%	935
5–10	330	53%	294	47%	624
11–15	281	50%	282	50%	563
Total	**2420**	**55%**	**1987**	**45%**	**4407**

FIGURE 4.8: AGE AND SEX PROFILE OF CHILDREN AGED <1 YEAR IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2017–2019 (N=2285)2017–2019 (N=4407)

	Male		Female		Total
	N	%	N	%	N
2 months or under	809	58%	579	42%	1388
3–5 months	269	54%	227	46%	496
6–8 months	136	55%	111	45%	247
9–11 months	75	49%	79	51%	154
Total	**1289**	**56%**	**996**	**44%**	**2285**

FIGURE 4.9: AGE PROFILE OF CHILDREN IN PAEDIATRIC CRITICAL CARE UNITS IN THE REPUBLIC OF IRELAND, 2019 (N=1514)

	CHI at Crumlin		CHI at Temple Street		Total	
	N	%	N	%	N	%
<1	592	58%	224	46%	816	54%
1–4	203	20%	108	22%	311	21%
5–10	119	12%	87	18%	206	14%
11–15	110	11%	71	14%	181	12%
Total	**1024**	**100%**	**490**	**100%**	**1514**	**100%**

FIGURE 4.10A: ADMISSIONS TO CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, BY PRIMARY DIAGNOSIS AND YEAR, 2017–2019

CHI at Crumlin	2017		2018		2019	
	N	%	N	%	N	%
Blood/lymphatic	*	1%	26	3%	11	1%
Body wall and cavities	20	2%	24	2%	28	3%
Cardiovascular	457	45%	375	37%	448	44%
Endocrine/metabolic	31	3%	33	3%	20	2%
Gastrointestinal	73	7%	66	6%	67	7%
Infection	50	5%	83	8%	61	6%
Multisystem	~	*	~	*	~	*
Musculoskeletal	45	4%	38	4%	25	2%
Neurological	54	5%	49	5%	33	3%
Oncology	22	2%	34	3%	32	3%
Other/unknown	28	3%	36	4%	34	3%
Respiratory	224	22%	245	24%	252	25%
Trauma	12	*	*	*	*	*
Total	**1026**	**100%**	**1024**	**100%**	**1024**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 4.10B: ADMISSIONS TO CHILDREN'S HEALTH IRELAND AT TEMPLE STREET PAEDIATRIC CRITICAL CARE UNIT, BY PRIMARY DIAGNOSIS AND YEAR, 2017–2019

CHI at Temple Street	2017		2018		2019	
	N	%	N	%	N	%
Blood/lymphatic	6	1%	~	*	~	*
Body wall and cavities	10	2%	10	2%	13	3%
Cardiovascular	7	2%	~	1%	8	2%
Endocrine/metabolic	20	5%	15	4%	25	5%
Gastrointestinal	29	7%	32	8%	38	8%
Infection	34	8%	33	8%	27	6%
Multisystem	0	0%	~	*	~	*
Musculoskeletal	25	6%	22	5%	25	5%
Neurological	109	25%	71	17%	109	22%
Oncology	19	4%	19	5%	38	8%
Other/unknown	20	5%	25	6%	28	6%
Respiratory	144	33%	158	39%	165	34%
Trauma	**14**	**3%**	**11**	**3%**	**9**	**2%**
Total	**437**	**100%**	**406**	**100%**	**490**	**100%**

~ Denotes five cases or fewer

FIGURE 5.3: BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, 2017 (N=7490 BED DAYS USED OF 8094 BED DAYS AVAILABLE)

		Total bed days available	Total bed days used	
		N	N	%
CHI at Crumlin	2017	8094	7490	93%
	2018	8356	7969	95%
	2019	8021	8006	100%
CHI at Temple Street	2019	2844	2499	88%

~ Denotes five cases or fewer

FIGURE 5.4A: BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, 2017 (N=7490 BED DAYS USED OF 8094 BED DAYS AVAILABLE)

	Total bed days available	Total bed days used	
	N	N	%
January	682	634	93%
February	601	593	99%
March	682	592	87%
April	649	546	84%
May	699	664	95%
June	660	585	89%
July	706	556	79%
August	702	657	94%
September	660	660	100%
October	694	671	97%
November	677	648	96%
December	682	684	100%
Total	**8094**	**7490**	**93%**

~ Denotes five cases or fewer

FIGURE 5.4B: BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN PAEDIATRIC CRITICAL CARE UNIT, 2018 (N=7969 BED DAYS USED OF 8356 BED DAYS AVAILABLE)

	Total bed days available	Total bed days used	
	N	N	%
January	713	647	91%
February	641	648	101%
March	709	689	97%
April	688	622	90%
May	703	620	88%
June	690	668	97%
July	708	626	88%
August	705	614	87%
September	686	677	99%
October	713	696	98%
November	690	712	103%
December	710	750	106%
Total	**8356**	**7969**	**95%**

~ Denotes five cases or fewer

FIGURE 5.5: PAEDIATRIC CRITICAL CARE UNIT BED OCCUPANCY IN CHILDREN'S HEALTH IRELAND AT CRUMLIN (N=8006 BED DAYS USED OF 8021 BED DAYS AVAILABLE) AND CHILDREN'S HEALTH IRELAND AT TEMPLE STREET (N=2499 BED DAYS USED OF 2844 BED DAYS AVAILABLE), 2019

	CHI at Crumlin, 2019			CHI at Temple Street, 2019		
	Total bed days available	Total bed days used		Total bed days available	Total bed days used	
	N	%	N	%	N	%
January	706	683	97%	246	253	103%
February	639	642	100%	197	176	89%
March	681	669	98%	247	183	74%
April	684	668	98%	247	221	89%
May	701	660	94%	243	177	73%
June	666	603	91%	238	164	69%
July	600	641	107%	256	186	73%
August	656	599	91%	245	185	76%
September	633	669	106%	213	191	90%
October	663	712	107%	223	223	100%
November	685	754	110%	235	269	114%
December	707	706	100%	254	271	107%
Total	**8021**	**8006**	**100%**	**2844**	**2499**	**88%**

FIGURE 5.6: PERCENTAGE OF FUNDED CRITICAL CARE BEDS IN CHILDREN'S HEALTH IRELAND AT CRUMLIN AND CHILDREN'S HEALTH IRELAND AT TEMPLE STREET OCCUPIED AT A 'NORMAL HOURS' CENSUS POINT, BY YEAR, 2017–2019

	Funded	Occupied	
	N	%	N
2017	27	21	78%
2018	27	22	82%
2019	27	24	89%

FIGURE 6.1: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL, BY UNIT, 2017–2019

	CHI at Crumlin		CHI at Temple Street	
	n	%	n	%
Enhanced Care	1535	7%	663	9%
High Dependency	1592	7%	1336	18%
High Dependency Advanced	6413	27%	1116	15%
Intensive Care Basic	4490	19%	2138	29%
Intensive Care Basic Advanced	7400	32%	1560	22%
Intensive Care Advanced	1497	6%	260	4%
Intensive Care Advanced Enhanced	240	1%	177	2%
Intensive Care ECMO/ECLS	293	1%	0	0%
Total	**23 460**	**100%**	**7250**	**100%**

FIGURE 6.2: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, 2017–2019 (N=23460 DAYS)

	N	%
Intensive Care Advanced Enhanced	240	1%
Intensive Care ECMO/ECLS	293	1%
Intensive Care Advanced	1497	6%
Enhanced Care	1535	7%
High Dependency	1592	7%
Intensive Care Basic	4490	19%
High Dependency Advanced	6413	27%
Intensive Care Basic Advanced	7400	32%
Total days	**23 460**	**100%**

FIGURE 6.3: PROPORTION OF DAYS OF CARE DELIVERED AT EACH HEALTHCARE RESOURCE GROUP LEVEL IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, 2017–2019 (N=7250 DAYS)

	N	%
Intensive Care Advanced Enhanced	177	2%
Intensive Care Advanced	260	4%
Enhanced Care	663	9%
High Dependency Advanced	1116	15%
High Dependency	1336	18%
Intensive Care Basic Advanced	1560	22%
Intensive Care Basic	2138	29%
Total days	**7 250**	**100%**

FIGURE 6.4A: DAILY INTERVENTIONS WHILE IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, BY YEAR, 2017–2019

CHI at Crumlin	2017		2018		2019	
	N	%	N	%	N	%
Invasive ventilation	644	63%	635	62%	630	62%
High-flow nasal cannula therapy	329	32%	353	34%	410	40%
Non-invasive ventilation	242	24%	279	27%	218	21%
Intravenous vasoactive drugs	476	46%	464	45%	520	51%
ICP device	0	0%	~	*	0	0%
Renal support	26	3%	31	*	37	4%
Tracheostomy	8	1%	*	1%	13	1%
ECMO	11	1%	15	1%	21	2%
Total number of cases	**1026**	**100%**	**1024**	**100%**	**1024**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 6.4B: DAILY INTERVENTIONS WHILE IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, BY YEAR, 2017–2019

CHI at Temple Street	2017		2018		2019	
	N	%	N	%	N	%
Invasive ventilation	268	61%	261	64%	300	61%
High-flow nasal cannula therapy	147	34%	182	45%	204	42%
Non-invasive ventilation	80	18%	94	23%	96	20%
ECMO	0	0%	0	0%	0	0%
Intravenous vasoactive drugs	54	12%	60	15%	58	12%
ICP device	36	8%	23	6%	34	7%
Renal support	*	*	14	3%	*	*
Tracheostomy	~	*	0	0.0%	~	*
Total number of cases	**437**	**100%**	**406**	**100%**	**490**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 6.5A: TYPE OF VENTILATION IN CHILDREN'S HEALTH IRELAND AT CRUMLIN, BY YEAR, 2017–2019

CHI at Crumlin	2017		2018		2019	
	N	%	N	%	N	%
Invasive only	493	48%	449	44%	493	48%
Non-invasive only	91	9%	93	9%	81	8%
Both	151	15%	186	18%	137	13%
Neither	291	28%	296	29%	313	31%
Total	**1026**	**100%**	**1024**	**100%**	**1024**	**100%**

FIGURE 6.5B: TYPE OF VENTILATION IN CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, BY YEAR, 2017–2019

CHI at Temple Street	2017		2018		2019	
	N	%	N	%	N	%
Invasive only	226	52%	195	48%	251	51%
Non-invasive only	38	9%	28	7%	47	10%
Both	42	10%	66	16%	49	10%
Neither	**131**	**30%**	117	29%	143	29%
Total	**437**	**100%**	**406**	**100%**	**490**	**100%**

FIGURE 6.6: ADMISSIONS BY VENTILATION STATUS AND AGE GROUP IN THE REPUBLIC OF IRELAND, BY YEAR, 2017–2019 (N=4407)

	Ventilation status	<1		1–4		5–10		11–15		Total
		N	%	N	%	N	%	N	%	N
2017	Both	86	67%	14	11%	13	10%	16	12%	129
	Invasive only	137	71%	18	9%	21	11%	17	9%	193
	Neither	132	31%	117	28%	79	19%	94	22%	422
	Non-invasive only	393	55%	163	23%	103	14%	60	8%	719
	Total	**748**	**51%**	**312**	**21%**	**216**	**15%**	**187**	**13%**	**1463**

	Ventilation status	<1		1–4		5–10		11–15		Total
		N	%	N	%	N	%	N	%	N
2018	Both	367	57%	122	19%	85	13%	70	11%	644
	Invasive only	125	30%	127	31%	83	20%	78	19%	413
	Neither	57	47%	25	21%	14	12%	25	21%	121
	Non-invasive only	172	68%	38	15%	20	8%	22	9%	252
	Total	**721**	**50%**	**312**	**22%**	**202**	**14%**	**195**	**14%**	**1430**

	Ventilation status	<1		1–4		5–10		11–15		Total
		N	%	N	%	N	%	N	%	N
2019	Both	412	55%	156	21%	104	14%	72	10%	744
	Invasive only	145	78%	15	8%	11	6%	15	8%	186
	Neither	165	36%	126	28%	83	18%	82	18%	456
	Non-invasive only	94	73%	14	11%	8	6%	12	9%	128
	Total	**816**	**54%**	**311**	**21%**	**206**	**14%**	**181**	**12%**	**1514**

FIGURE 7.1: NON-ELECTIVE TRANSPORTS BY MOBILISATION TIMES (IN MINUTES), UNITED KINGDOM AND REPUBLIC OF IRELAND, 2019

Ventilation status	0-30		31-60		61-180		≥181		Not recorded		Total
	N	%	N	%	N	%	N	%	N	%	N
2017											
T022 (IPATS)	*	*	52	63%	16	20%	~	*	7	9%	82
2018											
T022 (IPATS)	~	*	52	63%	22	27%	0	0%	*	*	83
2019											
T022 (IPATS)	11	13%	48	59%	18	22%	0	0%	5	6%	82

- Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 7.2: NON-ELECTIVE TRANSPORTS BY MOBILISATION TIMES (IN MINUTES) IN THE REPUBLIC OF IRELAND, 2017–2019 (N=247)

	0-30		31-60		61-180		≥181		Not recorded		Total
	N	%	N	%	N	%	N	%	N	%	N
2017	*	*	52	63%	16	20%	~	*	7	*	82
2018	~	5%	52	63%	22	27%	0	0%	*	6%	83
2019	11	13%	48	59%	18	22%	0	0%	5	6%	82

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 7.3: NON-ELECTIVE TRANSPORTS IN THE UNITED KINGDOM AND REPUBLIC OF IRELAND, BY TRANSPORT ORGANISATION AND GRADE OF CLINICAL TRANSPORT TEAM LEADER, 2019

	Consultant		Registrar		Nurse practitioner		Unknown		Total
	N	%	N	%	N	%	N	%	N
T022 (IPATS)	74	90%	8	10%	0	0%	0	0%	82

FIGURE 7.4: NON-ELECTIVE TRANSPORTS BY GRADE OF CLINICAL TRANSPORT TEAM LEADER IN THE REPUBLIC OF IRELAND, BY YEAR, 2017–2019 (N=247)

	Consultant		Registrar		Total
	N	%	N	%	N
2017	59	72%	23	28%	82
2018	75	90%	8	10%	83
2019	74	90%	8	10%	82

FIGURE 8.2: ADMISSIONS BY PREDICTED MORTALITY RISK GROUP, CHILDREN'S HEALTH IRELAND AT CRUMLIN, 2017–2019 (N=3074)

	N	%
<1%	1122	36%
1% to <5%	1405	46%
5% to <15%	450	15%
15% to <30%	70	2%
≥30%	27	1%
Total	**3074**	**100%**

FIGURE 8.3: ADMISSIONS BY PREDICTED MORTALITY RISK GROUP, CHILDREN'S HEALTH IRELAND AT TEMPLE STREET, 2017–2019 (N=1333)

	N	%
<1%	630	47%
1% to <5%	501	38%
5% to <15%	146	11%
15% to <30%	39	3%
≥30%	17	1%
Total	**1333**	**100%**

FIGURE 8.4: PROPORTION OF DEATHS IN PAEDIATRIC CRITICAL CARE UNITS, BY UNIT, 2019 (N=20383)

	Alive		Dead		Total
	N	%	N	%	N
CHI at Crumlin	979	96%	45	4%	1024
CHI at Temple Street	475	97%	15	3%	490

FIGURE 9.1: ADMISSIONS TO UNIVERSITY HOSPITAL LIMERICK PAEDIATRIC REGIONAL HIGH DEPENDENCY UNIT, BY SEX AND AGE GROUP (N=126)

	Male		Female		Total	
	N	%	N	%	N	%
<1 year	22	54%	19	46%	41	100%
1–4 years	24	49%	25	51%	49	100%
5–10 years	15	71%	6	*	21	100%
11–17 years	10	67%	~	33%	*	100%
Total	**71**	**56%**	**55**	**44%**	**126**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 9.2: LENGTH OF STAY IN UNIVERSITY HOSPITAL LIMERICK PAEDIATRIC REGIONAL HIGH DEPENDENCY UNIT, BY AGE GROUP (N=124)

	<1 year		1–4 years		5–10 years		11-17 years		Total	
	N	%	N	%	N	%	N	%	N	%
<24 hours	~	*	~	*	~	*	~	*	9	7%
1 day	6	15%	18	37%	*	33%	~	27%	35	28%
2–7 days	29	74%	25	*	13	62%	8	*	75	*
>7 days	~	*	~	4%	0	0%	~	13%	~	4%
Total	**39**	**100%**	**49**	**100%**	**21**	**100%**	**15**	**100%**	**124**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

FIGURE 9.3: ADMISSIONS TO UNIVERSITY HOSPITAL LIMERICK PAEDIATRIC REGIONAL HIGH DEPENDENCY UNIT, BY PRIMARY DIAGNOSIS, 2019 (N=126)

	N	%
Respiratory	69	55%
Neurological	20	16%
Infection	10	8%
Trauma	8	6%
Cardiovascular	~	*
Endocrine/metabolic	~	*
Gastrointestinal	~	*
Blood/lymphatic	~	*
Other/unknown	~	*
Total	**126**	**100%**

~ Denotes five cases or fewer
* Further suppression required to prevent disclosure of five cases or fewer

APPENDIX 5: PICANet ORGANISATION KEY

KEY	ORGANISATION
A	Addenbrooke's Hospital, Cambridge
C	Noah's Ark Children's Hospital for Wales, Cardiff
D	Royal Manchester Children's Hospital
E1	Great Ormond Street Hospital, London (PCCU/NICU)
E2	Great Ormond Street Hospital, London (CICU)
F	Evelina London Children's Hospital
H	King's College Hospital, London
I	Leeds General Infirmary
K2	Freeman Hospital, Newcastle upon Tyne
K3	Great North Children's Hospital, Newcastle upon Tyne
L	Royal Stoke University Hospital
M	Nottingham Children's Hospital, Queens Medical Centre, Nottingham
N	John Radcliffe Hospital, Oxford
O	Royal Brompton Hospital, London
P	Alder Hey Children's Hospital, Liverpool
Q	Sheffield Children's Hospital
R	Southampton Children's Hospital
S	James Cook University Hospital, Middlesbrough
T	St. George's Hospital, London
U	St. Mary's Hospital, London
V	Birmingham Children's Hospital
W	Bristol Royal Hospital for Children
X1	Glenfield Hospital, Leicester
X2	Leicester Royal Infirmary
Y	Royal Hospital for Sick Children, Edinburgh
Z	The Royal London Hospital
ZA	Royal Hospital for Children, Glasgow
ZB	Royal Belfast Hospital for Sick Children
ZC	Children's Health Ireland at Crumlin
ZD	Children's Health Ireland at Temple Street

CONTENTS >

KEY	ORGANISATION
ZE	Harley Street Clinic, London
ZF	The Portland Hospital, London
T001	Children's Acute Transport Service (CATS)
T002	Embrace Yorkshire & Humber Infant & Children's Transport Service
T003	North West and North Wales Paediatric Transport Service (NWTS)
T004	South Thames Retrieval Service (STRS)
T005	KIDS Intensive Care and Decision Support
T008	Southampton Oxford Retrieval Team (SORT)
T010	Paediatric Northern Ireland Specialist Transport and Retrieval (NISTAR)
T020	Scottish Specialist Transport and Retrieval (ScotSTAR)
T022	Irish Paediatric Acute Transport Service (IPATS)
T024	Wales and West Acute Transport for Children (WATCh)
T026	North East Children's Transport and Retrieval (NECTAR)
T027	Children's Medical Emergency Transport Service (CoMET)
T028	Heart Link ECMO Children's Service

NOTES