Paediatric Intensive Care Audit Network
Annual Report 2021

PICANet 2021 Report

Data collection period
January 2018–December 2020

UNIVERSITY OF LEICESTER

UNIVERSITY OF LEEDS

Organisation key

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 (PICU/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, Dublin (formerly Our Lady's Children's Hospital, Crumlin)
ZD   Children's Health Ireland at Temple Street, Dublin (formerly Temple Street Children's University Hospital)
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   Northern Ireland Specialist Transport and Retrieval (NISTAR) Paediatric
T020   Scotland 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 Service (NECTAR)
T027   Children's Medical Emergency Transport Service (CoMET)
T028   Heartlink ECMO Children's Service

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For the Supplementary Special Chapters, Tables, Figures and Appendices relating to this report, please visit the PICANet website www.picanet.org.uk.

Acknowledgements

The Paediatric Intensive Care Audit Network (PICANet) gathers information on all patients admitted to paediatric intensive care units (PICUs) in the UK and Republic of Ireland, in conjunction with centralised transport services (CTS).

We are indebted to the efforts of all the audit clerks, secretaries, nurses and doctors who support and contribute to PICANet from their own PICUs and CTS. We are particularly grateful for everyone's support and contributions over the past year given the significant challenges of the COVID-19 pandemic.

PICANet also continues to rely on the expertise and support from the Paediatric Critical Care Society (PCCS), the PICANet Steering Group and members of the Clinical Advisory Group who provide an essential link between PICANet and the clinical care teams. We would like to acknowledge this support, which enables the PICANet audit to continue to be a success.

We are also grateful to colleagues at Evelina London Children's Hospital for writing one of the special chapters this year on diabetic ketoacidosis (DKA).

Introduction

This is the eighteenth PICANet annual clinical audit report describing paediatric critical care activity which occurred within paediatric intensive care units in the United Kingdom (UK) and Republic of Ireland (ROI) between 2018 and 2020. The annual report forms one important component of PICANet's contracted obligations, cataloguing comprehensive information on referral, transport and admission events to monitor the delivery and quality of care in relation to agreed standards and evaluate clinical outcomes to inform national policy in paediatric critical care.

We report on five key metrics relevant to Paediatric Intensive Care services: case ascertainment including timeliness of data submission, retrieval mobilisation times, number of qualified nurses per bed, emergency readmissions within 48 hours of discharge and mortality in PICU. Although a formal outlier analysis and policy is only recommended for in-PICU mortality, we continue to provide real-time 'RSPRT' plots to enable PICUs to monitor their mortality outcomes on a much more regular basis.

This year, we have three special chapters included in a supplementary document. Two of the special chapters relate to the impact of the COVID-19 pandemic on paediatric intensive care units and provision: one provides an overview of the children with a confirmed coronavirus diagnosis treated in a PICU in the UK; the second investigates the impact of the pandemic on PIC beds, PICUs and staffing. Additionally, a third special chapter investigates how presentations and outcomes for diabetic ketoacidosis (DKA) admissions to PICUs have changed over the last ten years.

As in previous reports, we also provide a full set of tables and figures which document transport, referrals and admissions activity within PICUs between 2018 and 2020. Individual tables and figures can be downloaded in electronic form from the main PICANet website www.picanet.org.uk.

We also plan further enhancements to the PICANet web platform and underlying database to provide a more user-friendly and interactive experience so that all key performance data for units can be easily interrogated and visualised through an online dashboard.

Professor Liz Draper

Professor Richard Feltbower,

Principal Investigators

Key findings

- The number of admissions to paediatric intensive care across the UK and Republic of Ireland in 2020 showed a reduction due to the COVID-19 pandemic from just over 20,000 per year from 2018–19 to 16,400 in 2020. This reduction is reflected across all countries of the UK and Republic of Ireland.

- The reduction in admissions was also reflected in the number of bed days delivered across the UK and ROI, which fell by 20% in 2020 compared to the two previous years.

- Admission rates to paediatric intensive care also showed a reduction of around 20% across all nations, ranging from 83 per 100,000 children in the Republic of Ireland to rates of 136 in Scotland.

- Despite the pandemic, the likelihood of dying whilst being treated within PICUs remained very low with 96.4% of admissions discharged alive in 2020. The proportion of deaths within PICU showed a slight reduction in 2020, comprising around one in six of all children's deaths in the UK and one in every five in the ROI.

- Annual rates of reported unplanned extubation varied between 3.4 in Wales and 6.1 in Scotland for every 1,000 days of invasive ventilation throughout the reporting period. Two thirds of all units reported a decrease in the number of unplanned extubations in 2020 compared to 2019.

- The PICANet staffing census week coincided with the second wave of the pandemic in November 2020 and were consequently noticeably lower than previous years. The total intensive care occupancy rates were 65% in 'normal' hours, ranging from 45% to 67%. High dependency bed occupancy in 'normal' hours showed a similar decrease with an average of 47% in 2020 compared to over 80% in 2019. Intensive care bed occupancy out of hours ranged from 55% to 78%. For high dependency care, 'out of hours' bed occupancy was an average of 43%, ranging from 29% to 59%.

- 89% of units across the UK and Republic of Ireland (excluding Northern Ireland) provided complete and timely admissions' data to PICANet within three months of discharge. Fifteen units achieved completeness within three months for at least 98% of their admissions in 2020 compared to nine units in 2019. Excluding units affected by major IT issues, three units completed fewer than 60% of their admission records within this timescale.

- There was a 30% decrease in the average number of child retrievals compared to the previous two years. Of the 2,896 journeys carried out for children requiring urgent transport to a PICU, 64% were started within 30 minutes, with over 80% started within one hour of the clinical decision being made. Just over 1 in 30 journeys (3%) started more than three hours after the decision.

- Overall, the establishment figures for nursing staff across the UK and ROI showed that six PICUs (18%) met the PICS standards for nursing staff of 7.01 WTE (whole time equivalents), when all staff providing clinical care (including non-registered health care staff: Bands 2–4) are included. However, if all recorded vacancies were filled, then 16 PICUs (48%) would meet this standard. As in previous years the annual PICANet staffing census shows that both in 'normal', and 'out of hours' units ensure their staffing levels are appropriate for the number and care level provided for children on their unit despite COVID-19 pressures on staff and resources.

- Overall rates of emergency readmission within 48 hours of discharge remained stable at around 1.7% over the period 2018–2020. However in 2020 it varied by country, from 0.8% in Wales to 2.1% in Scotland.

- No negative statistical outliers were identified for mortality rates for any unit between 2018 and 2020. There were three units which were defined as positive outliers for mortality, indicating substantially lower numbers of deaths than would be predicted with these units having completed the PICANet outlier process. Further work will be carried out to identify particular areas of excellence within units for shared learning.

- In terms of COVID-19 in PICU, this report highlights the importance of screening as an infection control measure as more than 20% of children with a confirmed diagnosis of COVID-19 (without PIMS-TS) were asymptomatic during PICU admission and were detected only on routine screening.

- PICUs were able to collect additional custom audit data relating to COVID-19 and PIMS-TS cases in a timely manner despite significant resource limitations which has allowed for important monitoring and modelling to be undertaken throughout the pandemic for planning purposes.

- The impact of COVID-19 on PICU staffing during the time period from 7 February 2020 to 29 April 2021 was twofold. Firstly, over half (16 out of 31) PICUs received adult patients at some point in this time period. Overall paediatric bed occupancy was unchanged for 55% (17) PICUs with some variation, whilst 9 PICUs reported a decrease in PICU activity. Extra capacity beds were created in PICUs, the highest number was 172 extra beds opened to meet demand from March to June 2020, whilst 10% of the maximum total of beds open were closed to paediatric admissions. Secondly, 55% of PICUs redeployed their staff, predominantly nursing and medical staff. The majority of staff were used to aid Adult Intensive Care Units. 29% of PICUs were required to relocate children to another PICU or designated area. It is important to report the impact that COVID-19 has had on bed occupancy however, the data should not be used in the usual way for planning.

- The proportion of children admitted to PICU with a primary diagnosis of diabetic ketoacidosis more than doubled in 2020 to 1.3% compared with the average proportion of 0.6% for 2010 to 2019. This increase is in keeping with emerging evidence in international reports of an association of COVID-19 and diabetes.

- Diabetic ketoacidosis admissions in 2020 had similar outcomes (mortality and length of stay) and requirement for support (ventilation, intravenous vasoactive treatment and renal replacement therapy) to the preceding years.

- Changes in national diabetic ketoacidosis guidelines (2015 and 2020) do not appear to have had an impact on mortality or the incidence of cerebral oedema and acute renal failure in children presenting to PICU with a diagnosis of DKA.

Recommendations

1. Continue to monitor the impact of COVID-19 on admissions to paediatric intensive units across the UK and ROI, working closely with NHS organisations to support service planning.

   Action: NHS England, Paediatric Intensive Care Units (PICUs), commissioners, Operational Delivery Networks (ODNs)

2. Review data collection processes and procedures, to ensure ability to meet future two month timeliness standard as stated in the 2021 PCCS Quality Standards [1], and PIC10a (PICU Quality Dashboard 2021/2022).

   Action: organisations not meeting the timeliness standards for completion of data to PICANet

3. Review staffing levels following the pandemic to ensure adequate levels of care are maintained within paediatric intensive care.

   Action: National nursing professional bodies

4. Share examples of best practice with PICANet, to enable onward sharing with other PICUs.

   Action: PICUs which are positive outliers for mortality

5. Consider continuing to screen all children admitted to PICU for SARS-CoV-2 infection

   Action: PICUs

6. Continue to report COVID-19/PIMS-TS patients via PICANet notification/custom audit to aid early detection of patterns and trends that require a coordinated regional and/or national response.

   Action: PICUs, PICANet

7. Explore the positive and negative outcomes of the remodelling strategies used during the pandemic (such as caring for critically ill adult patients and redeployment of staff) to assess the potential for future adoption/application.

   Action: Commissioners, ODNs.

8. Consider increased provision of Level 2 care to reduce the pressure on PICUs as the majority of DKA children did not require invasive ventilation or intravenous vasoactive therapy, in line with the paediatric critical care review in 2019.

   Action: Commissioners, ODNs.

How we present our results

Results are presented in tables and figures. This Report focuses on children aged 0–15 years (unless otherwise specified); each specific measure of interest is explained in the results and metrics sections below under the heading "What are we measuring?".

Measures include the number of admissions, how many days patients are in PICU, the types of treatments patients receive and clinical outcomes such as death. We present data according to age, sex, country of admission, treating PICU as well as country of residence and where the child is living.

Data are presented in more granular detail in the "Tables and Figures". In general, data are presented for children aged 0–15 years and do not include any admissions where the child's age is unknown, however, some tables also include data relating to all patients admitted to PICU (including those who are 16 years and older or where we don't know the patient's age; these tables will have footnotes explaining this.

Rates

We present certain information in the form of rates, enabling comparisons to be made between countries even though the population size in each country is different. Rates are usually presented as the number per 1,000 or per 100,000 of the relevant population.

When we want to compare two rates we divide one rate by the other, to get a relative rate. For example, to compare the admission rate in Scotland to that in England we would divide the Scottish admission rate by the English admission rate. If the two rates were the same then the relative rate would be one. If the Scottish rate was higher than the English rate then the relative rate would be greater than one. If the Scottish rate was lower than the English rate then the relative rate would be less than one. This measure allows us to talk about the Scottish rate in comparison (or relative) to the English rate.

Deaths

We measure how poorly children were at the point when they were admitted to PICU using the Paediatric Index of Mortality version 3 (PIM3)[2]. This takes into account many factors (such as whether the child was admitted as an emergency and whether they needed help breathing) to estimate how likely each child is of dying.

When comparing deaths in PICU, we calculate the risk-adjusted standardised mortality ratio (SMR). This compares the number of deaths that have happened in a PICU and how many deaths we expected to happen given how poorly children were when they were admitted to PICU. We also use 'funnel plots' to compare individual PICUs in terms of mortality which enables us to display and compare the risk-adjusted SMR on the same graph. These plots tell us what range of values we might expect to see for the SMR in each PICU, given that we expect a certain amount of variation as these calculations are based on a very small number of deaths. Further details on funnel plots and how to interpret them are provided in the "Metric 5: Mortality in PICU" section.

Important notes

COVID-19 pandemic

The COVID-19 pandemic had an impact on all UK and ROI PICUs and PICANet data have been used or referenced in a number of peer-reviewed journal articles looking at both COVID-19 and paediatric inflammatory multisystem syndrome temporally associated with COVID-19 (PIMS-TS) patients [3]. Some PICUs closed to paediatric admissions entirely and some accepted admissions for both paediatric and adult patients [4]; this reduction in paediatric intensive care (PIC) provision is reflected throughout the data presented in this report in terms of workload and bed occupancy. We explore the impact of the pandemic on PIC and staffing in more detail in the COVID-19 special chapter.

Data collection issues

Northern Ireland had a pause in data collection in 2018 causing a delay in data submission which impacted 2018 and 2019 data completion timelines. The Republic of Ireland had a pause in data collection in 2020 due to a cyber-attack on the country's health service systems which impacted on data completion timelines and on data cleaning for this Annual Report.

Closure of ZE – Harley Street PICU

One non-NHS PICU (ZE) closed to paediatric admissions permanently in March 2020 such that 2020 data presented below for this unit does not represent a full calendar year. Data for 2020 for this unit is therefore not directly comparable to 2018 and 2019.

Headline figures: Admission numbers and bed days

What are we measuring?

Table 1 and Figure 1 below summarise the **number of admissions** to paediatric intensive care units in the UK and Republic of Ireland between 2018 and 2020 among children aged under 16 years at the time of admission. Table 2 and Figure 2 summarise the **number of bed days** of paediatric intensive care that were delivered during this period.

What did we find?

There were approximately 20,000 admissions to PICUs in 2018 and 2019 across the UK and Republic of Ireland; there was a fall in 2020 to just under 16,500 admissions which is likely to be attributable to the COVID-19 pandemic. This represented a reduction of around one-fifth (19.5%) from the number of admissions in 2019. We present further information on the COVID-19 pandemic and its impact on paediatric intensive care (PIC) in a special chapter.

The number of admissions to NHS PICUs in England reduced from approximately 16,000 per year in 2018 and 2019 to around 13,000 in 2020. There was also a small but steady reduction in admissions year on year in Northern Ireland and Wales, from just over 500 in 2018 to just over 350 in 2020. The number of admissions in Scotland had a peak of almost 1,700 in 2019, an increase of approximately 350 admissions from 2018. In 2020, the number of admissions in Scotland decreased to just under 1,200. Admissions in the Republic of Ireland remained fairly constant at around 1,400 to 1,500 admissions in each year. The number of admissions to non-NHS PICUs in England continued to decrease over the reporting period from a peak of over 350 admissions in 2018 to 200 admissions in 2020; one of the two non-NHS PICUs closed permanently to paediatric admissions in March 2020 which contributed to some of the reduction.

As with the reduction in the overall number of admissions in 2020 (Table 1), there was also a reduction in the number of bed days delivered in 2020; the number of bed days delivered fell from around 144,000 in 2018 and 2019 to 114,000 in 2020.

Table 1: Number of admissions by country of PICU and year of admission

Country of admission	2018	2019	2020
England (NHS)	16,038	15,905	12,956
England (non-NHS)	351	303	202
Wales	510	489	363
Scotland	1,351	1,697	1,178
Northern Ireland	501	492	353
Republic of Ireland	1,429	1,514	1,377
Total	20,180	20,400	16,429

Table 2: Number of bed days delivered by country of admission and year of provision

Country of admission	2018	2019	2020
England (NHS)	114,729	111,807	90,298
England (non-NHS)	2,695	3,281	1,095
Wales	2,509	2,626	2,117
Scotland	10,319	12,055	8,666
Northern Ireland	3,275	3,422	2,669
Republic of Ireland	10,176	10,393	9,312
Total	143,703	143,584	114,157

Figure 1: Number of admissions to PICU by country of admission and year of admission

Based on date of admission within the reporting period.

Figure 2: Number of bed days delivered by country of admission and year of provision

Presented based on year bed day provided regardless of admission date (note: this could include admissions for children who were admitted prior to the reporting period if they were still receiving PIC care in 2018–2020).

What does this mean?

Due to the COVID-19 pandemic, some PICUs temporarily closed to paediatric admissions in 2020 and/or admitted adult patients alongside children. Consequently, paediatric intensive care services saw a sharp fall in the number of admissions for children aged 0-15 years of around 20% in 2020 compared to 2018-19. This was reflected in a parallel reduction of around 20% in the number of bed days. The COVID-19 special chapter explores the impact of the pandemic on PIC care in more detail. It is important that we continue to closely monitor trends in PICU demand not only in terms of admission burden but equally for the number of bed days provided to ensure sufficient care provision is available, particularly as we move through and beyond the COVID-19 pandemic.

Further details

Definitions and methods

Every admission to a PICU in the UK and the Republic of Ireland is counted for each year, 2018 to 2020. If a child has been readmitted during that period this will be counted as a separate admission. A 'bed day' is counted if a child is in a PICU bed for a day or part of a day which occurs within the reporting period (i.e. between 1 January 2018 and 31 December 2020) even if the child was admitted to PICU prior to the reporting period.

We have only provided figures for children less than 16 years old (the normal age limit for admission to PICU). All designated PICUs across the UK and ROI provided data to PICANet including the two private providers[1] of PIC based in England up to the end of 2020.

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[1] As noted above, one non-NHS PICU closed to paediatric admissions permanently in March 2020.

Why is this important?

The number of admissions and the number of bed days tell us how busy the PICUs are and helps the commissioners, who provide funding for paediatric intensive care, to work out how many staff and beds are required to meet the demand. This is important, as too few beds might mean that a child may not receive intensive care when they need it, or there may be a delay. Although it is unlikely, if the commissioners overestimate demand, it is possible that staff and beds would be under-utilised, which would be a waste of resources.

Headline figures: Admission rates by country of residence

What are we measuring?

Annual rates of admissions to PICU between 2018 and 2020 are presented in Table 3 by country of residence, calculated per 100,000 children in the population. This identifies what proportion of the childhood population are treated by paediatric intensive care services in each country every year.

What did we find?

Overall between 2018 and 2020, PICU admission rates were highest in Scotland, reaching 161 admissions for every 100,000 children, followed by Northern Ireland (136), England (132), Wales (132), and the Republic of Ireland (128). For the UK and Republic of Ireland combined, admissions rates were 134 per 100,000 population per year.

Reflecting the impact of the COVID-19 pandemic, admission rates were lower in all countries in 2020. The largest decrease was seen in Northern Ireland with the rate in 2020 being half that in 2018 (83 admissions per 100,000 compared with 167 in 2018). In 2019, admission rates in Scotland increased to 192 per 100,000 from 154 in 2018 before dropping to 136 in 2020. Rates in Wales and England remained steady across 2018 and 2019 before dropping in 2020. In the Republic of Ireland rates were similar across all three years, ranging from 121 to 133 admissions.

Table 3: Rate of admissions per 100,000 childhood population, 2018-2020

Country of admission	2018	2019	2020	2018–2020
England	141.1	141.1	115.2	132.4
Wales	139.6	140.2	114.6	131.5
Scotland	154.3	191.8	136.4	160.8
Northern Ireland	166.6	159.3	83.3	136.4
Republic of Ireland	127.8	133.4	121.3	127.5
Total	141.6	144.3	116.1	134.0

Based on country of residence.
Children with unknown country of residence or country of residence outside of the UK or ROI were excluded from this analysis leaving n=55,466 admissions.

What does this mean?

There was substantial geographical variation in admissions rates to PICU between countries ranging between 128 and 161 in 2020, meaning this is essential information required for the planning of national PIC services. Possible explanations for these findings could involve differences in admission policies between each country, variation in response to the COVID-19 pandemic, the availability of specialised critical care and transport services at the time of admission and distance to the nearest PICUs.

Further details

Definitions and methods

For each of the UK countries and the Republic of Ireland, the number of admissions was divided by the number of children in the population; this number was multiplied by 100,000 to give the number of admissions per 100,000 children aged under 16 to give the admission rate. We used national census data to estimate the childhood population in each country [5, 6].

Why is this important?

It is important for each country participating in PICANet to know the rate of admission to paediatric intensive care to allow them to plan services effectively. The variation in admission rates could be investigated to understand if these are real geographical differences (e.g. proximity to PICU, level of urbanicity) or explained by differences in clinical practise or commissioning in the populations for each nation.

Headline figures: Death in PICU

What are we measuring?

All deaths that occur after admission but prior to discharge from PICU are recorded and reported here for children under 16 who were admitted between 2018 and 2020. Deaths are presented based on the country of admission (i.e. PICU location) as deaths must be registered in the country where the person died. In Table 4, percentages were calculated for each country based on the total number of admissions for that year.

What did we find?

Table 4 summarises the number of child deaths in PICU by country of admission and year. There was a total of 1,966 deaths over the three year period, equivalent to 966 children being discharged alive out of every 1,000. The proportions of in-PICU death remained similar across all three years, ranging from 3.4% to 3.6%.

Table 5 shows the proportion of deaths in PICU compared to all childhood deaths in the UK and Republic of Ireland reported from routine national government statistics [7-10]. For context, we also present the total number of deaths in PICU in brackets. For children admitted in the UK, PICU deaths accounted for between 15–16% of the total number of children's deaths. For children admitted in the Republic of Ireland, PICU deaths accounted for between 21–25% of the total number of children's deaths.

Table 4: Proportion of deaths in PICU of all PICU admissions, by country of admission and year

Country of admission	2018	2019	2020	2018–2020
England	3.4% (n=562)	3.6% (n=576)	3.7% (n=488)	3.6% (n=1,626)
Wales	4.3% (n=22)	2.0% (n=10)	3.3% (n=12)	3.2% (n=44)
Scotland	2.4% (n=33)	1.9% (n=33)	2.3% (n=27)	2.2% (n=93)
Northern Ireland	2.4% (n=12)	2.3% (n=11)	2.0% (n=7)	2.2% (n=30)
Republic of Ireland	4.1% (n=59)	4.0% (n=60)	3.9% (n=54)	4.0% (n=173)
Total	3.4% (n=688)	3.4% (n=690)	3.6% (n=588)	3.4% (n=1,966)

Data are presented based on date of admission
Due to small numbers, data for non-NHS and NHS organisations in England are presented combined.

Table 5: Proportion of deaths in PICUs of all children's deaths in the population: UK and Republic of Ireland, 2018–2020

Country of admission	2018	2019	2020	2018–2020
UK	15.6% (n=629)	15.9% (n=630)	14.6%** (n=534)	15.4% (n=1,793)
Republic of Ireland	25.2% (n=59)	22.1%* (n=60)	21.1%* (n=54)	22.7% (n=173)

Based on country of admission
* The numbers of total deaths for the Republic of Ireland for 2019 and 2020 are currently provisional and subject to change.
** The number of total deaths for Northern Ireland for 2020 is provisional and subject to change.

What does this mean?

Risk of death in paediatric intensive care is low with 96.6% of patients being discharged alive between 2018 and 2020. Deaths in PICU account for about one in every six of all children's deaths in the UK and about one in every five children's deaths in the Republic of Ireland in any given year. The difference between the UK and the Republic of Ireland could be due to organisational factors relating to paediatric services; in 2018 and 2019 the Republic of Ireland had the lowest rates of admission to PICU (Table 3) which could indicate differences in admission thresholds for PIC care between the two countries.

Further details

Definitions and methods

We have recorded the number of deaths in PIC by year and by country of admission for 2018 to 2020. The percentages in Table 4 are based on the number of admissions to PICUs over this period, not the number of individual children (i.e. if the same child had two admissions in the same time period, this would count as two admissions). In Table 5, we present deaths on PICUs (2018–2020) as a proportion of **all child deaths** (0–15 years) in the UK and the Republic of Ireland.

Why is this important?

Death on PICU is rare and the rate of PICU death has fallen steadily since PICANet started collecting data in 2002. It is important to record the number of deaths to facilitate the investigation of mortality trends over time. It also highlights any differences in death rates between countries. Where there are very small numbers of deaths, caution should be applied when making comparisons as apparently large differences may happen by chance.

Headline figures: Unplanned extubation

What are we measuring?

PICU patients who need help with their breathing may require a tube placed in their throat connected to a machine: this is called **invasive ventilation**. If the tube is accidentally dislodged, this is referred to as **unplanned extubation**[2]. In Table 6, we present the number of unplanned extubations for every thousand days of invasive ventilation for 0–15 year olds that were reported based on country of admission. Figure 3 shows the rate of unplanned extubation by organisation for each year of the reporting period, ranked by the 2020 rate.

What did we find?

There were 339 unplanned extubations (Table 6) reported in the UK and Republic of Ireland in 2018 which occurred over approximately 67,000 days of invasive ventilation; this equates to an unplanned extubation rate of 5.0 (95% confidence interval (CI): 4.5–5.6) per 1,000 days of invasive ventilation. In 2019, there were slightly fewer unplanned extubations (n=307) and there were also fewer days of invasive ventilation provided (around 64,000) leading to a rate of 4.8 (95% CI: 4.2–5.3). In 2020 the number of unplanned extubations fell to 209 and the number of days of invasive ventilation provided in PICUs also fell to under 50,000, equivalent to the lowest rate observed in the reporting period of 4.3 (95% CI: 3.7–4.9) unplanned extubations for every 1,000 days of invasive ventilation.

Table 6: Rate of unplanned extubation per 1,000 days of invasive ventilation by country of admission and year of unplanned extubation, 2018–2020

	2018	2019	2020	2018–2020
England	5.1 (n=284)	4.7 (n=248)	4.5 (n=176)	4.8 (n=708)
Wales	2.4 (n=3)	2.9 (n=3)	6.0 (n=4)	3.4 (n=10)
Scotland	6.4 (n=25)	6.2 (n=25)	5.7 (n=16)	6.1 (n=66)
Northern Ireland	3.5 (n=5)	5.9 (n=8)	0.9 (n<3)	3.6 (n=14)
Republic of Ireland	4.0 (n=22)	4.2 (n=23)	2.5 (n=12)	3.6 (n=57)
Total	5.0 (n=339)	4.8 (n=307)	4.3 (n=209)	4.7 (n=855)

Data are presented based on date of unplanned extubation rather than date of admission and therefore this table may include children who were admitted prior to the reporting period who were still in PICU.
Due to small numbers, data for non-NHS and NHS organisations in England are presented combined.

Unplanned extubations rates in England showed a steady reduction from 5.1 unplanned extubations per 100,000 ventilated days in 2018 to 4.5 in 2020. Scotland showed a similar pattern with a rate of 6.4 in 2018 reducing to a rate of 5.7 in 2020. Wales showed large variation between years due to small but consistent numbers of unplanned extubations in each year and small numbers of ventilated days (ranging from approximately 1,200 days in 2018 to 650 days in 2020). Unplanned extubations rates in Northern Ireland showed large variation between years ranging from 5.9 in 2019 and reducing to 0.9 in 2020; the number of ventilated days for Northern Ireland was small but fairly similar across all years (ranging between 1,100 and 1,500) and the reduction in rate is likely partially down to this but also
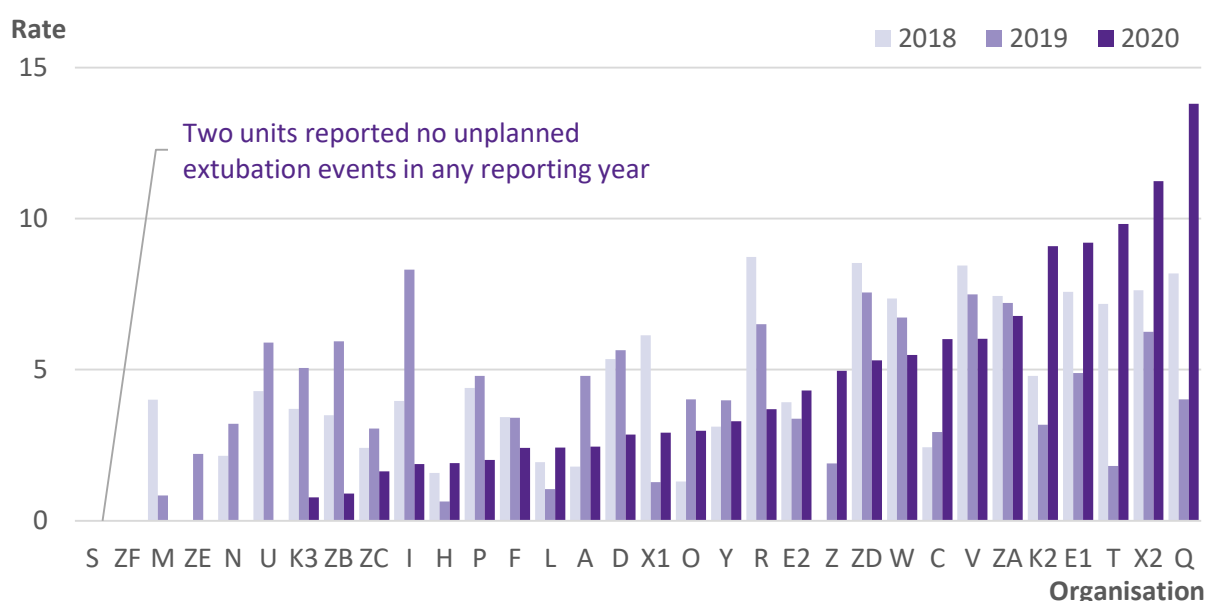
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[2] PICANet definition of unplanned extubation: a dislodgement of the endotracheal tube from the trachea, without the intention to extubate immediately and without the presence of airway competent clinical staff in the bed space, appropriately prepared for the procedure

due to a reduction in the number of unplanned extubations recorded (dropping from eight in 2019 to less than three in 2020).

Nineteen PICUs demonstrated a decrease in their unplanned extubation rate in 2020 when compared with 2019 and 11 units had an increase in rate (Figure 3). Increased rates ranged between 1.3 and 5.4 of the 2019 rate—however it is important to remember that the number of unplanned extubations this relates to is relatively small.

There were two units for which there were no unplanned extubation events reported in any year of the reporting period. Four further units reported no unplanned extubations 2020[3]. It is important to understand the reasons for these observations in terms of whether this reflects high performing units or differing standards of data reporting.

Figure 3: Unplanned extubation rates per 1,000 days of invasive ventilation by health organisation, 2018-2020

Ranked by unplanned extubations rate for 2020.
This figure includes admissions where the patient was aged 16+ years at admission or where the patient's age was unknown.
Data are presented based on date of unplanned extubation rather than date of admission and therefore this table may include children who were admitted prior to the reporting period who were still in PICU.
Data behind this Figure can be found in Table 44 of the Tables and Figures.

What does this mean?

Unplanned extubation remains a relatively rare event within paediatric intensive care services with a recorded annual rate of between four and five per 1,000 days of invasive ventilation on average in 2018–2020. All units reported unplanned extubation rates below 14 per 1,000 intubated days in 2020. This is still a relatively new data item and quality assurance of this metric was undertaken in all three years of this reporting period for the first time. Changes in rates of unplanned extubation should still be carefully monitored over the

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[3] This includes one non-NHS PICU closed to paediatric admissions permanently in March 2020 where data presented does not represent a whole calendar year and two units where paediatric beds were closed during the first and/or second wave of the COVID-19 pandemic.

next few years and consideration may be given to including unplanned extubations as a key metric in future.

Further details

Definitions and methods

When a child is intubated and ventilated it means that they have a tube placed in their throat attached to a machine that helps them to breathe. The machine can be used to provide different levels of oxygen to help their recovery. If the tube is accidentally removed, this is called an unplanned extubation. As we are comparing such events between PICUs, we need to calculate a rate of unplanned extubation, based on how many days of invasive ventilation are provided in each PICU, as the more patients that are ventilated on a PICU, the more likely an unplanned extubation will occur. To calculate the rate, we take the number of unplanned extubations for every 1,000 invasive ventilation days delivered. This makes comparisons between units with different volumes of invasive ventilation possible. Unplanned extubation is referred to as an 'adverse event'.

Why is this important?

Unplanned extubation is an adverse event leading to disconnection from a ventilator and airway compromise. This can lead to complications such as hypoxaemia (low blood oxygen), and/or hypercarbia (high blood carbon dioxide), and these adverse events are associated with mortality, prolonged mechanical ventilation, longer PICU stays and increased costs [11] and rarely death [12], and therefore should be avoided where at all possible. The Paediatric Intensive Care (PICU), Quality Dashboard 2021/2022 [13] aim for a threshold of less than 5 in 1,000 ventilator days, and therefore these adverse events need to be monitored to demonstrate whether this clinical outcome is being achieved. In addition, by continuously monitoring unplanned extubation rates units may be able to detect risk factors associated with unplanned extubation such as high-risk children, sedation scoring, longer term ventilation, staff/patient ratios, endotracheal tube care, and changes in clinical practice [11, 12].

Headline figures: Bed occupancy during 'normal hours' and 'out of hours'

What are we measuring?

The annual staffing study for PICANet collects information about the number of open and funded (commissioned), intensive care and high dependency care beds in PICUs during the week beginning 2 November 2020 in the UK and Republic of Ireland. The number of open beds is the number of intensive care (IC) and high dependency (HD) beds on a PICU for whom staff were available. The term 'normal hours' refers to midday on Wednesday (one time), and 'out of hours' refers to midnight and weekend hours (three times, midnight Wednesday, and midday and midnight Sunday).
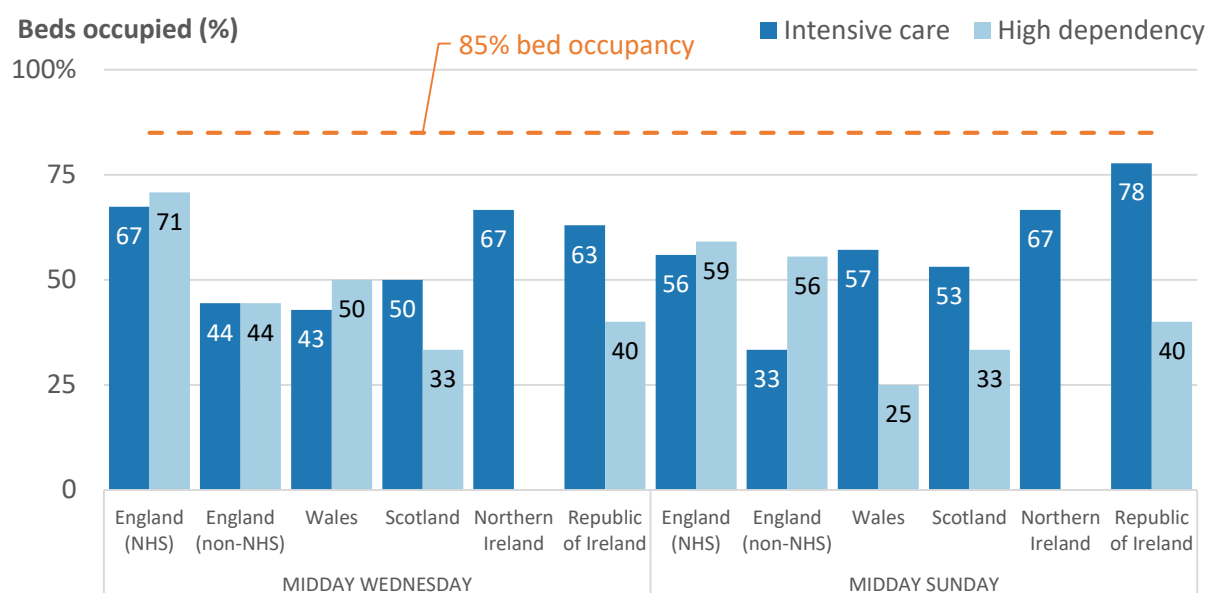
What did we find?

Overall the occupancy figures for both IC and HD beds were on average 15% lower than previous years reflecting the impact of COVID-19 on PICU admission rates for 2020.

At the 'normal hours' census point (midday Wednesday) in 2020, IC bed occupancy at the highest point was 67% for England (NHS), and Northern Ireland, decreasing to 63% in ROI, 50% for Scotland, and below 45% for Wales and England (non NHS). HD occupancy in 'normal hours' at its highest was 71% in England (NHS), dropping to 50% in Wales, 44% in England (non-NHS), with lower percentages for Scotland and the ROI (Figure 4).

At the 'out of hours' census report for all three times, there were again lower bed occupancy numbers. IC bed occupancy was highest at 78% for ROI, then Northern Ireland at 67%, dropping to an average of 55% for England (NHS), Wales and Scotland. Similarly, for HD 'out of hours' bed occupancy, the highest at 59% was England (NHS), 56% for England (non NHS), decreasing to 40% for ROI, and below 35% for Wales and Scotland (Figure 5).

Figure 4: Percentage bed occupancy at midday Wednesday 'normal hours' and midday Sunday 'out of hours' in November, 2020

Number of funded beds reported in the appendices. The red line shows 85% bed occupancy.

Figure 5: Percentage of beds occupied at midday Wednesday and midday Sunday in November, 2018–2020

MIDDAY WEDNESDAY

MIDDAY SUNDAY

Number of funded beds reported in the appendices.

What does this mean?

Bed occupancy refers to an open bed within a PICU that is occupied and staff available to care for that patient. Across the UK reported bed occupancy rates in PIC have dropped significantly in 2020 during 'normal hours' and 'out of hours'. This reflects decreased activity in PICUs observed since the start of PICANet in 2002–2003, and highlights the impact of the COVID-19 pandemic in admission rates to PICU in 2020, with reduction in elective respiratory 'winter' admissions, and non-elective admissions post-surgery, although there was variation between units and specialities [14].

The number of funded IC beds reported to PICANet has remained consistent over the last three years for IC beds in England, Wales, Scotland, Northern Ireland and the ROI. For HD units these numbers also remain consistent apart from a decrease in the private sector in England.

Overall occupancy of beds recorded as a snapshot of activity in November each year does show some variation between the countries for 2018, and 2019. Figure 4 shows that for England (NHS), there was a small reduction from 93% in 2018 to 80% in 2019, whilst in Scotland IC bed occupancy was above 85% for both 2018 and 2019. However overall bed occupancy is greatly reduced for all units in 2020. Whilst this may be to some degree a limitation of data collection at 'census' time points, or a change in provision of critical care or changing practice, this uniform reduction in bed occupancy is supported by the overall reduction in PICU admission in 2020.

It is important to note that the PICANet 2020 staffing survey snapshot was taken in the week beginning 2 November, coinciding with the second wave of the COVID-19 pandemic as defined by the Coronavirus Infection Survey (2021).

To place context within the decrease in bed occupancy PICANet undertook an extra staffing survey to ascertain whether the impact of COVID-19 in bed occupancy such as: admission of adults patients onto PICU; staff redeployment, staff shielding, and relocation of children, affected bed occupancy. The results are summarised in the special chapter.

Further details

Definition and methods

Information about bed occupancy is collected each year as part of the PICANet staffing study. The survey collects details about the total number of open and funded (commissioned) intensive care and high dependency care beds, and the number of actual children being cared for on each PICU by the level of care requirement for four 'snapshot' time periods: a weekday; and weekend; at noon and midnight. The proportion of open and funded beds occupied during 'normal hours' (Wednesday at noon) and 'out of hours' (Wednesday at midnight, Sunday at midday and Sunday at midnight) are then calculated. In Figure 4 we present the data for midday on a Wednesday and Sunday, and in Figure 5 we compare this data for a three year period 2018–2020.

Additional data for 'out of hours' bed occupancy is reported in the Tables and Figures section of the PICANet Annual Report.

Why is this important?

Information about levels of bed occupancy is important for both the commissioners and providers of PIC to ensure that there is adequate provision of paediatric critical care beds. PICANet data was used to model and plan bed capacity in advance of the first wave of COVID-19. Readers should be reminded that the 2020 data has been completely affected by COVID-19 and the data should therefore not be used in the usual way for planning. However, it is important to report the impact that COVID-19 has had on bed occupancy, in particular around potential respiratory syncytial virus (RSV) surge planning following low rates in the previous year due to the social distancing measures in place to reduce the transmission of COVID-19.

The NHS England recent paediatric critical care review also used this information to inform their review of the service. PICS standard L3-704 [15], states that average bed occupancy on the unit exceeding 85% for more than two successive months should be specifically reviewed. The unit should be monitoring occupancy and there should be evidence of escalation within the Hospital and involvement of Health Boards/Commissioners if occupancy exceeds 85% for more than two successive months. Bed occupancy is also used as an NHS Services Quality Dashboard measure (PICO 5a).

Metric 1: Case ascertainment and timeliness of data submission

What are we measuring?

PICANet collect data from all 32 PICUs in the UK and ROI giving 100% coverage of the PICU network. Within each PICU we measure case ascertainment which is a measure of the proportion of total admissions that are reported to PICANet. This is one aspect of data quality. 100% case ascertainment would mean we received information for all admissions. Case ascertainment is usually assessed independently of the PICUs by the PICANet Team during routine validation visits. Due to the COVID-19 pandemic it was not possible for these validation visits to be undertaken in 2020 and as such we are unable to present this metric this year due to lack of independent assurance.
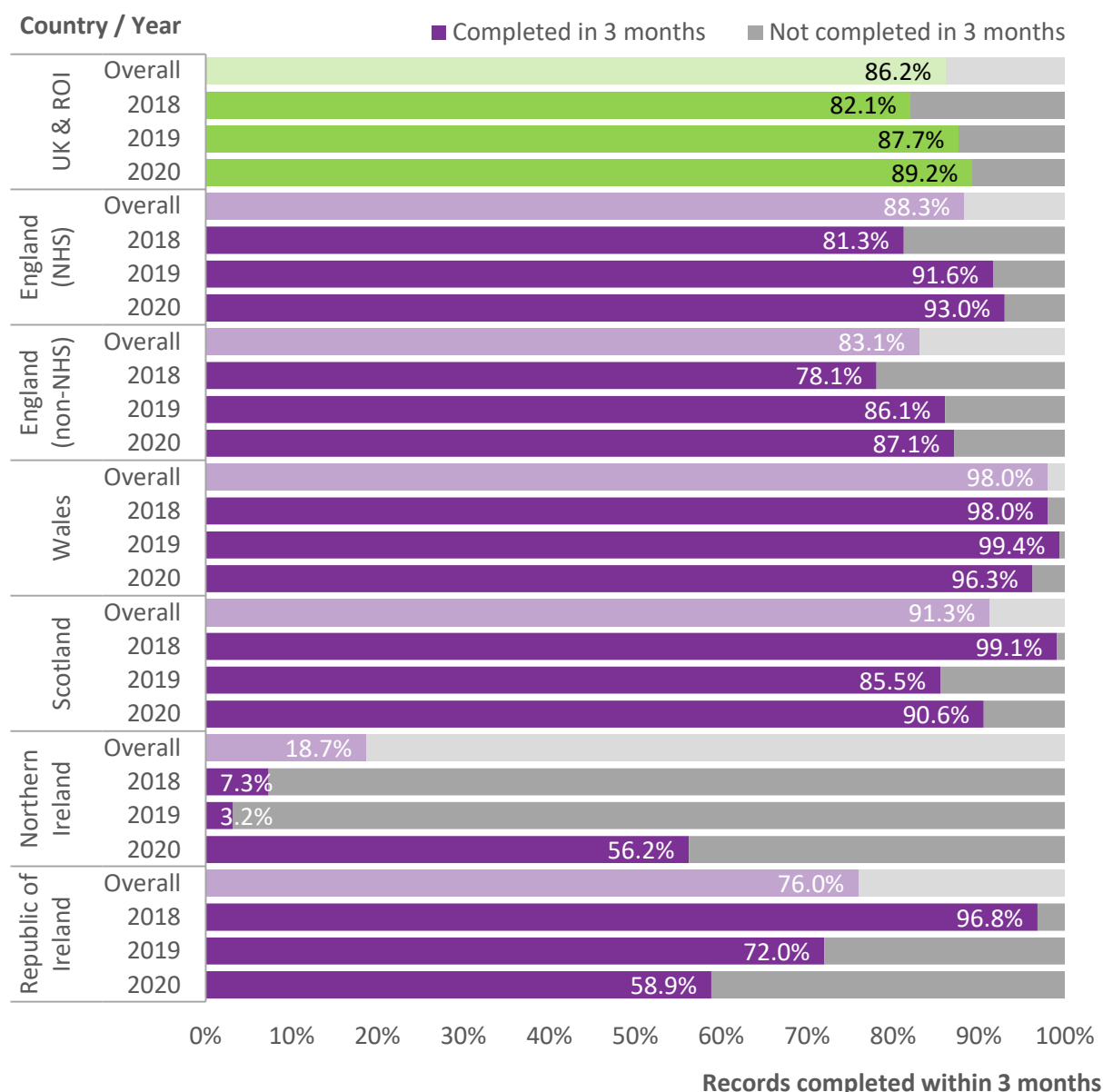
We also measure the timeliness of data collection and present how many of the admission events are completed on the PICANet database within three months of discharge—a requirement of the PICS standards. An admission record was defined as complete when all validation checks relating to PICU admission, discharge and care in PICU had been fulfilled (i.e. excluding any validation checks on 30 day follow-up). Figure 6 shows the proportion of admission records defined as complete within three months of patient discharge in each country and Figure 7 provides a breakdown for individual PICUs. All admissions are included in these metrics regardless of the age of the patient.

What did we find?

Timeliness of data submission

The completeness of patients' admission data within three months of their discharge from the unit was 86.2% for the three-year period from 2018 to 2020 across the UK and Republic of Ireland (Figure 7). The rate increased to 88.7% when excluding Northern Ireland, which had a pause in data submission due to the introduction of the General Data Protection Regulation (GDPR) so that the unit could not submit within the required timelines, and the Republic of Ireland, which had pause in data collection in 2020 due to a cyber-attack on the health service's systems.

Figure 6: Proportion of all admission records completed within 3 months of discharge by country of admission, 2018–2020

Country / Year		Completed in 3 months	Not completed in 3 months
UK & ROI	Overall	86.2%	
	2018	82.1%	
	2019	87.7%	
	2020	89.2%	
England (NHS)	Overall	88.3%	
	2018	81.3%	
	2019	91.6%	
	2020	93.0%	
England (non-NHS)	Overall	83.1%	
	2018	78.1%	
	2019	86.1%	
	2020	87.1%	
Wales	Overall	98.0%	
	2018	98.0%	
	2019	99.4%	
	2020	96.3%	
Scotland	Overall	91.3%	
	2018	99.1%	
	2019	85.5%	
	2020	90.6%	
Northern Ireland	Overall	18.7%	
	2018	7.3%	
	2019	3.2%	
	2020	56.2%	
Republic of Ireland	Overall	76.0%	
	2018	96.8%	
	2019	72.0%	
	2020	58.9%	

Records completed within 3 months

This figure is ordered by overall rate of completion within 3 months for each country.

This figure excludes any patients still in PICU at the time of analysis and **includes** admissions where the patient was aged 16+ years at admission or where the patient's age was unknown.

Northern Ireland had a pause in data collection in 2018 causing a delay in data submission. Republic of Ireland had a pause in data collection in 2020 due to a cyber-attack on the ROI health service systems.
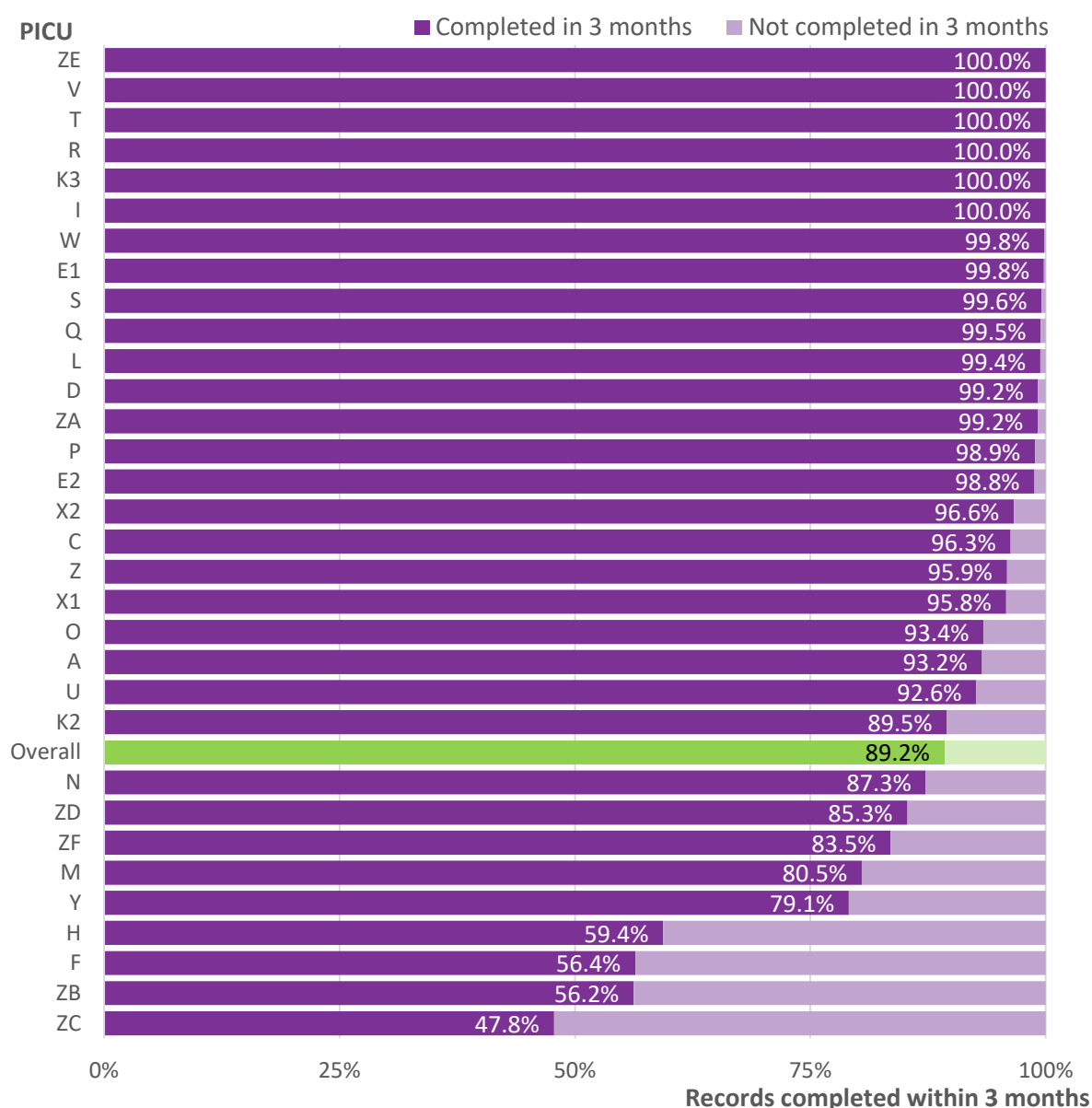
The 'Overall' category combines all admissions and calculates the timely completion rate overall, it is not calculated by taking an average of each unit's completion rate.

Wales had the highest overall rate of timely completion at 98%, followed by Scotland at 91% and England (NHS) at 88%. Wales consistently had timely completion rates of over 95% in each year of the reporting period. Scotland had a reduction from 99% to 86% between 2018 and 2019 before increasing to 91% in 2020. NHS units in England saw an increase from 81% in 2018 to 92% in 2019 which was sustained into 2020; a similar trend was seen in non-NHS PICUs. Both the Republic of Ireland and Northern Ireland was impacted by unavoidable pauses in data collection during the reporting period; as such the rate of timely completion in

ROI fell over the three-year period, from 97% to 59%, and rose in Northern Ireland, from less than 10% in 2018 and 2019 to 56% in 2020.

In 2020, of the 32 PICUs, 27 (84%) units had a timely completion rate of over 80% including 15 units which had at least 99% of records complete within three months (Figure 7). Nine units provided 100% of admissions data within the expected timeframe. Four units had less than 60% of records completed within three months of discharge including one from the Republic of Ireland affected by the data pause.

Figure 7: Proportion of admission records completed within 3 months of discharge by PICU, 2020

The 'Overall' category combines all admissions and calculates the timely completion rate overall, it is not calculated by taking an average of each unit's completion rate.
This figure excludes any patients still in PICU at the time of analysis and **includes** admissions where the patient was aged 16+ years at admission or where the patient's age was unknown.
Republic of Ireland had a pause in data collection in 2020 due to a cyber-attack on the ROI health service systems (ZC and ZD).
ZE closed permanently to paediatric admissions in March 2020 and data above only represent three months' worth of data as opposed to a whole year.

What does this mean?

High levels of case ascertainment ensure that we are confident our findings will be representative of the events and care processes that take place in PICUs. PICUs in England, Wales, Scotland and England had more than 80% of admission data submitted in a timely manner over the whole reporting period; Northern Ireland and the Republic of Ireland both had unavoidable pauses in data collection in 2018 and 2020 respectively. Despite this, data timeliness overall has been increasing over the three year period, rising to around 90% overall in 2020.

Further details

Definitions and methods

Every PICU receives a validation visit from the PICANet research nurse on a rolling programme. At those visits, the numbers of admissions recorded locally are compared with the numbers held on the PICANet database. Any discrepancies are followed up by the PICU. This is called an ascertainment check. Not every PICU is visited each year, so our ascertainment check is based on those PICUs that have received a visit in the most recent year of the reporting period. Due to the COVID-19 pandemic it was not possible for any validation visits to be undertaken in 2020 and as such we have been unable to present an independently validated estimate of case ascertainment. We also monitor the timeliness of data completion, benchmarking against the PICS standard for reporting admissions to PICANet within three months of discharge from the unit.

Why is this important?

We want to base our analyses on **all admissions** to be sure that we can interpret our findings appropriately. If a significant proportion of admissions is missing we cannot be as confident about our conclusions. For example, if a number of admissions of children who had died on PICU were missing, we may make the wrong conclusion when comparing standardised mortality ratios (SMRs) between PICUs. We were unable to present data on case ascertainment for 2020 due to the COVID-19 pandemic, however PICANet has consistently had high case ascertainment (e.g. between 2015 and 2019 our estimate of case ascertainment was greater than 97% each year) and it is unlikely that the pandemic would have reduced our case ascertainment rate. Even though we don't have an exact estimate of case ascertainment for 2020, previously high case ascertainment rates mean that we can be confident about our findings.

As well as ensuring we collect data on as many admissions as possible, we also want to ensure that data are collected in a timely manner, that data are accurate and that all relevant data are available for analysis.

Please note that as from 1st January 2022, PICANet will be moving to a two month submission guideline in accordance with L3-702 of the PCCS Quality Standards for Critically Ill or Injured Children (2021), and PIC10a of the Paediatric Intensive care Quality Dashboard 2021/2022.

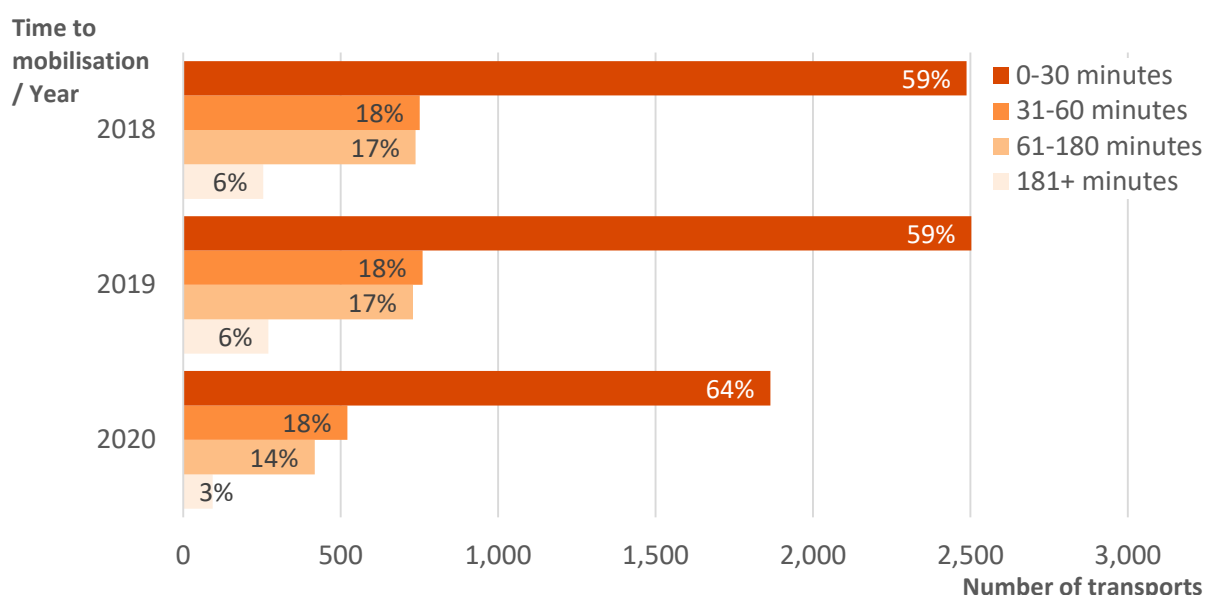# Metric 2: Retrieval mobilisation times

What are we measuring?

Some children need to be transported to a PICU in a different hospital for urgent care (non-elective transports). PICANet have calculated how long it takes for the PIC centralised transport service (CTS) team to mobilise and start their journey to retrieve a child needing urgent PIC admission once the decision has been made that PIC transport is required. The mobilisation times of 30 minutes, 31 to 60 minutes, 61 to 180 minutes, and over 180 minutes are represented for the UK and ROI for 2020. This information is further summarised for the individual PIC transport teams.

What did we find?

For 2018 and 2019, the average number of non-elective transports was just over 4,200 journeys. For 2020 this number decreased by 30% to 2,896 non-elective (emergency) transports. Figure 8 shows that 64% of all PIC transport teams mobilised within 30 minutes, an increase from 59% in 2018 and 2019.

Of these, eight of the 12 organisations, mobilised within 30 minutes for more than half of their transports. During 2020 for over half of the specialist PIC transport teams, over four-fifths of their journeys commenced within one hour after the decision was taken that the child required emergency transport.
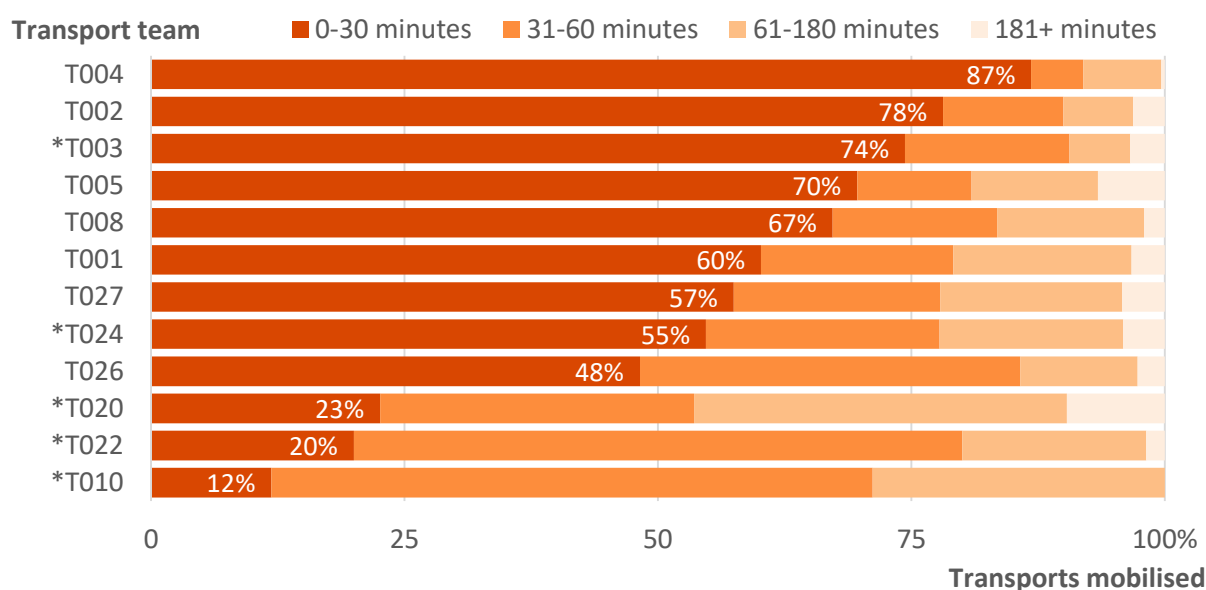
Figure 8: Number on non-elective PIC transports mobilised by time to mobilisation

Organisations are ranked by the NHS England 30 minute target. Northern Ireland, Scotland, Wales and the Republic of Ireland are exempt from this target but included in the figure.

Just over 1 in 30 journeys (3%) started more than three hours after this decision. For the three-year period 2018–2020 (Figure 9), the time taken to mobilisation was consistent with at least 77% of journeys started within one hour of the decision to transport each year, although there was a 30% reduction in the number of journeys carried out in 2020.

Figure 9: Proportion of non-elective transports mobilised by PIC CTS team by time to mobilisation: UK and Republic of Ireland, 2020

*Organisations are ranked by the NHS England 30 minute target. Northern Ireland, Scotland, Wales and the Republic of Ireland are exempt from this target but included in the figure.

What does this mean?

In the vast majority of cases, PIC transport teams take less than an hour to start their journey to pick up a child who requires urgent critical care. The NHS England Quality Dashboard recommends that the team departs the transport base within 30 minutes from the time the referral is accepted for retrieval. Most PIC transport teams aim to depart base within 30 minutes of accepting a child for urgent transport. In those cases where it takes longer for the team to depart, the reason for this may relate to the availability of staff, a transport vehicle or a PICU bed.

At busy times identifying an available paediatric intensive care bed may delay departure and some journeys require road and air transport which also requires additional planning before the team can depart.

Time to mobilise does show some variation between transport teams due to covering different and sometimes remote geographical areas, using both road and air travel to achieve their retrieval. The planning required to effect these types of transport may further delay departure from base.

Further details

Definitions and methods

Once a specialist transport organisation has agreed to transport a child they have a target set by the Care Quality Commission to start their journey within one hour and NHS England Quality Dashboard monitors the percentage of emergency retrievals undertaken where the team departs the transport base within 30 minutes from the time the referral is accepted for retrieval. Standards for mobilisation time have not been defined for the devolved nations and

ROI. We measured the time from when the team agreed to the transport to the time they set off in the ambulance (or helicopter / plane) for what are called 'non-elective' or urgent transports—these are **not** planned transfers from one PICU to another or from a PICU to a district general hospital.

Why is this important?

Any delay in receiving intensive care could put the sick child at risk, as the referring hospital may not have the resources to look after a critically ill child. Delays in getting the team mobilised may just mean that it is very busy, e.g. during periods of 'winter pressures'. Persistent delays may mean that there are insufficient resources in the transport organisation or there are some other organisational issues that need to be addressed. By measuring the time it takes to mobilise the transport team continuously over a long period of time PICANet are able to monitor and report back on PIC transport teams performance, enabling the transport organisations to make changes to improve the quality of their service if appropriate.

The time it takes the PIC centralised transport service (CTS) team to start their journey to pick up a child who needs urgent PIC care and the time taken by the team to travel, from the journey start point to the child's bedside in the referring hospital, are added together to provide a measure called the 'time to bedside'.

Reaching the bedside of a critically ill child within three hours of agreeing the child requires urgent PIC care is a key target for Paediatric Critical Care Transport Teams (PCCTs) to achieve in the United Kingdom. Whilst timely access to specialist care is necessary for these children, a study from England and Wales, undertaken by DEPICT [16] showed no evidence that reducing the time-to-bedside target for PIC CTS teams will improve the survival of critically ill children.

Metric 3: Number of nurses providing clinical care per bed

What are we measuring?

In November of each year, we ask PICUs to record how many clinically qualified nurses and non-registered health care staff are employed on their PICU, both in terms of their establishment (i.e. total funded posts) and any vacant posts.
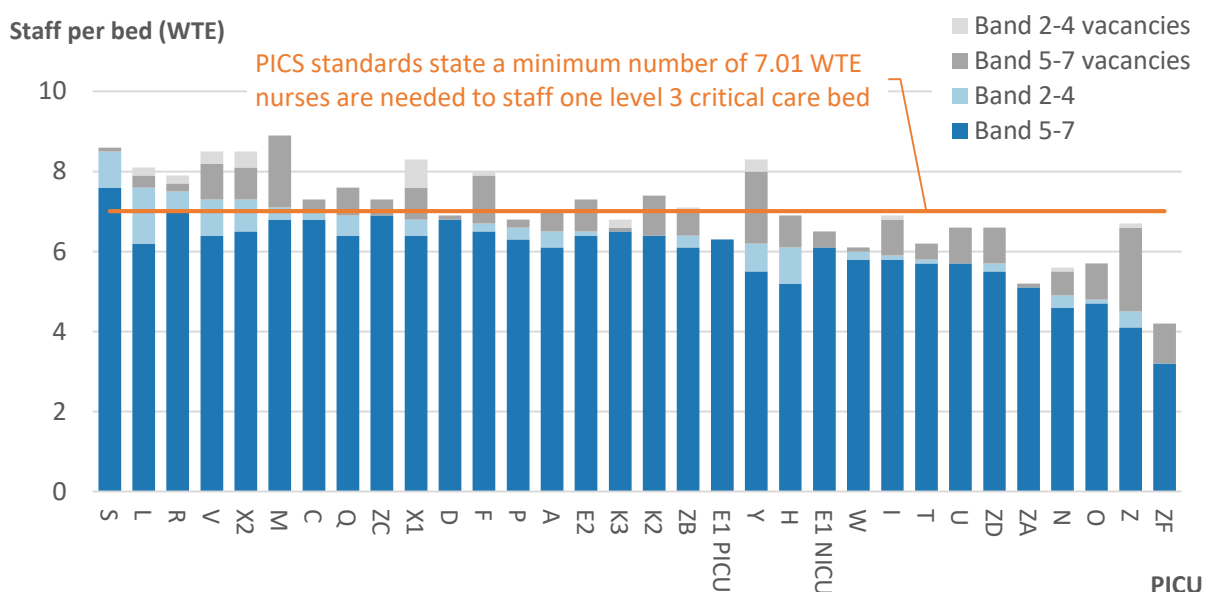
The Paediatric Intensive Care Society (PICS) Standards (2015), state a minimum number of 7.01 Whole Time Equivalent (WTE) qualified (registered) nurses are needed to staff one level 3 critical care bed. Non-registered staff with appropriate competencies may be included in calculations of staffing levels per child requiring critical care, so long as they are working under direct supervision of a registered nurse at all times.

What did we find?

Overall the establishment figures from PICUs across the UK and the Republic of Ireland show that in 2020 only one PICU (3%) met the PICS standards for nursing staff of 7.01 WTEs per bed of clinically qualified nurses. This increased to six PICUs (18%) when non-registered health care staff (Bands 2–4) providing clinical care were included (Figure 10).

However, if all the recorded vacancies for qualified nurses and non-registered health care staff working clinically were filled, 16 (48%) PICUs would meet the PIC standard of 7.01 WTEs per bed.

Figure 10: Number of registered and non-registered nursing staff providing clinical care in post (WTE) per bed by band and by health organisation, 2020

Ranked by total staff per bed (WTE) for bands 2–7 combined. Data behind this Figure can be viewed in Table S1c in the Tables and Figures.

What does this mean?

Based on the data provided by UK and Republic of Ireland PICUs in November 2020, only one PICU met the recommended standard of the Paediatric Intensive Care Society for the minimum number of WTE nurse establishment of 7.01. The addition of bands 2–4 delivering clinical care has enabled five additional PICUs to meet this standard. However, despite few PICUs meeting these standards, staffing data from the census shows that the units ensure that their staffing levels are appropriate for the number of children on the unit and their care requirements, despite NHS and staff working under pressure during the COVID-19 pandemic. This may be achieved by unit staff working flexibly, undertaking additional shifts or using bank or agency staff. The data should be used to inform the future planning of PIC particularly post COVID-19 workforce planning.

Further details

Definition and methods

Each year PICANet carries out a staffing study to monitor staffing levels within PICUs and to audit the appropriate standards of the Paediatric Critical Care Society. These are currently the PCCS Quality Standards for the Care of Critically Ill or Injured Children (6th Edition, October 2021). Staffing data are collected in the November of each year: for the week beginning 2 November in 2020, PICANet present the percentage of PICUs meeting the recommended level of nurse staffing per funded critical care bed. PICS Quality Standards for the Care of Critically Ill Children (5th Edition, December 2015) were in place at the time of the 2020 staffing data collection.

The recommended number of nurses required (or nurse staffing establishment), in order to provide the appropriate levels of care for the number and given dependency of the bed, is calculated according to the PICS Standards (2015), (one nurse to one bed) and high dependency (one nurse for every two beds).

Why is this important?

PICUs need to be able to monitor whether they have adequate nursing staff available to run their unit efficiently. PICS Standard L3-207 (2015), and guidance from the PICS Nurse Workforce Planning document for Level 3 Paediatric Critical Care Units, October 2016 states that 'the minimum number of qualified nurses required to staff one level 3 critical care bed is a minimum of 7.01 WTE'. Non-registered staff (health care assistants) with appropriate competencies may be included in calculations of staffing levels per child requiring critical care so long as they are working under direct supervision of a registered nurse at all times.

The availability of specialist PIC nurses is affected by many factors external to PIC including nursing salaries and the cost of living in capital cities. Some PICUs are developing the role of band 2–4 health care assistants to support qualified staff in delivering clinical care in critical care units. Whilst staff recruitment and retention was considered as part of the critical care review, unfortunately the impact of COVID-19 pandemic has shifted the focus to flexible ways of working, alternative staff/patient ratio [17, 18] and staff well-being aimed at retention of staff rather than recruitment [19]. The UKCCNA has emphasised a review of recruitment and retention strategies post pandemic [20].

Metric 4: Emergency readmissions within 48 hours

What are we measuring?

For each PICU, we record the frequency of emergency readmissions to the discharging PICU within 48 hours of discharge in comparison to the average for the UK and Republic of Ireland (Table 7). This is calculated using the admission and discharge dates and times. The emergency readmission rate for each nation was calculated by dividing the number of emergency readmissions by the total number of admissions occurring in that nation for a given year.

We also consider relative emergency readmission rates; these allow us to compare each PICU's rate of emergency readmission within 48 hours with the equivalent rate over the UK and Republic of Ireland combined (Figure 11), by dividing their 48 hour emergency readmission rate by the combined UK and Republic of Ireland rate. Relative readmission rates higher than one indicate that a PICU has a higher rate of emergency readmissions within 48 hours than the overall rate for the UK and Republic of Ireland.

What did we find?

On average between 2018 and 2020 around 310 children (equivalent to about 1.7 out of every 100 admissions) on average were discharged from PICU but then readmitted as an emergency within 48 hours each year (Table 7). Rates of emergency readmissions remained steady in England over the reporting period. Wales and Northern Ireland both saw a peak in emergency readmissions in 2018 with rates falling in 2019 and 2020. Rates in Scotland were steady in 2018 and 2019 but increased slightly in 2020. In the Republic of Ireland, emergency readmission rates were lowest in 2018 and remained at 1.7% in 2019 and 2020.

In 2020, the rate of readmissions for individual PICUs ranged between 0% and 3.7%; however, it is important to note that not all PICUs were open to paediatric admissions for the whole of 2020 due to the COVID-19 pandemic. The rate of readmission for individual PICUs over the three years of the reporting period combined ranged between 0.2% and 2.6%.

Table 7: Number of emergency readmissions within 48 hours, 2018–2020
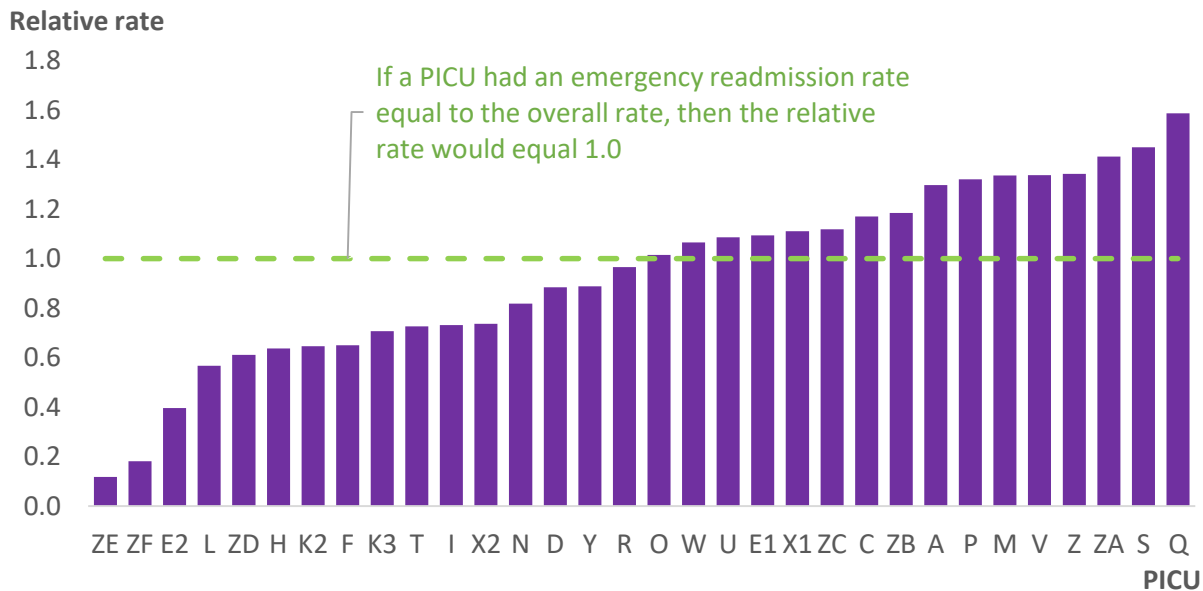
Country	2018	2019	2020	2018–2020
England	268 (1.6%)	244 (1.5%)	216 (1.6%)	728 (1.6%)
Wales	15 (2.9%)	8 (1.6%)	3 (0.8%)	26 (1.9%)
Scotland	26 (1.9%)	31 (1.8%)	25 (2.1%)	82 (1.9%)
Northern Ireland	14 (2.8%)	8 (1.6%)	4 (1.1%)	26 (1.9%)
Republic of Ireland	18 (1.3%)	26 (1.7%)	24 (1.7%)	68 (1.5%)
Total	341 (1.7%)	317 (1.6%)	272 (1.7%)	930 (1.6%)

Readmissions within 48h defined as an unplanned admission to the discharging PICU within 48 hours of discharge from that PICU.
Due to small numbers, data for non-NHS and NHS organisations in England are presented combined.

The emergency readmission rate for each PICU for the 3-year reporting period ranged from 0.1 to 1.6 times the overall UK and Republic of Ireland rate. We would expect to see substantial variation in each PICU because of the low number of emergency admissions within 48 hours within each individual unit.

Figure 11: Relative rate of emergency readmission within 48 hours of discharge by PICU for 2018–2020

Emergency readmission rates for each individual unit are relative to the overall rate of 1.63, the horizontal dotted line shows where a bar would sit if a unit had an emergency readmission rate that was exactly the same as the overall rate.

Data behind this Figure can be found in Table 42 in the Tables and Figures

What does this mean?

The proportion of patients requiring emergency re-admission within 48 hours of discharge from PICU was low in all countries, with around 1.6 per 100 admissions. There was substantial variation in the relative emergency readmission rate between PICUs and within PICUs year on year. This must be interpreted within context of the waves of the COVID-19 pandemic as some units closed to paediatric admissions for part of 2020.

Further details

Definitions and methods

We defined an emergency readmission within 48 hours as any unplanned admission to the same PICU within 48 hours of their last discharge from PICU. So if a child was admitted on 1 March at 12:00 and discharged on 2 March at 17:00, but then admitted as an emergency (an unplanned admission) before 4 March at 17:00, they would have been counted in our analysis as they returned to PICU within 48 hours. We then calculated the number of emergency readmissions within 48 hours for every 100 admissions in each PICU to give a rate per 100 admissions. This allows us to compare PICUs with different numbers of admissions.

There is no standard set for the acceptable rate of emergency readmissions within 48 hours, so in order to calculate relative rates we used the overall readmission rate for each specific

year based on all PICUs contributing to PICANet as the standard. We then compared the 48-hour emergency readmission rate for each individual PICU to this overall rate. When interpreting the data, PICUs with relative readmission rates below one have a lower readmission rate than that seen in the UK and Republic of Ireland combined and PICUs with a relative rate above one have a higher readmission rate.

Why is this important?

Emergency readmission within 48 hours is an undesirable outcome. From an individual child's perspective, it suggests that their health has deteriorated in a short space of time and that they require further intensive care treatment. This will cause stress to the child, their families and their carers. For a busy PICU, each admission also creates additional demand on a service that usually operates close to capacity.

It should be noted that although emergency readmission is used as a quality indicator, we cannot say that the sole or primary readmission was a reflection of the care provided. PICANet is therefore unable to assess whether the child was discharged too early, or into the wrong care environment, or whether the need for future intensive care was not foreseen.

Relative rates of emergency readmission within 48 hours compared with the overall rate for the UK and Republic of Ireland show considerable variation year on year, although some of this variation could be due to small numbers of emergency readmissions within 48 hours in each PICU. This suggests that emergency readmission rates should be monitored on an ongoing basis.
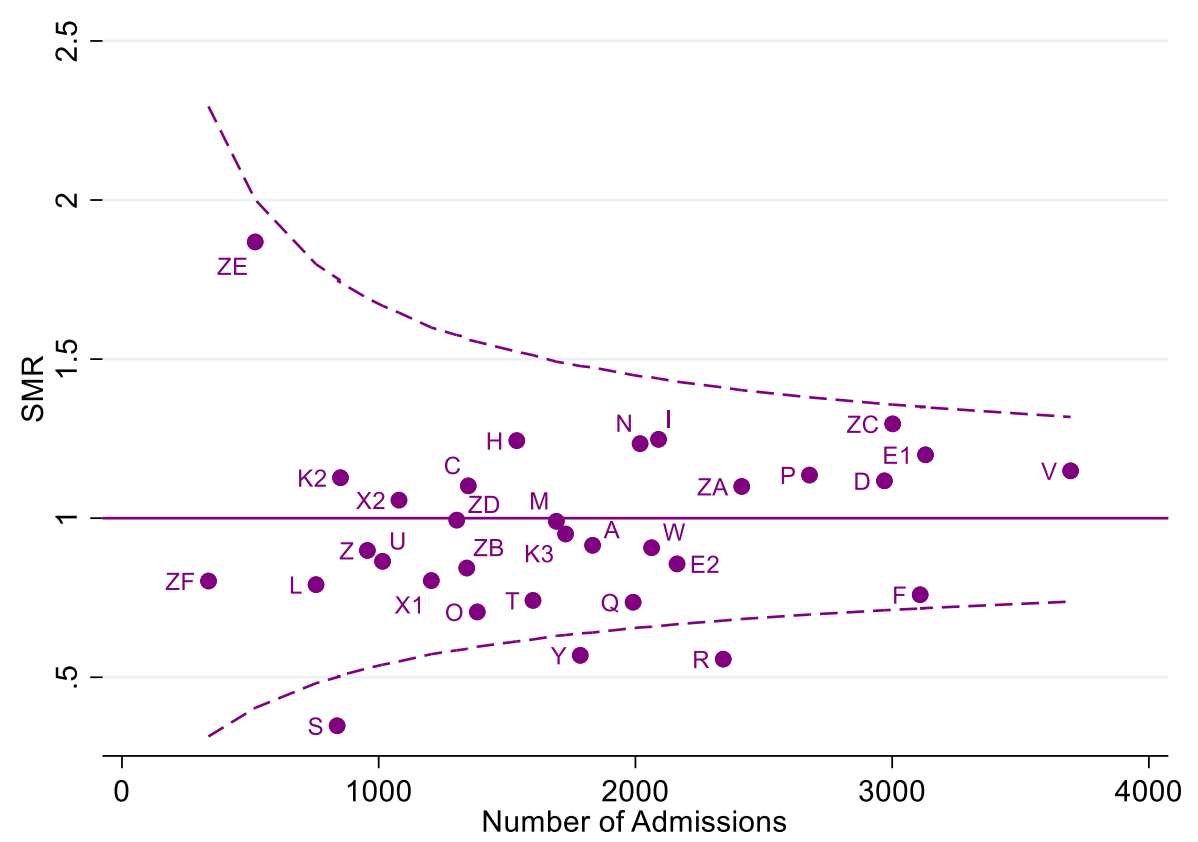
Metric 5: Mortality in PICU

What are we measuring?

Mortality (death) rates are assessed for every PICU based on a statistical approach that accounts for the severity of the child's illness at the time of admission. This method is known as risk adjustment. The number of children who actually die (the 'observed' number) is compared to the number we predict to die (the 'expected' number, based on their clinical characteristics at the time of admission) to derive the risk-adjusted Standardised Mortality Ratio (SMR). The risk-adjustment method used to calculate expected mortality was the Paediatric Index of Mortality version 3 (PIM3)[2], which has been recalibrated based on the data within this reporting period. Further details on recalibration can be found in the Tables and Figures document. This year we present risk-adjusted SMRs only for admissions for children aged 0–15 years (as opposed to previous years where we presented based on all admissions); this is because PIM3 was created and validated on data from children rather than all admissions and as such the risk-adjustment is most appropriate in this age group.

What did we find?

The risk-adjusted SMR for each PICU in the UK and Republic of Ireland for the three-year reporting period 2018–2020 is plotted in Figure 12. There was no evidence that any PICU had an excess mortality rate compared to what would be expected either when looking at just children (0–15 year olds). Three PICUs had a substantially lower mortality rate than would be expected even after allowing for natural variation: Edinburgh, Middlesbrough and Southampton.

Figure 12: Risk-adjusted Standardised Mortality Ratio (SMR) by health organisation for 0–15 year olds, 2018–2020

Risk-adjustment based on PIM3 calculations recalibrated in 2021.
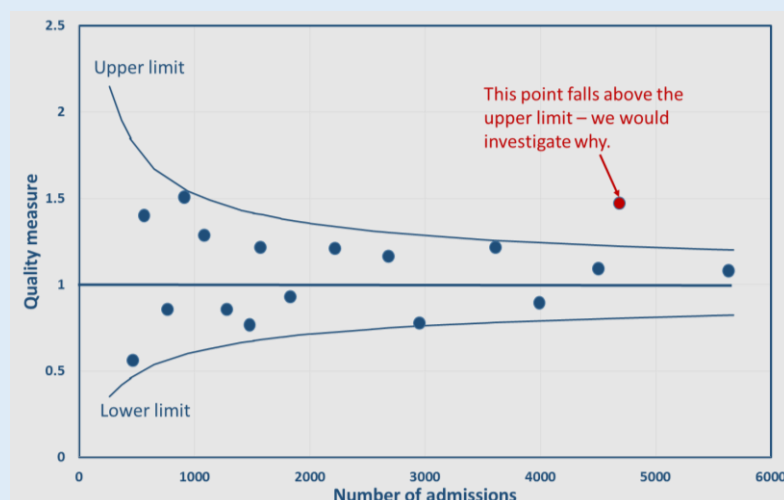Data behind this Figure can be found in Table 47 in the Tables and Figures.

What does this mean?

No PICUs had substantially more deaths than was to be expected after allowing for the level of sickness of the patient at the time of admission; three PICUs had substantially fewer deaths than expected.

How to read a funnel plot

Figure 13 is a simple example of what a funnel plot might look like. The 'funnel' is created using statistical methods that tell us what range of values we might expect for mortality, given that there are normal 'ups and downs' (natural variation). The limits are wider where there are fewer admissions because with only a few observations we cannot be as certain about our findings. With more observations we can be more confident that the outcome is likely to fall within narrower limits.

Figure 13: Example funnel plot

The blue dots represent individual PICUs. They are plotted from left to right (horizontal-axis) based on the number of admissions to each PICU.

The blue line in the middle of the funnel represents what is "expected", in other words if a dot were to fall exactly on this line then this would mean that the number of deaths observed and the number of expected deaths are equal to each other (so there are no more or fewer deaths than we anticipate). It would be quite rare for a dot to fall exactly on this line and you would always expect a scatter of dots above and below this line. The whole point about funnel plots is to allow us to see differences between units taking into account natural variation.

Any dot that falls within the funnel shape is within the limits of what we would expect to see so the number of observed deaths is no greater (or smaller) than the number we expect. We therefore have no concerns about PICUs with blue dots within the 'funnel'.

If a dot is above the funnel shape (like the red dot in Figure 13) we say that it is outside the upper limit and is a 'statistical outlier'. This means that the number of deaths in the PICU are higher than the number we expect and that this is possible due to a cause other than natural variation. There are many reasons that a PICU could have a dot which lies above the upper limit including the fact we may not have properly accounted for how sick patients are when they enter the ward, or purely due to chance alone. We have a specifically designed process for investigating whether these PICUs really do have a higher number of deaths than expected and is a 'true outlier'.

Further details

Definitions and methods

Clinical data collected on admission are used in a statistical model to predict the probability that each child might die in PICU: the worse a patient's clinical condition is on admission, the higher the probability that they might die. These probabilities are added up for each PICU to give an overall expected number of deaths in any one period. We then count the actual (observed) number of deaths and calculate what is known as a Standardised Mortality Ratio (SMR) by dividing the observed number of deaths by the expected number. We then use the funnel plot to assess the level of mortality in the PICUs against what is expected.

Why is this important?

Although death whilst receiving care on a PICU is extremely rare, it is important to assess whether more (or fewer) deaths than expected occur, as this can indicate that there is something different happening in a PICU. It only represents a statistical measure of mortality and it is very important to use this as an indicator that further investigation is required, not as a true measure of the quality of care delivered.

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Glossary

CAG	Clinical Advisory Group
CHI	Community Health Index
CTS	Central Transport Services
GDPR	General Data Protection Regulation
HD	High dependency
HQIP	Healthcare Quality Improvement Partnership
HRA	Health Research Authority
HRG	Healthcare Resource Group
IC	Intensive Care
NCAPOP	National Clinical Audit and Patient Outcomes Programme
NHS	National Health Service
NOCA	National Office of Clinical Audit
ODN	Operational Delivery Networks
PCCS	Paediatric Critical Care Society
PCCT	Paediatric Critical Care Transport
PIC	Paediatric Intensive Care
PICANet	Paediatric Intensive Care Audit
PICS	Paediatric Intensive Care Society
PICU	Paediatric Intensive Care Unit
PIM3	Paediatric Index of Mortality 3
RA-RSPRT	Risk Adjusted Resetting Sequential Probability Ratio Test
ROI	Republic of Ireland
SG	Steering Group
SMR	Standardised mortality ratio
UKCCNA	UK Critical Care Nursing Alliance
UK	United Kingdom
WHSSC	Welsh Health Specialised Service Committee
WTE	Whole time equivalent

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