Paediatric Intensive Care Audit Network
Annual Report 2020

Summary Report

Data collection period
January 2017–December 2019

UNIVERSITY OF LEICESTER

UNIVERSITY OF LEEDS

GIG CYMRU NHS WALES

HCA Hospitals World-Class Healthcare

NOCA National Office of Clinical Audit

HSC Belfast Health and Social Care Trust

NHS National Services Scotland

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

Acknowledgements

Introduction

This is the seventeenth annual PICANet clinical audit report documenting paediatric critical care activity which occurred in the United Kingdom (UK) and Republic of Ireland (ROI) between 2017 and 2019. This report forms part of PICANet's contracted obligations, providing key information 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.

Information on five key metrics related to Paediatric Intensive Care services is provided: case ascertainment including timeliness of data submission, retrieval mobilisation times, number of qualified nurses per bed, emergency readmissions within 48 hours and mortality in PICU. Whilst outlier analysis is only mandated for mortality, PICANet provides an additional monitoring function for mortality within each unit through the availability of real-time 'RSPRT' plots. We encourage units to continue to use this functionality to monitor performance.

Although this Summary Report offers an overview of the key findings and recommendations, readers are guided to the full set of tables and figures which have been released simultaneously and comprehensively describe admissions, referrals and transport activity within PICUs over the last three years. Individual tables and figures can be downloaded in electronic form from the main PICANet website www.picanet.org.uk.

We also remain committed to the continued development of the PICANet web platform and underlying database to enhance the user experience and to ensure that all key performance data for units can be visualised through an online dashboard.

Professor Liz Draper

Dr Richard Feltbower,

Principal Investigators

Key findings

- The number of admissions per year to paediatric intensive care across the UK and Republic of Ireland showed a slow and steady increase over the period 2017–2019 from 19,869 to 20,383. This increase was mainly driven by a 22% increase in admissions in Scotland between 2017 (n=1390) and 2019 (n=1697) and a small increase in English NHS units and in the Republic of Ireland. Numbers of admissions in Wales and Northern Ireland remained steady.

- Units across the UK and ROI delivered on average around 142,000 bed days per year between 2017–2019. There was a steady increase in bed days over the period specifically in Wales, Scotland and the ROI.

- Admission rates to paediatric intensive care varied by country, ranging from 132 per 100,000 children in the Republic of Ireland to rates of 165 and 168 in Northern Ireland and Scotland, respectively.

- The likelihood of dying whilst being treated within PICUs was very low throughout the three-year period, with 96.5% of admissions discharged alive. Deaths within PICU comprise around one in every 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 3.7 and 5.0 for every 1,000 days of invasive ventilation throughout the reporting period. Two fifths of all units reported a decrease in the number of unplanned extubations over the three years 2017 to 2019.

- Over the period 2017 to 2019 specialist PIC transport services accepted 16,623 (92.3%) of referrals for urgent transfer to PIC. Rates of refusal ranged from 0% to 12.8% for those transport teams providing a 24 hour service.

- Once again, reported rates of bed occupancy remain high in PICUs. During the PICANet staffing census week intensive care bed occupancy rates were 100% in Scotland and over 80% in England (NHS), Wales, Northern Ireland and the Republic of Ireland. High dependency bed occupancy 'in normal hours' was reported at 86% in England (NHS) and lower rates were reported in the devolved nations and the Republic of Ireland. 'Out of hours' bed occupancy was similarly high with reported rates of 100% Intensive Care (IC) bed occupancy for Scotland, above 90% for Northern Ireland and the Republic of Ireland and around 80% for Wales and England (NHS). For high dependency (HD) care 'out of hours' bed occupancy was reported as over 75% for England and Wales. Lower rates were reported for the other devolved nations and the Republic of Ireland.

- At least 95% of admissions reported to PICANet from nine PICUs in 2019 were confirmed after a validation exercise was undertaken, with six of these units reporting more than 99% of cases.

- 85% 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. Nine units achieved completeness within three months for at least 98% of their admissions. One unit completed fewer than 50% of their admission records within this timescale.

- Of the 4,245 journeys carried out for children requiring urgent transport to a PICU, just under three fifths (58.8%) were started within 30 minutes and three quarters (76.5%) started within one hour of the decision being made. Just over 1 in 20 journeys (6.3%) started more than three hours after this decision.

- One quarter of PICUs (25%) met the PICS standard for nursing staff of 7.01 WTEs (whole time equivalents) when all staff providing clinical care (including non-registered health care staff: Bands 2–4) are included. However, if recorded vacancies were filled to unit nurse establishment figures half of PICUs (48%) would meet this standard. Nevertheless, as in previous years, the annual PICANet census shows that units ensure their staffing levels are appropriate for the number of children on the unit and their care requirements.

- Overall rates of emergency readmission within 48 hours of discharge remained the same across the reporting period, at around 1.7%. However, these ranged from 1.6% in England and the Republic of Ireland to 2.1% in Northern Ireland.

- No negative statistical outliers were identified for mortality rates for any unit between 2017 and 2019.

Recommendations

1. Monitor bed occupancy levels in close liaison with commissioners and Operational Delivery Networks (ODNs) to ensure adequate critical care beds are available to meet demand.

   Action: Paediatric Intensive Care Units (PICUs), commissioners and ODNs.

2. Review the timeliness and quality of their submission of data to PICANet, to ensure compliance with the PICS standards.

   Action: PICUs and Paediatric Intensive Care (PIC) Centralised Transport Services.

3. Investigate events where their retrieval mobilisation times do not meet the 30-minute NHS England target and develop a strategy to ensure optimal compliance.

   Action: PIC Centralised Transport Service teams.

4. Ensure adequate staff availability for the PIC Centralised Transport Service by reviewing PICANet data with commissioners.

   Action: PIC Centralised Transport Service teams and commissioners.

5. Review and improve national recruitment and retention initiatives of PIC nurses and the use of non-registered health care staff to support qualified nurses in delivering clinical care, to ensure that all PICUs have appropriate staffing levels.

   Action: national nursing professional bodies, NHS Trusts and Health Boards and Health Education bodies in the UK and RoI.

6. Ensure that the data collected to monitor unplanned extubation rates complies with the agreed PICANet definition. PICUs with the lowest rates of unplanned extubations should be encouraged to share examples of best practice to reduce variation between units.

   Action: PICUs.

7. Work should be carried out to develop a more robust risk-adjustment score for in-PICU mortality.

   Action: Paediatric Critical Care Society-Study Group, PICU clinicians.

How we present our results

Results are presented in tables and figures. In general, data are presented for children aged 0–15 years, however data are also presented in separate tables for patients who are 16 years and older and treated on PICU. Each specific measure of interest is explained in the results and metrics sections of this report under the heading "What are we measuring?"

We look at a wide range of measures including 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.

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, if we wanted to compare the admission rate in Scotland to that in England then 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 3 (PIM3)[3]. 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 is a way of displaying and comparing 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.

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 2017 and 2019 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 every year between 2017 and 2019 across the UK and Republic of Ireland. The number of admissions per year increased slightly year on year, reaching a peak of around 20,400 in 2019. The number of admissions to non-NHS PICUs in England decreased over the reporting period from a peak of over 500 admissions in 2017 to around 300 admissions in 2019. There was also a small but steady reduction in admissions in Northern Ireland, from over 520 in 2017 to just over 490 in 2019. The number of admissions in Scotland increased in 2019 from around 1,400 admissions per year in 2017 and 2018 to approximately 1,700 admissions.

The number of bed days delivered ranged from around 140,000 to 144,000. Whilst the number of admissions to non-NHS PICUs in England decreased over the reporting period, the equivalent number of bed days rose reaching approximately 3,300 in 2019. The increased number of admissions in Scotland in 2019 was mirrored by an increase in the number of bed days delivered. A steady increase in bed days was also observed in the Republic of Ireland over the three-year period.

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

Country of admission	2017	2018	2019
England (NHS)	15,475	16,029	15,888
England (non-NHS)	526	351	303
Wales	493	510	489
Scotland	1,390	1,351	1,697
Northern Ireland	522	501	492
Republic of Ireland	1,463	1,430	1,514
Total	19,869	20,172	20,383

N.B. This table does not include admissions where the child's age is unknown or those aged 16+ years at admission.

Figure 1: Number of admissions to PICU by country of admission and year
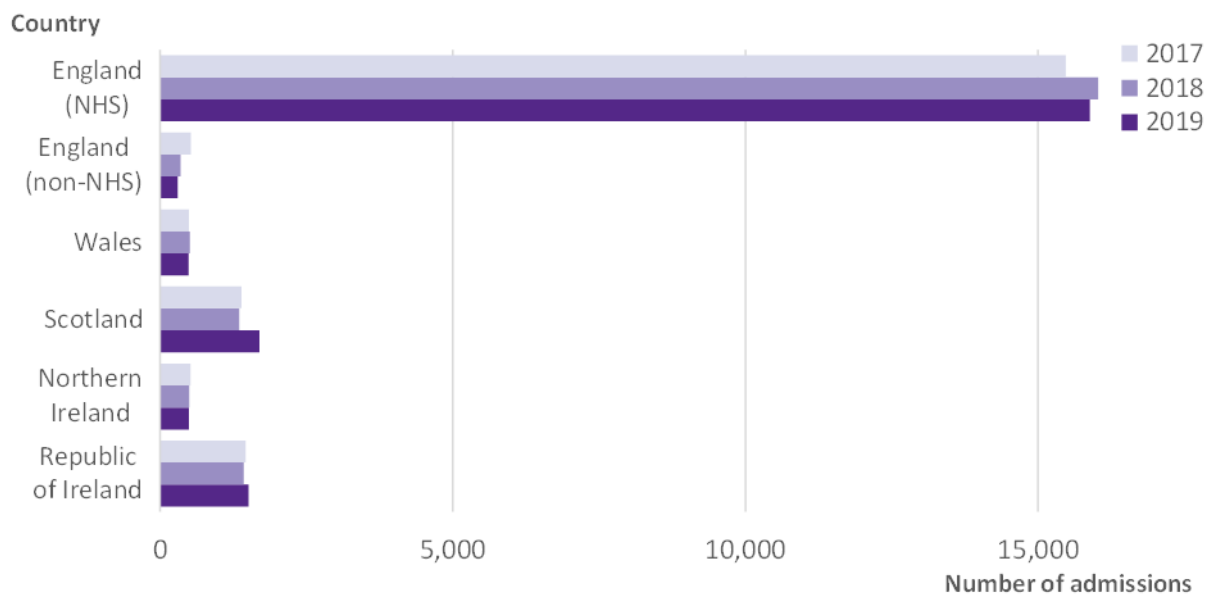
Table 2: Number of bed days delivered by country of admission and year

Country of admission	2017	2018	2019
England (NHS)	110,067	114,720	111,757
England (non-NHS)	2,829	2,695	3,281
Wales	2,451	2,509	2,626
Scotland	10,765	10,319	12,054
Northern Ireland	3,695	3,282	3,422
Republic of Ireland	9,607	10,177	10,393
Total	139,414	143,702	143,533

N.B. This table does not include admissions where the child's age is unknown or those aged 16+ years at admission.

Figure 2: Number of bed days delivered by country of admission and year
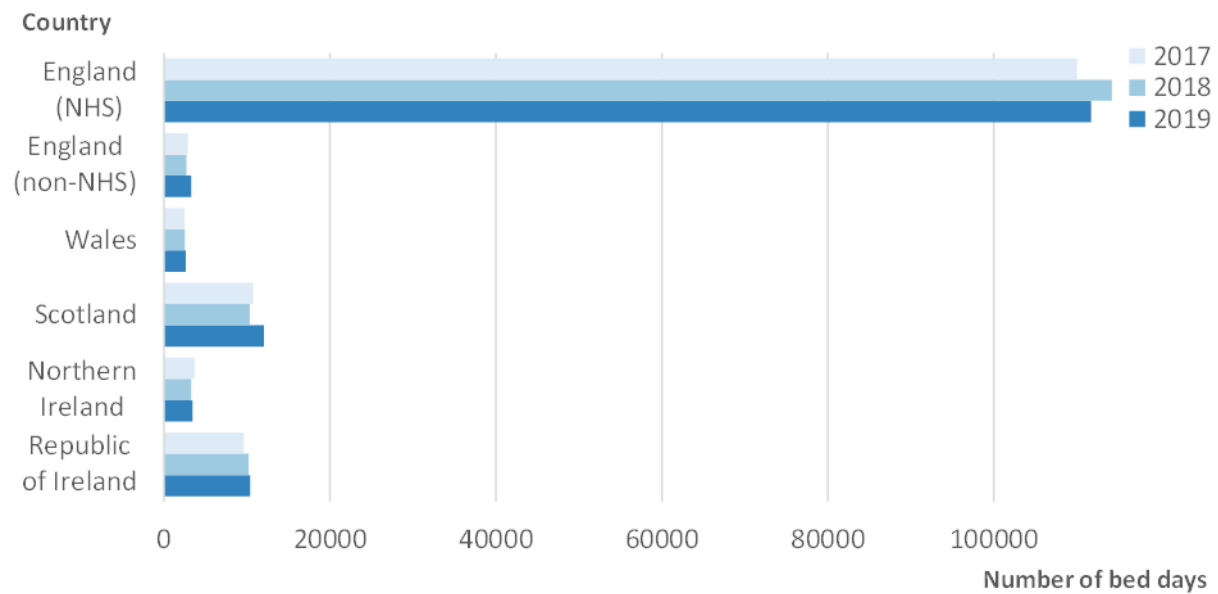
What does this mean?

Paediatric intensive care services continue to experience high demand across the UK and Republic of Ireland; this is reflected in an average of over 55 new admission events per day. The number of admissions increased slightly year on year, and the increase in bed days delivered between 2017 and 2018 was sustained into 2019. These apparent changes in trends over the reporting period illustrate the requirement to closely monitor 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.

Further details

Definitions and methods

Every admission to a PICU in the UK and the Republic of Ireland is counted for each year, 2017–2019. 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 2017 and 31 December 2019).

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 of PIC based in England up to the end of 2019.

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.

The data regarding PICU admissions and bed days delivered have been used by the recent Paediatric Critical Care Review for England[1].

Headline figures: Admission rates by country of residence

What are we measuring?

Annual rates of admissions to PICU between 2017 and 2019 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?

PICU admission rates were highest in Scotland, reaching 168 admissions for every 100,000 children, followed by Northern Ireland (164), England (140), Wales (139), and the Republic of Ireland (132). For the UK and Republic of Ireland combined, admissions rates were 142 per 100,000 population per year.

Admissions rates in Northern Ireland decreased over the reporting period from 169 to 159. In 2019, the admission rates in Scotland increased to 190. Rates in the Republic of Ireland, Wales and England remained steady across the three-year period.

Table 3: Rate of admissions per 100,000 childhood population, 2017-2019

Country of admission	2017	2018	2019	2017-2019
England	137.3	141.3	141.3	140.0
Wales	139.1	138.8	139.4	139.1
Scotland	160.9	152.9	190.1	168.0
Northern Ireland	169.2	166.4	159.0	164.8
Republic of Ireland	131.8	129.8	135.5	132.4
Total	139.4	141.8	144.5	141.9

Based on country of residence.

What does this mean?

There was substantial geographical variation in admissions rates to PICU between countries, comprising essential information required for the planning of national PIC services. Possible explanations for these findings could involve differences in admission policies between each country, 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.

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 2017 and 2019. 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.

What did we find?

Table 4 summarises the number of deaths in PICU by country of admission and year. The percentages were calculated for each country based on the total number of admissions for that year. There was a total of 2,104 deaths over the three year period, equivalent to 965 children out of every 1,000 being discharged alive.

Table 5 shows the proportion of deaths in PICU, compared to all childhood deaths in the UK and Republic of Ireland. For context, we also present the total number of deaths in the population 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 21–22% 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	2017	2018	2019	2017-2019
England	3.8% (n=604)	3.4% (n=562)	3.6% (n=575)	3.6% (n=1,741)
Wales	2.0% (n=10)	4.3% (n=22)	2.0% (n=10)	2.8% (n=42)
Scotland	2.5% (n=35)	2.4% (n=33)	1.9% (n=33)	2.3% (n=101)
Northern Ireland	3.4% (n=18)	2.4% (n=12)	2.3% (n=11)	3.0% (n=41)
Republic of Ireland	4.1% (n=60)	4.1% (n=59)	4.0% (n=60)	4.1% (n=179)
Total	3.7% (n=727)	3.4% (n=688)	3.4% (n=689)	3.5% (n=2,104)

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, 2017–2019

Country of admission	2017	2018	2019
UK	16.1% (n=667)	15.6% (n=629)	15.9% (n=629)**
Republic of Ireland	22.0% (n=60)	21.1% (n=59)*	22.1% (n=60)*

Based on country of admission
* The numbers of total deaths for the Republic of Ireland for 2018 and 2019 is currently provisional and subject to change.
** The number of total deaths for Northern Ireland for 2019 is provisional and subject to change.

What does this mean?

Risk of death in paediatric intensive care is low with 96.5% of patients being discharged alive between 2017 and 2019. 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.

Further details

Definitions and methods

We have recorded the number of deaths in PIC by year and by country of admission for 2017 to 2019. 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 (2017–2019) 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?

Children 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**. In Figure 3 and Table 6, we present the number of unplanned extubations for every thousand days of invasive ventilation 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 2019 rate.

What did we find?

The number of unplanned extubations in the UK (excluding Wales) and Republic of Ireland in 2017 was 254 and in 2018 was 339 out of a total of over 67,000 days of invasive ventilation provided in each year. In 2019, this decreased to 306 unplanned extubations out of a total of just over 66,000 days of invasive ventilation. These figures equate to unplanned extubation rates of 3.7 (95% confidence interval (CI): 3.3 – 4.2), 5.0 (95% CI: 4.5 – 5.6) and 4.6 (95% CI: 4.1 – 5.2) unplanned extubations for every 1,000 days of invasive ventilation for 2017, 2018 and 2019 respectively.

Eighteen PICUs demonstrated a decrease in their unplanned extubation rate between 2018 and 2019, and 12 units had an increase in rate.

There were two units for which there were no unplanned extubation events reported in either 2017, 2018 or 2019. Two further units reported no unplanned extubations in 2017 or 2018 but did report at least one event in 2019. 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, 2017 -2019
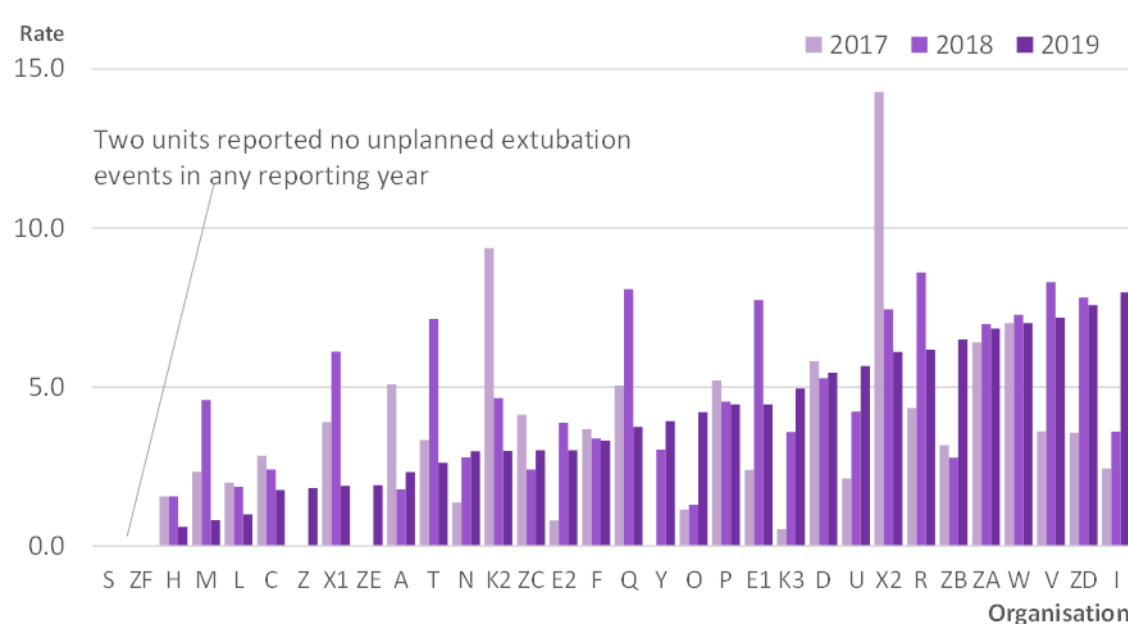
Ranked by unplanned extubations rate for 2019

Table 6: Rate of unplanned extubation per 1,000 days of invasive ventilation by country of admission

	2017	2018	2019	2017-2019
England (NHS)	3.6 (n=206)	5.1 (n=287)	4.5 (n=248)	4.4 (n=741)
Wales				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)
Republic of Ireland	4.0 (n=20)	3.8 (n=21)	4.2 (n=24)	4.0 (n=65)
Total	3.7 (n=251)	5.0 (n=336)	4.6 (n=306)	4.4 (n=901)

Data are presented based on date of unplanned extubation

Due to small numbers, data for non-NHS and NHS organisations in England are presented combined and data for Wales are presented for the whole reporting period combined only.

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 2017–2019. All units reported unplanned extubation rates below eight per 1,000 intubated days in 2019. However, this is still a relatively new data item, as units have only recently been required to report and quality assure this metric. Changes in rates of unplanned extubation should therefore be carefully monitored over the next few years.

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 the most common adverse event related to airway management in intensive care: it can cause complications such as hypoxaemia (very low blood oxygen), hypercarbia (high blood carbon dioxide) and sometimes, but very rarely, death[2]. Clearly, it is best to avoid unplanned extubation, if at all possible, but there are no established guideline levels: the NHS England service specification notes the threshold is still to be agreed[3]. Kanthimathinathan and colleagues referred to a notional threshold equivalent to 10/1000 days[2]. By continuously monitoring unplanned extubation rates, it may be possible to detect when a change in practice occurred, such as the change in the adhesive tapes that caused an increase in unplanned extubation rates noted by Kanthimathinathan and colleagues[2].

Headline figures: Referral for transport

What are we measuring?

If a child needs specialist paediatric intensive care (PIC) transport, a referral is made to the PIC transport team. Sometimes the initial referral may not result in a transport, and this is called a refusal. We have recorded the number of referrals during the period 2017–2019, the number which were successful and the number which were refused. We have also looked at the reason why they were refused.

What did we find?

Over the three years 2017–2019, the details of 18,349 referrals for PIC transport where clinicians agreed that PIC transport was required. The number of these referrals by PIC Central Transport Service (CTS) is presented by the grey bars on Figure 4. Of these, 92.1% (16,893) were accepted for transport by one of the twelve commissioned specialist paediatric intensive care (PIC) transport teams in the UK and Republic of Ireland. Around 1 in 13 (1,456) were not accepted for transport. The proportion of referrals refused for transport varied from 0% to 28.5% per PIC CTS – this is shown ranked by refusal rate by the orange circles on the figure. Four CTS organisations (T002, T005, T022 and T026) reported less than a 2% refusal rate, one of which provides a service for a devolved nation. T010 that reported a 28.5% refusal rate (reduced from 34% the previous year) endeavour to provide a 24 hour service but this is often limited by staff availability.

Reasons for refusal include: no PIC transport team being available; the condition of the child being assessed as time critical and therefore the transport of the child could be delivered appropriately by another team; or as being 'out of scope of care', for example a neonatal transfer team who provide transport for small babies could more appropriately provide care.

Figure 4: Refusals following referral for urgent paediatric intensive care transport: UK and Republic of Ireland 2017-2019
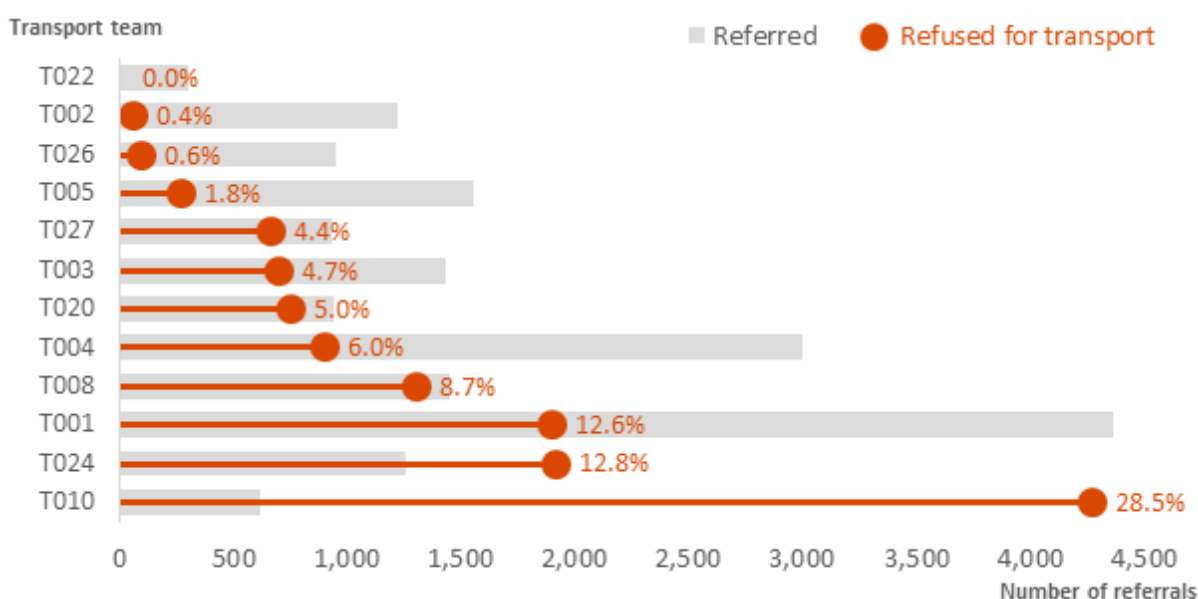
T027 was established in March 2017

What does this mean?

When a transport team receives a referral, and the specialist PIC doctor agrees that the child requires transfer from the original admitting hospital to a PICU in another hospital, they also need to confirm that the PICU has a bed available to care for the child. If a bed is not available at the nearest PICU, the PIC transport team will seek an available bed in an alternative PICU. Over the period 2017–2019, the specialist PIC transport service were able to provide a response to over 92% of requests for transport.

When the transport team refuse the referral because they are already busy with other transfers, urgent referrals may be passed to another PIC transport team, or the child may remain at the local hospital with ongoing provision of support and advice about treatment being provided by the specialist PIC transport doctor, until a staffed transport team is available.

PIC transport may also be provided for children who are transferred from one PICU to another, to another specialist service, a hospice or home.

All children requiring PIC transport (agreed by the PIC specialist doctor) will be cared for and transferred by a PIC transport service or another transport provider.

Further details

Definitions and methods

We have recorded how many children have a referral for a specialist PIC transport team to collect them and transfer them to a PICU. Where the transport does not happen, PICANet record the reasons given by the transport teams. T028 is an ECMO transport team, not a commissioned specialist PIC transport team and therefore excluded from this headline figure.

Why is this important?

Although only a small proportion of referrals were not accepted for urgent transfer to PIC it is important to investigate the reason for any refusals. Almost half of refusals were due to the lack of availability of a PIC team. These requests may be passed to another PIC specialist transport team or the child may remain in the care of their local hospital under close supervision from the PIC team until transport can be mobilised. However this may result in the child being moved to a PICU in another part of the country.

Delays in receiving intensive care may have clinical implications and can cause stress for the patients and their carers.

Sometimes the PIC transport team advise that the local hospital transfer the child themselves to urgently access specialist treatment e.g. a child with a serious head injury. This is recorded by PICANet as a time critical transfer. In cases where the PIC transport team assess that the specialist transport required is out of their scope of care, the transport is provided by another specialist transport team (e.g. a neonatal team providing transport for an extremely preterm infant). For some teams the ability to respond to an urgent referral 'out of hours' may at times be limited by staff availability.

The ability of a PIC transport team to transfer a child to a PICU also depends on there being a PIC bed available.

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 beds in PICUs that were occupied at midday on a weekday and a weekend day, during the week beginning 11 November 2019 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.

What did we find?

At the 'normal hours' census point (midday Wednesday) in 2019, 100% of IC beds were occupied in Scotland and over 80% in England (NHS), Wales, Northern Ireland and, the Republic of Ireland (Figure 5). HD bed occupancy 'in normal hours' was reported at 86% in England (NHS), although lower numbers were reported in Wales, Scotland and the Republic of Ireland.

At the 'out of hours' census point at midday on a Sunday 100% IC bed occupancy was again reported for Scotland, whilst Northern Ireland and the Republic of Ireland (NHS) were above 90%, Wales at 83% and England at 78%. 'Out of hours' bed occupancy for HD care was reported as over 75% for England (NHS) and Wales, with lower numbers reported for Scotland and the Republic of Ireland.

Figure 5: Percentage of funded critical care beds occupied at midday Wednesday and midday Sunday in November, 2019
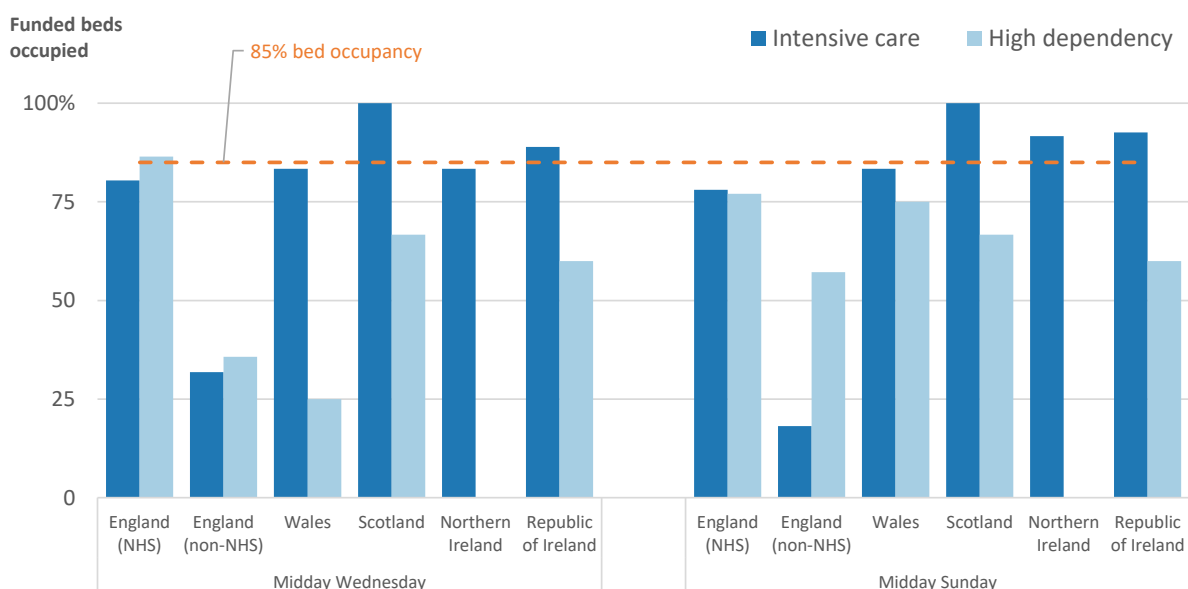
Number of funded beds reported in the appendices

Figure 6: Percentage of funded critical care beds occupied at midday Wednesday and midday Sunday in November, 2017–2019
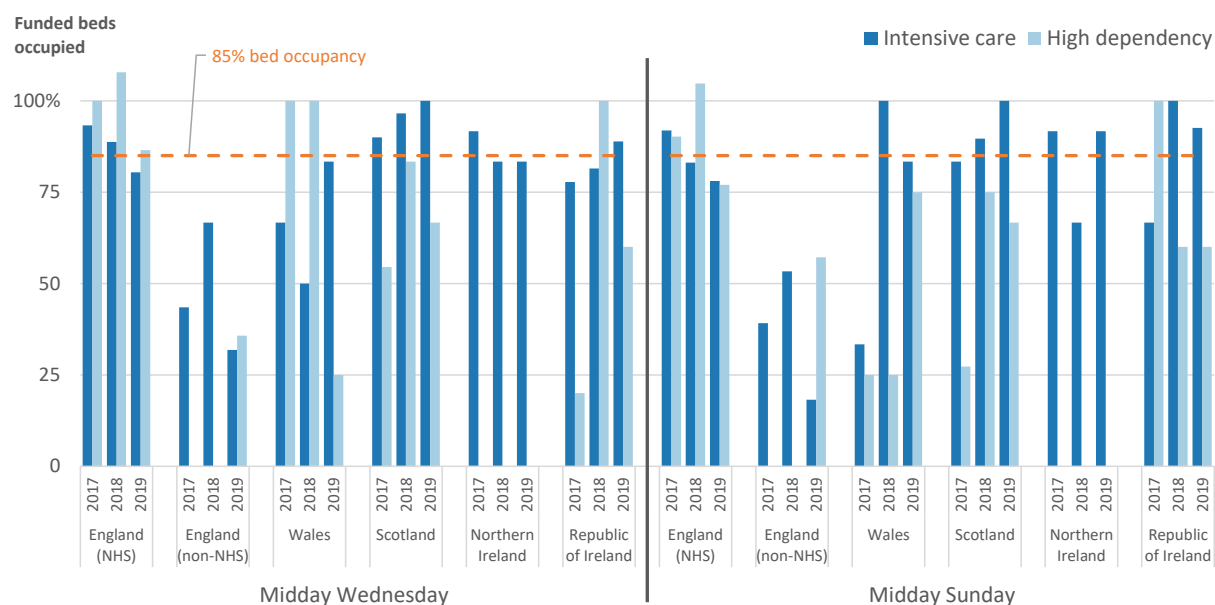
Number of funded beds reported in the appendices

What does this mean?

Across the UK reported bed occupancy rates in PIC remain high both during 'normal hours' and 'out of hours'. This reflects the ongoing steady increase in activity in PICUs observed since the start of PICANet in 2002–2003.

The number of funded IC beds reported to PICANet has remained consistent over the previous three years in England (NHS), Wales, Northern Ireland and the Republic of Ireland; in Scotland a small reduction (10%) is reported. For HD level beds housed within a PICU the number of reported beds has increased in England (NHS) and England (non-NHS) due to changes in designation of funded beds or reporting in a small number of units over the three years 2017–2019.

Overall occupancy of IC beds, recorded as a snapshot in November each year shows high variation; in England (NHS) Figure 6 shows a small reduction from 93% in 2017 to 80% in 2019 and in Scotland IC bed occupancy is above 85% in all three years. This may be a limitation of data collection at 'census' time points'; or may indicate a change in provision of critical care or changing practice.

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 5 we present the data for midday on a Wednesday and Sunday and in Figure 6 we compare this data for a three year period 2017–2018.

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. The NHS England recent paediatric critical care review also used this information to inform their review of the service. PICS standard L3 – 704 (2015) 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?

Case ascertainment is a measure of the proportion of total admissions that are reported to PICANet. This is one aspect of data quality. 100% ascertainment would mean we received information for all admissions.

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 had been fulfilled. Figure 7 shows the proportion of admission records defined as complete within three months of patient discharge in each country and Figure 8 breaks this down further to look at individual PICUs.

What did we find?

Case ascertainment

In the 11 PICUs visited in between 01 April 2019 and 31 December 2019, we were able to independently validate the number of PICU admissions in nine units (82%). In these nine PICUs, we found that 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 database following the validation was undertaken, resulting in the number of PICUs reporting more than 99% of cases increasing to six.

Timeliness of data submission

The completeness of patients' admission data within three months of their discharge from the unit was 85.4% for the three year period from 2017 to 2019 across the UK (excluding Northern Ireland) and Republic of Ireland (Figure 7).

Figure 7: Proportion of admission records completed within 3 months of discharge by country of admission, 2017–2019
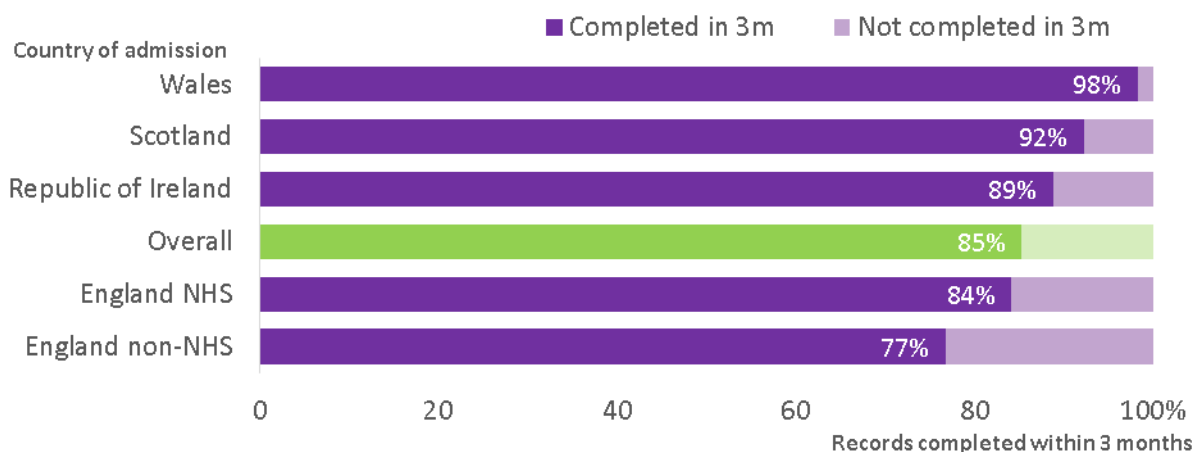
Northern Ireland excluded due to pause in data collection in 2018
The 'Overall' category combines all admissions and calculates the timely completion rate overall, it is not calculated by taking an average of each unit's completion rate

Northern Ireland was excluded when the reporting period was considered as a whole because data submission had to be paused in 2018 due to the introduction of the General Data Protection Regulation (GDPR) such that the unit could not submit within the required timelines.

Wales had the highest rate of timely completion at 98%, followed by Scotland at 92% and Republic of Ireland at 89%. Within England, 84% of NHS PICUs and 77% of non-NHS PICUs completed within 3 months.

Of the 31 PICUs (excluding Northern Ireland), 27 (87%) units had a timely completion rate of over 80% including nine units which had at least 98% of records complete within three months (Figure 8). One unit had 55% of data reported within the stipulated three month PICS standard and another had less than 50% of data reported within the timescale.

When the most recent year of the reporting period was considered alone (Figure 8a), nine units had 100% completion within three months and a further 12 units had over 95% timely completion. Overall 88% of records were completed within three months, up from 81% in 2017 and 82% in 2018.

Figure 8: Proportion of admission records completed within 3 months of discharge by PICU, 2017–2019

Organisation ZB excluded

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
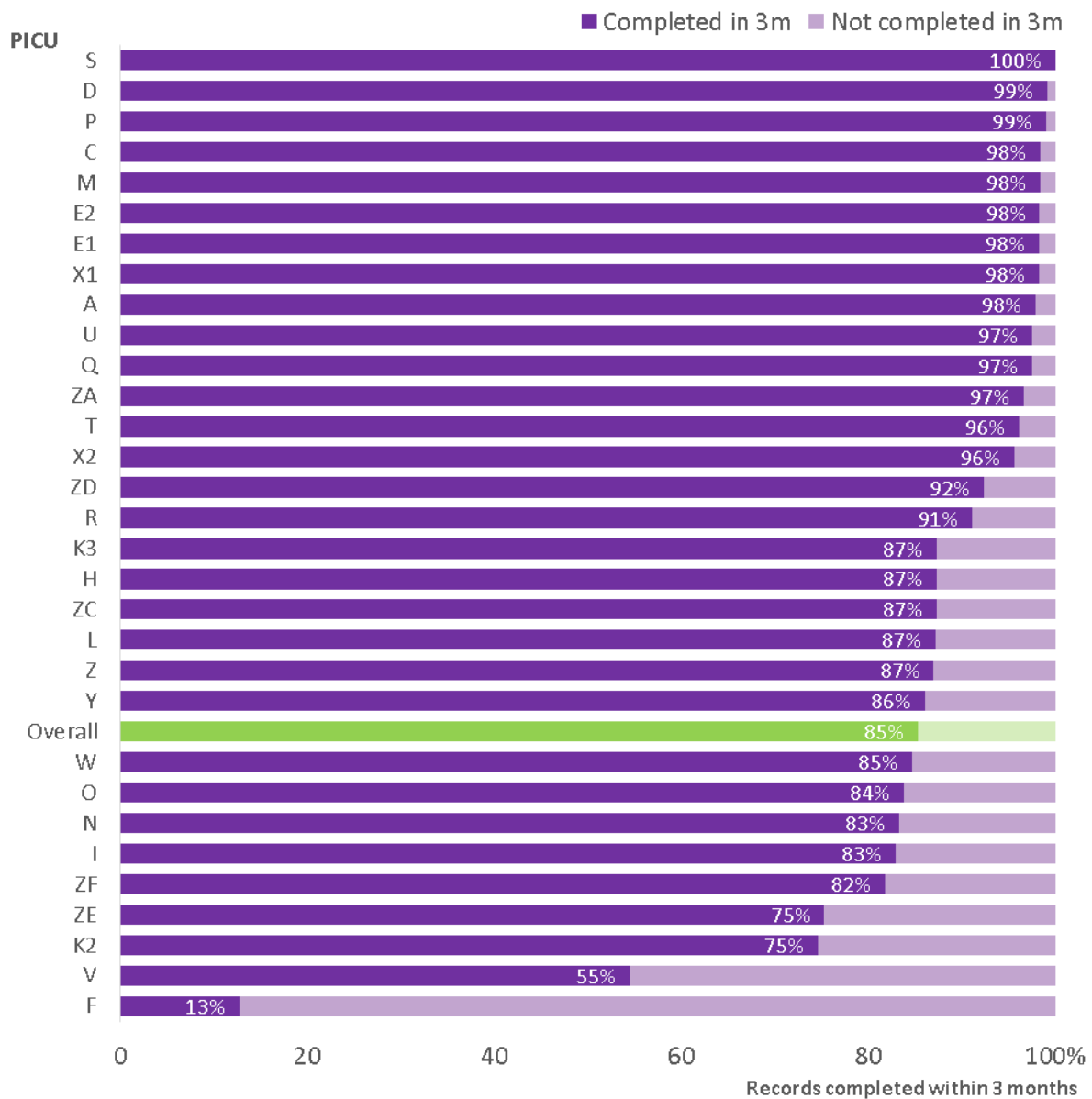
PICANet 2020 annual summary report

Figure 8a: Proportion of admission records completed within 3 months of discharge by PICU, 2019

Legend: ■ Completed in 3m ■ Not completed in 3m

PICU	Records completed within 3 months
ZF	100%
ZA	100%
W	100%
T	100%
S	100%
R	100%
P	100%
M	100%
I	100%
V	100%
X1	100%
C	99%
Q	99%
U	99%
D	99%
E1	99%
K3	99%
H	99%
E2	99%
L	99%
O	97%
A	96%
X2	95%
Z	88%
N	88%
Overall	88%
K2	85%
ZD	83%
ZE	80%
Y	70%
ZC	67%
ZB	3%
F	

Records completed within 3 months
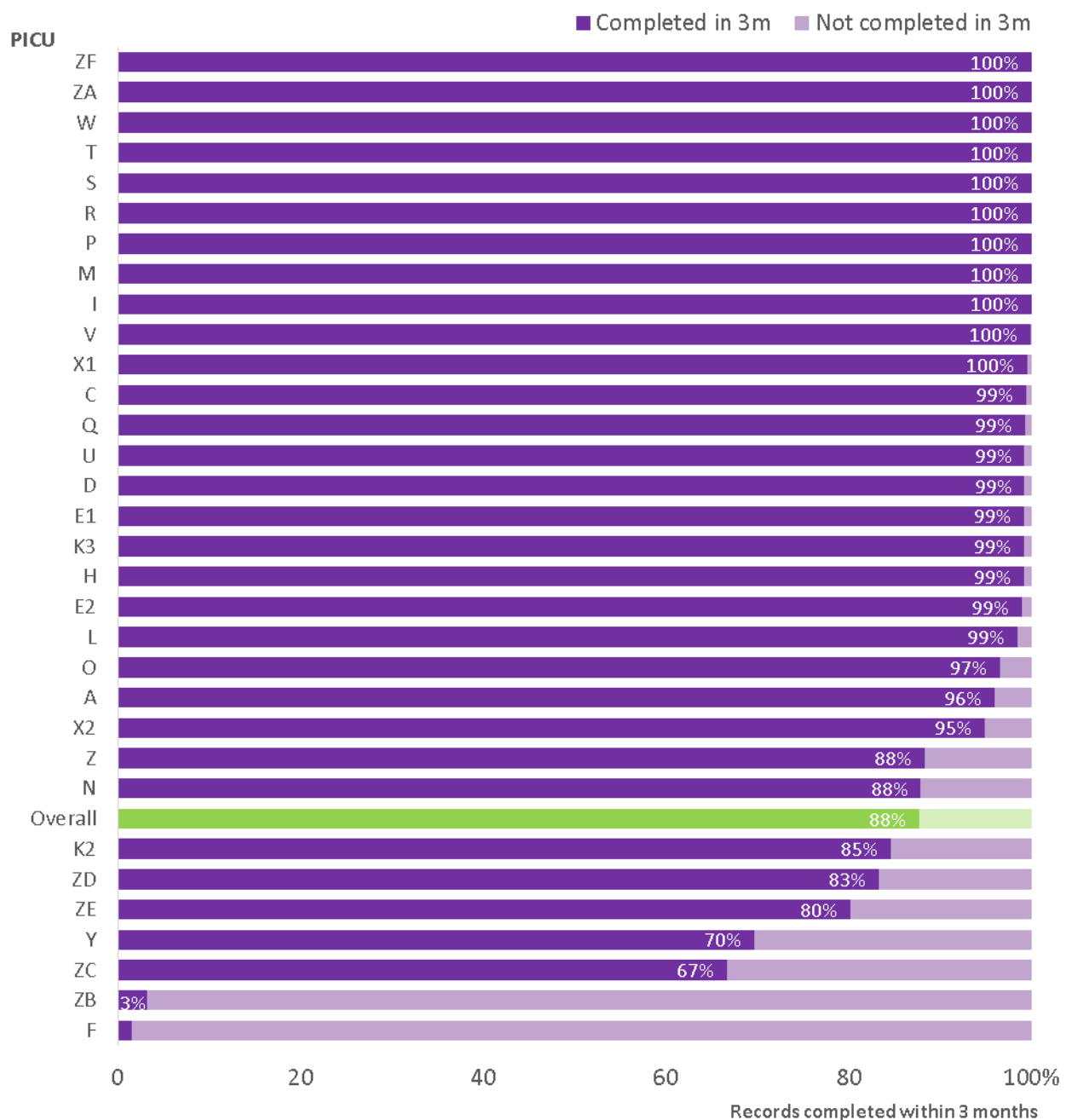
What does this mean?

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 the Republic of Ireland had high or very high standards of timeliness of submission of admission data. This is reflected in most units reporting the majority of their data within 3 months of patient discharge, although there were a small number of units which exhibited low rates of timely completion.

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. 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. Our high ascertainment rate therefore means 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.

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). For 2019, we have calculated how long it takes for the PIC centralised transport service (CTS) team to start their journey to pick up a child who needs urgent PIC following a clinical decision that PIC transport is required. The proportion of these journeys that started within 30 minutes, 31 to 60 minutes, 61 to 180 minutes, and over 180 minutes are presented for 2019 for the UK and Republic of Ireland overall. This information is summarised for the individual PIC transport teams.

What did we find?

More than half of the 12 organisations (T001, T002, T003, T004, T005, T008 and T024) mobilised within 30 minutes for more than half of the journeys. In 2019, five of the 12 specialist PIC transport services mobilised their team within an hour more than 75% of the time (Figure 9).

Findings for 2019 were very similar to 2018 with just under three fifths (59%) out of a total of 4,262 journeys started within 30 minutes. Similarly just over 3 in 4 journeys (77%) started within one hour after the decision was made that the child required urgent transport. Just over 1 in 20 journeys (6%) started more than three hours after this decision. For the three year period 2017-2019 (Figure 10) the time taken to mobilisation is quite consistent with at least 77% of journeys started within one hour of the decision to transport each year.

Figure 9: Proportion of non-elective transports mobilised by PICU CTS team by time to mobilisation: UK and Republic of Ireland, 2019
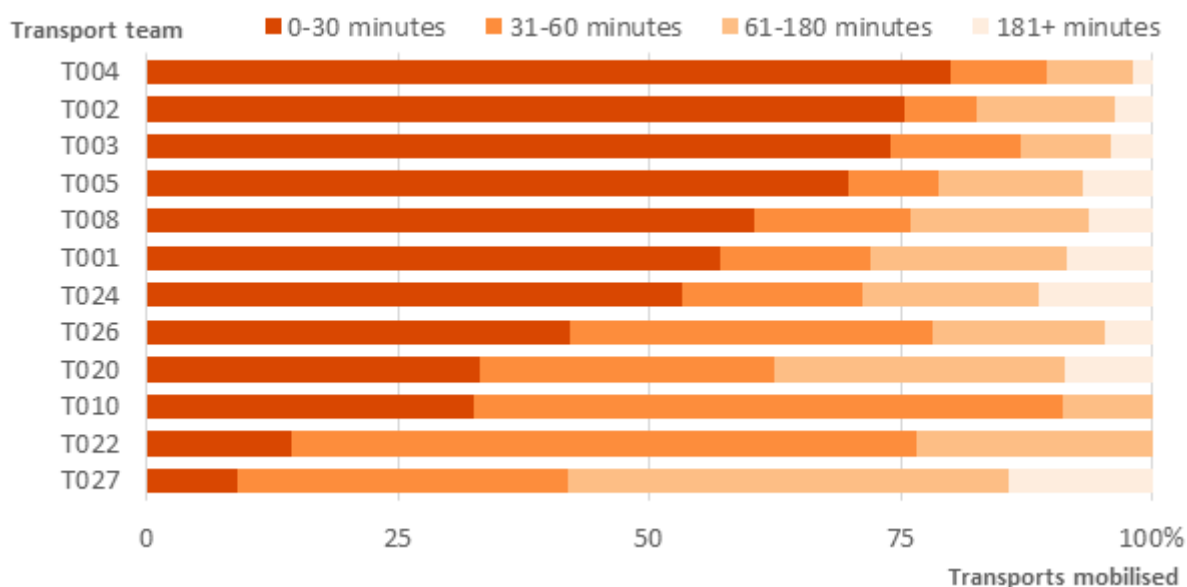
Organisations are ranked by the NHS England 30 minute target, from which Northern Ireland, Scotland, Wales and the Republic of Ireland are exempt

Figure 10: Number of non-elective PIC CTS transports mobilised by time to mobilisation: UK and Republic of Ireland, 2017-2019
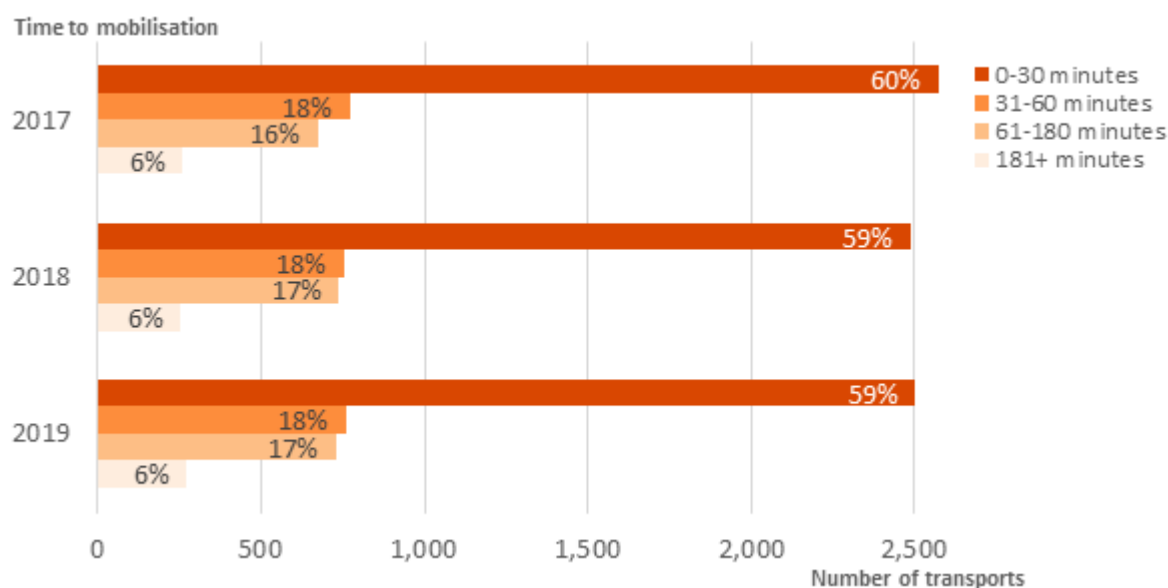
What does this mean?

In the vast majority of cases, PIC CTS 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 CTS 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.

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 CTS 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[4] 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 their establishment (i.e. total funded posts) and any vacant posts.

The Paediatric Intensive Care Society (PICS) Standards state a minimum number of 7.01 Whole Time Equivalent (WTE) qualified (registered) nurses are needed to staff one level 3 critical care bed (2015). 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. Previous PICS Standards (2010) endorsed the bench mark of 6.4 WTE qualified nurses to staff one level 3 critical care bed.

What did we find?

Overall, the establishment figures for PICUs across the UK and the Republic of Ireland show that in 2019 few units achieved either of the PICS standards. Six (18%) PICUs met 7.01 WTEs per bed of clinically qualified nurses; this increased to eight (25%) when non-registered health care staff (Bands 2-4) providing clinical care were included (Figure 11). Twelve (28%) PICUs met the previous standard of 6.4 WTEs (2010), without including non-registered staff.

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 standard of 7.01 WTEs per bed and 23 (69%) would meet the previous standard of 6.4 WTE.

Figure 11: Number of clinically qualified nurses and non-registered staff providing clinical care in post (WTE) per bed by health organisation, 2019
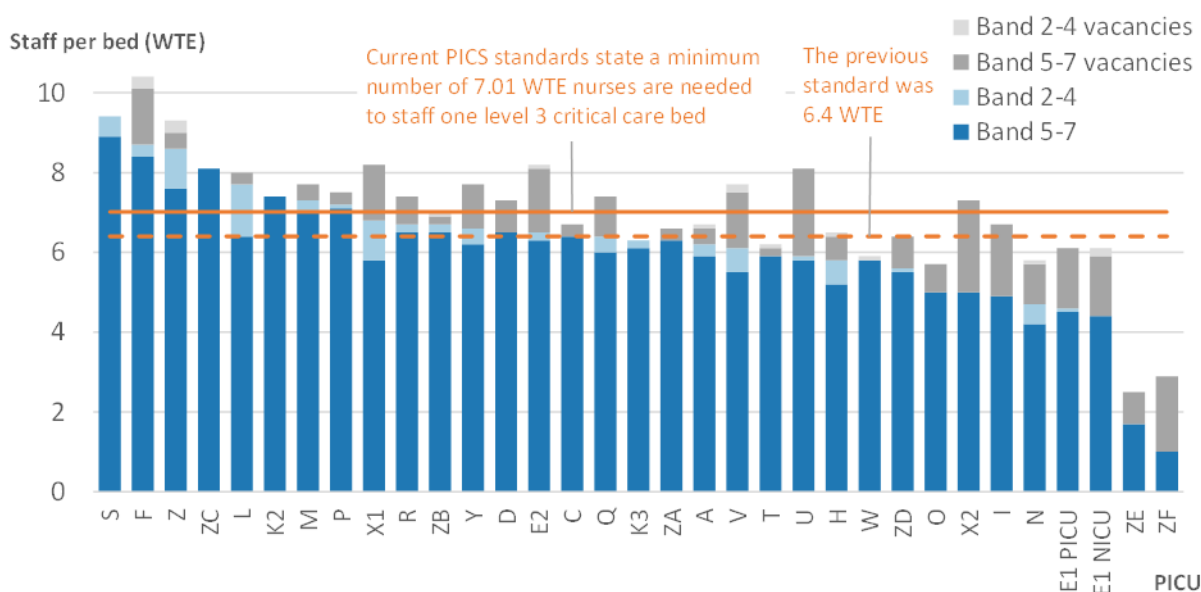
What does this mean?

Based on the data provided by UK and Republic of Ireland PICUs in November 2019, a quarter of PICUs met the recommended standard of the Paediatric Intensive Care Society. The addition of bands 2-4 delivering clinical care has enabled two 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. This may be achieved by unit staff working flexibly, undertaking additional shifts or using bank or agency staff. These data should be used to inform the future planning of PIC.

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 Intensive Care Society: currently the PICS Quality Standards for the Care of Critically Ill Children (5th Edition, December 2015). Staffing data are collected in the November of each year: for the week beginning 11 November in 2019, we present the percentage of PICUs meeting the recommended level of nurse staffing per funded critical care bed.

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 for Intensive Care (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 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. Staff recruitment and retention is currently under review as part of the paediatric critical care review. 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. There is also additional concern about the effect of the ongoing Covid-19 pandemic on staff retention and recruitment in intensive care.

Metric 4: Emergency readmissions within 48 hours

What are we measuring?

For each PICU, we record the frequency of emergency readmissions 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 12), 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 unit 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?

Between 330 and 350 children per year (or about 1.7 out of every 100 admissions) were discharged from PICU, but then readmitted as an emergency within 48 hours (Table 7). Rates of emergency readmissions remained fairly constant in England over the reporting period although there was a slight drop in 2019; Wales and Northern Ireland both saw a peak in emergency readmissions in 2018 with rates dropping again in 2019. Rates in Scotland slightly decreased in 2018 and this was sustained into 2019. In the Republic of Ireland, emergency readmission rates decreased slightly in 2018 but this was not sustained into 2019. The rate of readmission for individual PICUs over the three years of the reporting period combined ranged between 0.4% and 2.7%.

Table 7: Number of emergency readmissions within 48 hours 2017–2019

Country	2017	2018	2019	2017-2019
England	270 (1.7%)	272 (1.7%)	251 (1.6%)	793 (1.6%)
Wales	5 (1.0%)	16 (3.1%)	8 (1.6%)	29 (1.9%)
Scotland	32 (2.3%)	26 (1.9%)	32 (1.9%)	90 (2.0%)
Northern Ireland	5 (1.0%)	14 (2.8%)	8 (1.6%)	27 (1.8%)
Republic of Ireland	24 (1.6%)	18 (1.3%)	26 (1.7%)	68 (1.5%)
Total	336 (1.7%)	346 (1.7%)	325 (1.6%)	1,007 (1.7%)

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-years of the reporting period ranged from 0.3 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.

Looking at each of the organisations individually (Figure 12), over the three-year reporting period 18 PICUs had lower rates of emergency readmissions within 48 hours than the combined rate with 11 of these having lower than the combined rate across all three years separately. Higher rates were observed for 15 PICUs with four of these have a rate at least 1.5 times higher than the combined average.

Figure 12: Relative rate of emergency readmission within 48 hours of discharge by PICU 2017–2019
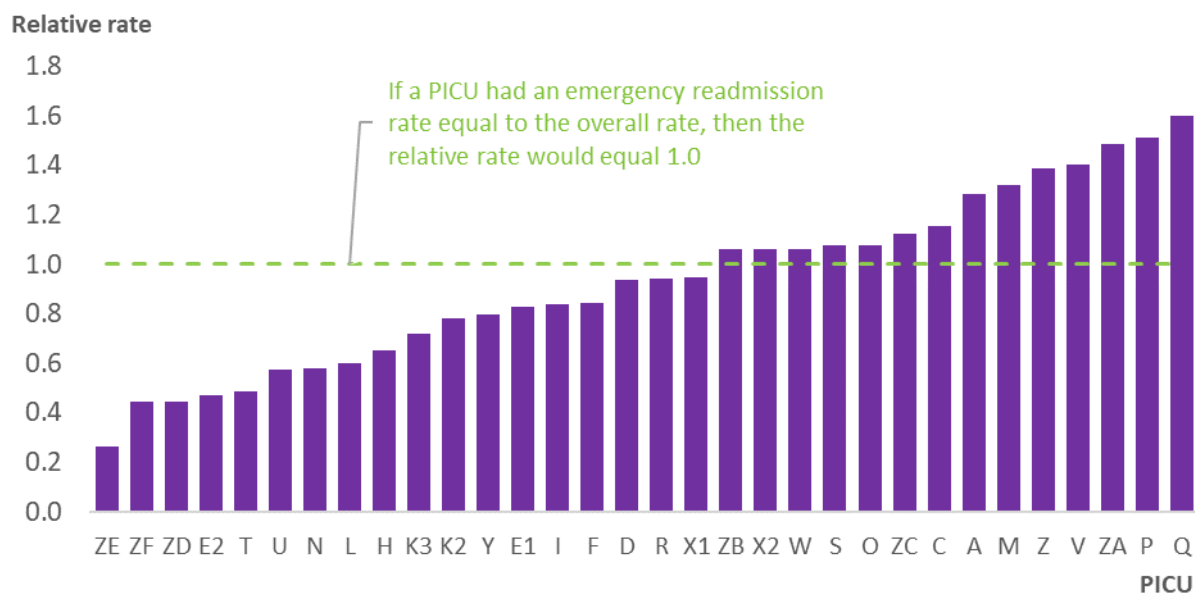
Emergency readmission rates for each individual unit are relative to the overall rate of 1.68, the horizontal dotted line shows where a bar would sit if a unit had an emergency readmission rate that was exactly the same as the overall rate

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 1.7 per 100 admissions. There was substantial variation in the relative emergency readmission rate between PICUs and within PICUs year on year.

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 3 (PIM3)[4], 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.

What did we find?

The risk-adjusted SMR for each PICU in the UK and Republic of Ireland is plotted in Figure 13 according to the number of admissions for the period from 2017 to 2019. For the three-year period combined there was no evidence that any PICU had an excess mortality rate compared to what would be expected. Three PICUs had a substantially lower mortality rate than would be expected even after allowing for natural variation, Middlesbrough, Edinburgh and Southampton.

Figure 13: Risk-adjusted Standardised Mortality Ratio (SMR) by health organisation, 2017–2019
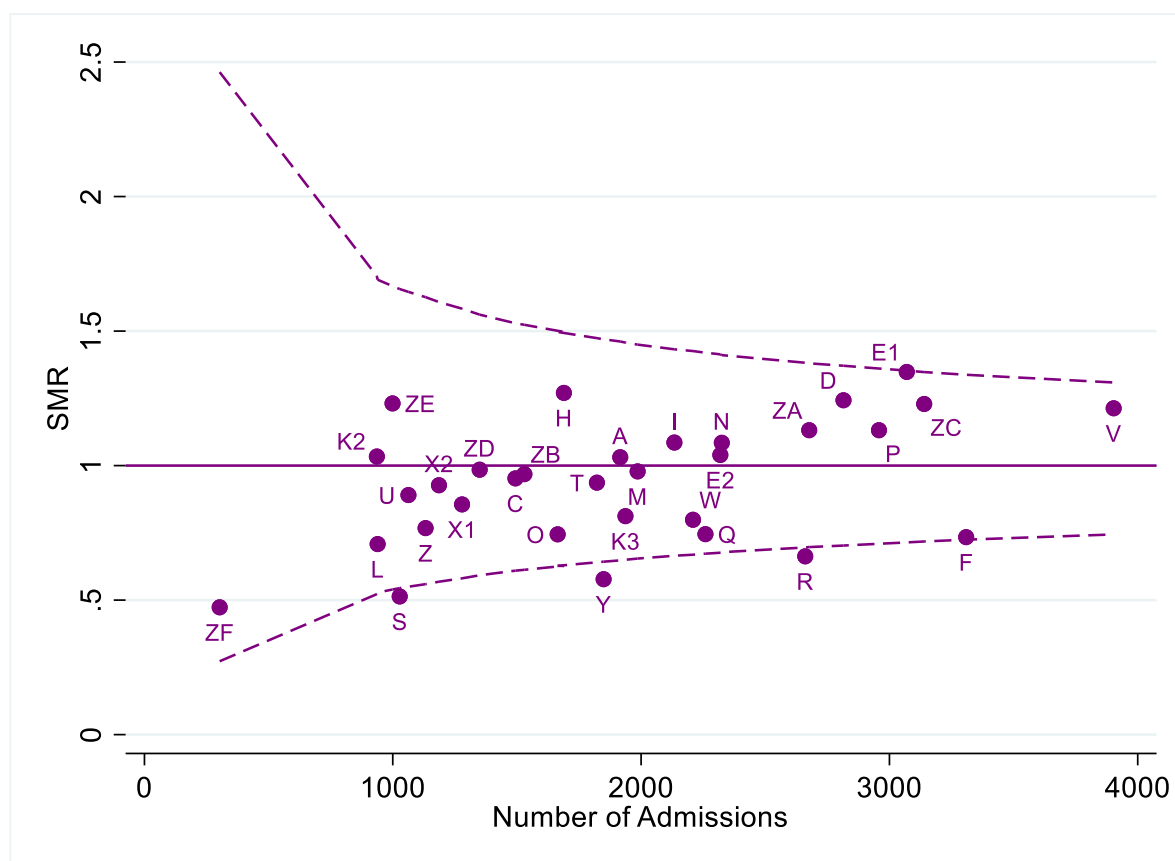
Risk-adjustment based on PIM3 calculations recalibrated in 2020

What does this mean?

After allowing for the level of sickness of the patient at the time of admission, no PICUs had a higher than expected mortality rate when the three-year reporting period was considered, and three PICUs had a substantially lower than expected mortality rate.

How to read a funnel plot

Figure 14 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 14: Example funnel plot
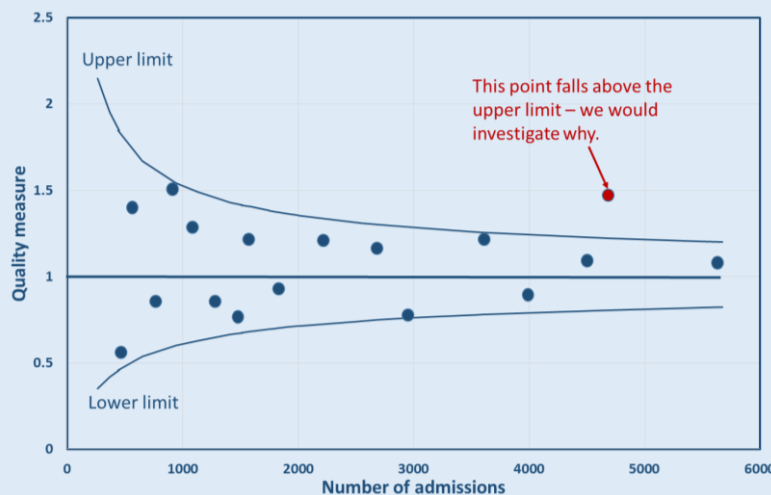
The blue dots represent individual PICUs. They are plotted from left to right (horizontal-axis) based on the number of admissions to each PICU.

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 14) 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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Additional information

Background

PICANet was established in 2001 with funding from the Department of Health and started collecting data from English and Welsh paediatric intensive care units in November 2002. The PICUs at the Royal Hospital for Sick Children, Edinburgh and the Royal Hospital for Children, Glasgow started submitting data in December 2004 and March 2007 respectively. The Royal Belfast Hospital for Sick Children joined in April 2008 and Children's Health, Ireland, Crumlin and Children's Health, Ireland, Temple Street, both based in Dublin, have submitted anonymised data to PICANet since 2009 and 2010, respectively. The Harley Street Clinic PICU started contributing data in September 2010, and the PICU at the Portland Hospital from October 2013, allowing both these non-NHS units to compare their performance against the national benchmark provided by PICANet.

A full list of participating PICUs can be found in Appendix A.

Governance

PICANet continues to receive support from the NHS Health Research Authority Confidentiality Advisory Group (NHS HRA CAG) (formerly the NIGB) to collect personally identifiable data without consent on infants and children admitted to paediatric intensive care.

See https://www.hra.nhs.uk/documents/2143/piag-register-master-2019_LzQaqan.xls

Ethics approval has been granted by the Trent Medical Research Ethics Committee, ref. 18/EM/0267.

PICANet supports transparency in its data processing and has patient information sheets and posters on display in PICUs and issues a Privacy Notice and Fair Processing Statement on its website outlining the legal basis for processing of data under the General Data Protection Regulations (May 2018). Details can be found at https://www.picanet.org.uk/.

PICANet receives support and advice from a Clinical Advisory Group (CAG) drawing on the expertise of doctors and nurses working within the speciality and a Steering Group (SG), whose membership includes Health Services Researchers, representatives from the Royal Colleges of Paediatrics and Child Health, Nursing and Anaesthetics, a lay member and commissioners. Appendices B and C provide a full list of CAG and SG members. Additional support from the clinical community is provided through the UK Paediatric Intensive Care Society.

Commissioning

The following organisations commission paediatric intensive care in the UK:

- England: NHS England Specialised Services
- Wales: Welsh Health Specialised Service Committee (WHSSC)
- Scotland: National Services Division of NHS National Services Scotland
- Northern Ireland: Health and Social Care Board

In the Republic of Ireland, Children's Health Ireland, Crumlin and Children's Health Ireland, Temple Street are both voluntary hospitals, funded by the Health Service Executive.

Methods

Basic methodology

Most critically ill children who need complex clinical care and life support are treated in Paediatric Intensive Care Units (PICUs). These children may have had complex surgery, an accident or a severe infection and may arrive in the PICU from an operating theatre, emergency department or from a hospital ward. In some cases they may have been transferred from another hospital and, rarely, admitted directly from home.

PICANet is an audit that collects personal, organisational and clinical data on all children with a clinically determined need for paediatric intensive care in the UK and Ireland, to compare outcomes and activity between PICUs and specialist transport organisations and also between health regions and nations.

Data are stored on a secure database. Each organisation is able to view and download their own data and reports on their data quality and activity as well as comparative national data. An annual report is produced each autumn that includes a summary of what has happened to children admitted to PICU including why they were admitted, where they were admitted from, how long they stayed, what treatments they received and their outcome at the time of discharge. Comparisons between PICUs are made to assess how well they perform against established clinical standards and guidelines.

In addition to the annual report, PICANet provides technical and statistical support for the use of its data for local audit and research, regional and national commissioning, national and international research and to provide baseline information for clinical intervention trials.

Participating organisations and data submission

PICANet has collected data from all PICUs in England and Wales since 2002. The two PICUs in Scotland, one from Northern Ireland and two from the Republic of Ireland, along with two non-NHS units based in London have joined PICANet at different times so that coverage is now for the whole of the UK and the Republic of Ireland. There are 32 PICUs and 12 specialist transport organisations currently submitting data to PICANet.

Data are submitted by individual PICUs prospectively, using our secure web-based data collection application with real-time online validation reporting, systematic monthly validation review by our research nurse and regular on-site validation visits. Data submission can involve direct entry of patient data or an upload of a data file from an existing clinical information system. PICANet provides full documentation on data definitions, which have been developed in collaboration with our Clinical Advisory Group, as well as technical specifications for IT and database professionals. In addition, standardised data collection forms are supplied to all organisations where there is no in-house provision for data collection.

Data collected

PICANet collects three core datasets:

Admission data contains demographic details of each child including their name*, date of birth**, NHS/CHI number, address* and ethnic group; it also records where children are admitted from, their date of admission and clinical diagnoses, some physiological parameters on admission including blood gases, blood pressure, medical history and ventilation status. Data on outcome and discharge details are included. The medical interventions received on each day by each child are recorded as part of the audit and to help NHS organisations in England to supply information on the cost of their activity.

Referral data for all children where clinicians agree a paediatric intensive care bed and/or paediatric intensive care transport is required includes details of the referring hospital, demographic details of the child, grade of the referring doctor or nurse, the outcome of the referral, the transport team involved and the destination PICU.

Transport data for all children transported to a PICU from their original admitting hospital or who are transported by a specialist PIC transport service but are not admitted to a PICU includes patient details as well as information about their presenting physiology. Details of the composition of the transport team, journey times, any interventions carried out and critical incidents are also recorded.

Additional data collection takes place to understand more about staffing on PICU:

Staffing data are collected each year in November to monitor staffing levels within PICUs as well as the PICS standards relating to staffing requirements.

* Not collected for data from Northern Ireland or the Republic of Ireland

** Limited to month and year for Northern Ireland

Analytical techniques

Statistical techniques used include simple cross tabulations, the calculation of crude and risk-adjusted SMRs and 95% confidence intervals; the construction of crude and risk-adjusted funnel plots of SMRs; and local provision of Risk Adjusted Resetting Sequential Probability Ratio Test (RA-RSPRT) plots to assess real-time performance related to in-PICU mortality. Risk adjusted SMRs were calculated using the latest version of the Paediatric Index of Mortality (PIM3[3]) recalibrated based on data within the current reporting period.

Assessing case ascertainment, data quality and validation

PICANet Web allows PICU staff to obtain reports on their own data to check monthly admissions totals. In addition, during validation visits by the PICANet research nurse a cross check is carried out against records held on PICU (such as admission books, or in-house data collection systems) and PICANet Web. These checks allow us to assess case ascertainment and the on-site validation visits are a core element of our data quality assurance process.

Data are validated online via PICANet Web using logic and range checks as well as flagging missing data items. The Modulus 11 algorithm is used to validate the NHS number based on a check digit – this is a standard method of ensuring the NHS number is a true NHS number and improves our ability to trace patients through the PICANet database and in linked healthcare data.

Collaborative working supporting policy, commissioning, research and clinical trials

PICANet has become established as the definitive source of data on paediatric intensive care activity in the UK and Ireland. Its data have been used to plan PIC services, model demand, assess interventions and outcomes and provide data to underpin research to facilitate the development of new standards for critical care provision for children. PICANet has provided baseline data for the development of the I-KID, SANDWICH and FEVER trials, all of which have been funded and will make use of the routinely collected PICANet data using the custom data download facility. This allows local control over the data. We are also working closely with a number of other funded studies, including DEPICT, ENACT, FIRST-ABC, LAUNCHES-QI, Neuro-PACK, OXY-PICU, PERMIT, PREVAIL and QualDash.

Small number policy

Publication of PICANet data is subject to scrutiny of small numbers. When small numbers of admissions are involved, other data items may become identifiable i.e. a living individual may be identified from the data. This is still the case in aggregated data where small groups of individuals are presented. These are reviewed and in some cases, categories are combined or cells anonymised where necessary.

Outlier policy

When unusual performance is detected following routine or bespoke analysis, which suggests that a PICU is an outlier, PICANet follow the established procedure outlined in our outlier policy, which relates specifically to assessment of risk-adjusted mortality.

Historically there have been three specific occasions where PICUs have been identified as outliers with excess risk-adjusted mortality. In two of these cases this was attributable to data quality issues and when corrected, the outliers fell within normal limits. In one case this was not attributable to data quality and resulted in internal and external reviews.

Links with the clinical community, patients and their families

PICANet has until recently had an active PICU Families Group comprising both Lay representatives (parents of children who are currently or have previously received paediatric intensive care) and a multidisciplinary group of health professionals including Family Liaison Sisters, critical care nurses, audit staff, PIC consultants and members of the PICANet team. Availability of Lay representatives has become difficult over recent years and so we are developing a Lay stakeholder group encompassing any PIC or disease specific support group that deals with parent or child PIC related issues to feed into the future development of PICANet. In addition, we have a standing lay representative on our Steering Group and work closely with the charity Well Child. To date, all communications we have had from patients/parents have been very positive, supporting PICANet and its work and requesting further information.

PICANet has the support of the Paediatric Intensive Care Society and the associated PICS Study Group, the PICANet Clinical Advisory Group and the Clinical Reference group which oversees Paediatric Critical Care and PCC transport.

Glossary

CAG	Clinical Advisory Group
CCG	Clinical Commissioning Group
CHI	Community Health Index
CTS	Central Transport Services
EC	Enhanced care
ECLS	Extracorporeal life support
ECMO	Extracorporeal membrane oxygenation
GDPR	General Data Protection Regulation
HD	High dependency
HFNCT	High flow nasal cannula therapy
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
PIC	Paediatric Intensive Care
PICANet	Paediatric Intensive Care Audit
PICS	Paediatric Intensive Care Society
PCCS	Paediatric Critical 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
UK	United Kingdom
WHSSC	Welsh Health Specialised Service Committee
WTE	Whole time equivalent

www.picanet.org.uk

picanet@leeds.ac.uk

University of Leeds

Richard Feltbower
Hannah Buckley
Sophie Butler
Victoria Hiley
Lee Norman
Benjamin Fox

PICANet
Leeds Institute for Data Analytics
School of Medicine
University of Leeds
Clarendon Way
Leeds
LS2 9JT

University of Leicester

Elizabeth Draper
Caroline Lamming
Lyn Palmer
Martin Perkins
Sarah Seaton

PICANet
Department of Health Sciences
University of Leicester
George Davies Centre
University Road
Leicester
LE1 7RH