Paediatric Intensive Care Audit Network

Annual Report 2018

Summary Report

Data collection period
January 2015–December 2017

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	Queen's 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	Our Lady's Children's Hospital, Crumlin, Dublin
ZD	Temple Street Children's University Hospital, Dublin
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
T016	ScotSTAR Paediatric Retrieval Service (Edinburgh)
T017	ScotSTAR Paediatric Retrieval Service (Glasgow)
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)

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

Acknowledgements

This work uses data provided by patients and collected by the NHS, the Health Service Executive or private hospitals as part of their care and support.

The continued success of this international clinical audit is due to the hard work and commitment of those within the paediatric intensive care community. We are very grateful to all the audit clerks, secretaries, nurses and doctors who support and contribute to the Paediatric Intensive Care Audit Network (PICANet) from their own paediatric intensive care units (PICUs) and centralised transport services (CTS).

PICANet was established in collaboration with the Paediatric Intensive Care Society (PICS) and their active support continues to be a key component of our successful progress. The PICANet Steering Group (SG) has patient, academic, clinical, government and NHS members all of whom are thanked for their continuing assistance and advice. Members of the Clinical Advisory Group (CAG) provide a formal interface between PICANet and the clinical care teams and their valuable support and contribution is gratefully acknowledged.

We are also grateful for the support and commitment given by members of the PIC Families Group.

Introduction

We are delighted to present the fifteenth annual PICANet clinical audit report describing paediatric intensive care (PIC) activity in the United Kingdom (UK) and Republic of Ireland (ROI). The purpose of PICANet is to improve critical care services provided to patients as part of PIC services by measuring the quality of care and outcomes against pre-determined standards, using data from the UK and Republic of Ireland as a whole as a benchmark.

We have again made minor changes to the layout and information presented in this year's Summary Report so that it is easier to read. In addition to the standard headline figures on PICU activity, mortality, transport referrals, staffing, occupancy and the five quality measures, we focus on referral and transport data examining the impact of winter pressures. We provide this information for the whole of the UK and Republic of Ireland, and by individual country.

This report provides information on five key metrics: case ascertainment, retrieval mobilisation times, number of qualified nurses per bed, emergency readmissions within 48 hours and mortality in PICU. However, for metrics such as unplanned extubation and emergency readmissions within 48 hours, there is no agreed standard as to the acceptable level. We therefore present each PICU in comparison to the overall average for the UK and Republic of Ireland. Importantly, PICANet will be in a position to contribute robust clinical audit data when needed so that these standards can be agreed and are evidence based.

Once again a comprehensive set of tables and figures have been produced, which complement the Summary Report and are available as a separate PDF document or for download as an Excel spreadsheet in addition to the Appendices. These represent crucial descriptors of PICU activity and outcomes across the UK and Republic of Ireland for both commissioners and clinicians, identifying key areas to focus on in order to improve PIC services at a local and national level.

PICANet continues to play a vital role within the Paediatric Critical Care Review, providing key intelligence on PIC activity and outcomes to support evidence based recommendations emerging from the Review, and which is expected to be published in 2019.

Richard Feltbower
Liz Draper

Principal Investigators

Key findings

- Across the UK and Republic of Ireland , there were approximately 20,000 admissions to paediatric intensive care per year in the period 2015–2017. There was a small reduction in the number of admissions in 2017 compared to 2016, attributable to all PICUs except those in the Republic of Ireland.

- The number of bed days delivered has fluctuated during the three year reporting period, with a higher number of bed days delivered in 2016. The decrease in 2017 is possibly due to the fall in the number of admissions in the same year.

- There was geographical variation in admission rates for paediatric intensive care, ranging from 124 and 141 admissions per 100,000 children in the Republic of Ireland and England to 184 admissions per 100,000 children in Northern Ireland in the 3 year reporting period.

- More than 96% of patients were discharged alive from PICU between 2015 and 2017, showing that the risk of death remains low. The proportion of deaths occurring in PICUs out of the total number of childhood fatalities in the population is around one in six.

- Unplanned extubation rates in PICU for 2017 were typically around 4 per 1,000 days of invasive ventilation for the UK and Republic of Ireland combined.

- Few agency and bank nursing staff are used on PICUs to provide care for critically ill children in the UK & Republic of Ireland during normal working hours. However in November 2017 in NHS hospitals in London 13.7% of the nursing staff working at midday on census Wednesday and around one fifth (19.8%) of nursing staff 'out of hours' on census Sunday at midday were bank or agency employees. No bank or agency staff were in use at any census point in either the Republic of Ireland or Wales in 2016 or 2017.

- Specialist PIC transport services provided a rapid response for 92% (15,978) of requests for emergency transport over the period 2015–2017. Fewer than 1 in 20 requests were not accepted due to a lack of PIC transport team availability.

- Reported rates of occupancy in PICUs were very high during the staffing census week with intensive care (IC) bed occupancy rates of at least 90% in England (NHS), Scotland and Northern Ireland and a high dependency bed occupancy rate of 100% in England (NHS) and Wales during normal working hours. Rates of bed occupancy showed little reduction 'out of hours' across the UK and the Republic of Ireland. However 'out of hours' rates for both IC and high dependency beds were low for Wales (33.3%, and 27.3%, respectively).

- For children requiring urgent transport, four out of five (78.2%) journeys were started within 1 hour. A small proportion (6.1%) of these journeys started more than 3 hours after the decision was made that the child required urgent transport.

- In 2017, of the specialist PIC transport services, eight out of 14 organisations (Figure 9) mobilised their team within 1 hour for more than three quarters of urgent transports, and mobilised within 30 minutes for 60.2% of all urgent transports.

- Overall the establishment figures for PICUs across the UK and Republic of Ireland show that in 2017 few units met the current PICS standards (n=3, 9% of PICUs), although if all the recorded vacancies for qualified nurses were filled (n=6, 18%), PICUs would have met 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.

- Virtually all admissions in 2017 were reported to PICANet so that our estimated case ascertainment was 99.4%. In terms of overall timeliness of data completion, 80% of units' admissions met the PICS standard for reporting to PICANet within 3 months of their discharge from the unit.

- We found that 1.6% of children admitted to PICUs were discharged and then readmitted as an emergency within 48 hours. Although these readmission rates varied by country, there was no evidence that any individual PICU discharged children too early during 2015–2017.

Recommendations

1. PICANet should continue to work with the Paediatric Intensive Care Society, the Care Quality Commission and other stakeholders to develop new quality indicators and an evidence-base for current standards and quality metrics reported by PICANet, in particular unplanned extubation and emergency readmission within 48 hours.

2. PICANet should continue to monitor trends in admissions and number of bed days delivered to confirm whether the stabilisation in activity levels in 2017 is sustained.

3. PICANet should work with PICUs and the Paediatric Intensive Care Society to consider whether the current clinical standards for the minimum number of qualified nurses per critical care bed are appropriate. This should be carried out in conjunction with the Royal College of Nursing and the National Paediatric Critical Care Review.

4. National nursing professional bodies should develop recruitment and retention initiatives for paediatric intensive care nurses to ensure all PICUs have adequate staffing levels.

5. Paediatric intensive care centralised transport service teams should continue to monitor mobilisation response times for retrievals and urgent transport of children to PICUs.

6. The high levels of occupancy in designated intensive care and high dependency beds in PICUs should inform the recommendations emerging from the National Paediatric Critical Care Review.

7. PICANet should work with PICUs to develop support processes that will enhance the timeliness of data.

How we present our results

Results are presented in tables, figures and as maps. We use what are called 'funnel plots' to compare individual PICUs with the overall average for the UK and the Republic of Ireland for a number of the outcomes we measure including: mortality, emergency readmissions within 48 hours and unplanned extubation. Each measure is explained in the results and metrics sections of this report under the heading "What are we measuring?"

We describe below how funnel plots should be interpreted.

Figure 1: Example funnel plot
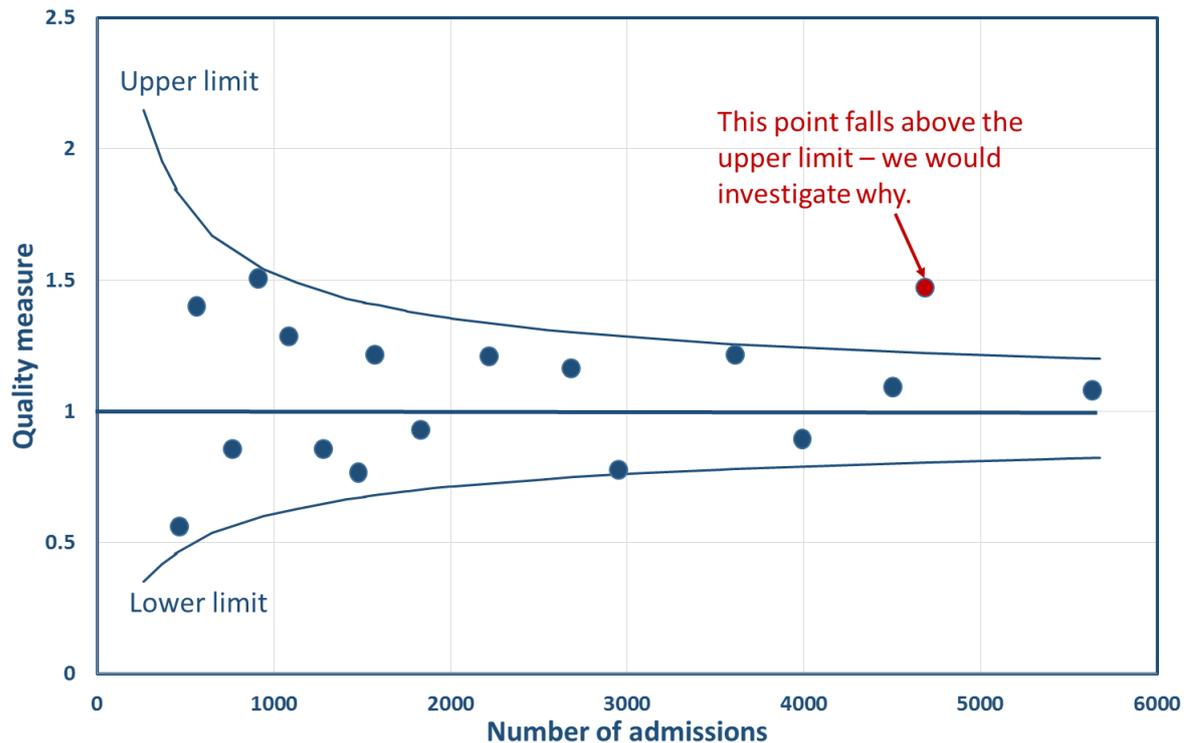
Figure 1 is a simple diagram of what a funnel plot might look like. The 'funnel' is created using statistical methods that tell us what range of values we might expect for each measure, given that there are normal 'ups and downs' (natural variation). The limits are wider where there are fewer admissions because with only a few values we cannot be as certain about our findings. With more values we can be more confident that the outcome is likely to fall within narrower limits.

The blue dots represent the individual PICUs with different numbers of admissions. The red dot indicates a PICU that is outside the upper limit. We say that this is 'statistical outlier' and we have a process for investigating why this has occurred.

The blue line in the middle of the funnel represents the ratio where the observed and expected number of events are equal for each outcome based on the UK and the Republic of Ireland findings as a whole. You would always expect a scatter of dots above and below this line if you know the average. The whole point about funnel plots is to allow us to see differences between units taking into account natural variation.

Headline figures: Admission numbers and bed days

What are we measuring?

Table 1 and Table 2 below summarise the **number of admissions** to paediatric intensive care units in the UK and Republic of Ireland between 2015 and 2017 among children aged under 16 years and the **number of bed days** of paediatric intensive care that were delivered during this period.

What did we find?

On average, there were approximately 20,000 annual admissions to PICUs in 2015, 2016 and 2017 across the UK and Republic of Ireland, although there was a slight fall in 2017 in all countries except the Republic of Ireland and the English non-NHS PICUs. The number of bed days provided fluctuated throughout the 3 year reporting period in all the admitting countries with a consistent peak in 2016 in most countries with the exception of Northern Ireland.

Table 1: Number of admissions by country and year

Country	2015	2016	2017
England (NHS)	15,811	15,964	15,462
England (non-NHS)	270	336	502
Wales	466	530	493
Scotland	1,321	1,487	1,393
Northern Ireland	630	557	522
Republic of Ireland	1,397	1,401	1,463
Total	19,895	20,275	19,835

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

Country	2015	2016	2017
England (NHS)	107,700	113,827	110,174
England (non-NHS)	3,292	3,473	2,413
Wales	2,353	2,757	2,451
Scotland	8,747	11,020	10,768
Northern Ireland	3,822	3,480	3,695
Republic of Ireland	10,174	10,319	9,607
Total	136,088	144,876	139,108

What does this mean?

There continues to be high demand placed upon paediatric intensive care services in the UK and Republic of Ireland based upon the number of patient admissions and bed days delivered. Substantial variation in service demand by country demonstrates the need for continued careful monitoring in the future.

Further details

Definitions and methods

Every admission to a PICU in the UK and the Republic of Ireland is counted for each year, 2015–2017. If a child has been readmitted during that period this will also be counted. A 'bed day' is counted if a child is in a PICU bed for a day or part of a day. We have only given figures for children less than 16 years old (the normal age limit for admission to PICU) and have excluded any admissions where the age at admission was unknown.

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 is being considered by the current Paediatric Critical Care Review for England.

Headline figures: Admission rates by country

What are we measuring?

Annual rates of admissions to PICU between 2015 and 2017 are presented in Figure 2 below by country, calculated per 100,000 children in the population. This identifies what fraction of the childhood population are treated by paediatric intensive care services in each country every year.

What did we find?

Rates were highest in Northern Ireland, reaching 184 admissions for every 100,000 children, followed by Scotland (163), Wales (144), England (142) and the Republic of Ireland (124). For the UK and Republic of Ireland combined, admissions rates were 143 per 100,000 population per year.

Figure 2: Rate of admissions per 100,000 childhood population 2015–2017

Prevalence for Admission

	123.9
	141.5
	144.4
	162.8
	184.4
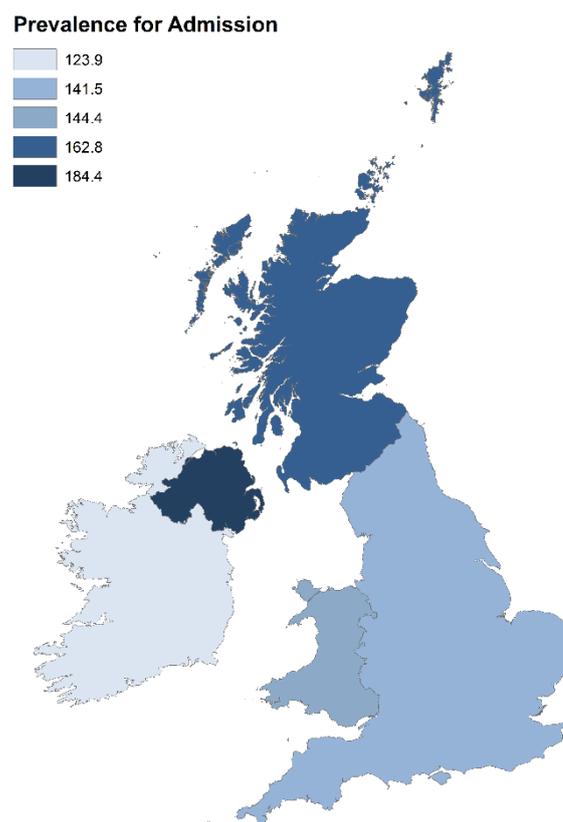
What does this mean?

There is clear geographical variation in admissions rates to PICU by country, with Northern Ireland for example exhibiting 50% higher rates compared to the Republic of Ireland. The reasons for these differences are likely to be complex and multifactorial but could include the proximity of patients to the PICUs, variation in admission policies between countries and the extent of other services available to treat critically ill children.

Further details

Definitions and methods

Having counted the admission numbers, we have then worked out how many admissions there are for every 100,000 children under 16 in each of the UK countries and the Republic of Ireland in 2015–2017. This is called the admission rate. We have used national census data to find out what the childhood population is 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.

Headline figures: Death in PICU

What are we measuring?

All deaths that occur prior to discharge from PICU are recorded and reported here for children under 16 who were admitted between 2015 and 2017. Deaths were broken down in two ways: firstly, based on the country of admission (i.e. PICU location) and secondly based on the patient's recorded country of residence.

What did we find?

Table 3 summarises the number of deaths in PICU by country of admission and year. The percentages are calculated based on the total number of admissions for that year. For the UK and Republic of Ireland there were 2,179 deaths in total over the three years. This means that for every one hundred children admitted to PICU at least 96 are discharged alive. Table 4 presents the number of deaths in PICU based on the country of residence alongside the total number of deaths in the population. The percentages of PICU deaths are calculated based on the total number of deaths in the population registered for each year. For the UK and Republic of Ireland from 2015–2017, PICU deaths accounted for 16% of the total number of children's deaths.

Table 3: Number of deaths in PICU by country of admission and year

Country of admission	2015	2016	2017
England (NHS)	626 (4.0%)	576 (3.6%)	598 (3.9%)
England (non-NHS)	5 (1.9%)	9 (2.7%)	3 (0.6%)
Wales	8 (1.7%)	11 (2.1%)	10 (2.0%)
Scotland	30 (2.3%)	36 (2.4%)	35 (2.5%)
Northern Ireland	20 (3.2%)	9 (1.6%)	18 (3.5%)
Republic of Ireland	72 (5.2%)	53 (3.8%)	60 (4.1%)
Total	761 (3.8%)	694 (3.4%)	724 (3.7%)

Table 4: Number of deaths in PICUs as a proportion of all children's deaths in the population: UK and Republic of Ireland, 2015–2017

Country of residence	2015	2016	2017
UK	675 (15.8%)	624 (14.9%)	644 (15.6%)
Republic of Ireland*	67 (22.0%)	51 (18.2%)	52 (20.1%)

* For 2016 and 2017, the numbers of total deaths for the Republic of Ireland are provisional and subject to change

What does this mean?

Risk of death in paediatric intensive care remains rare, with 96.4% of patients being discharged alive between 2015 and 2017. Deaths in PICU account for about one in every six of all children's deaths in the UK and 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 2015 to 2017 (Table 3). The percentages in Table 3 are based on the number of admissions to PICUs over this period, not the number of individual children. In Table 4 we present deaths on PICUs (2015–2017) as a proportion of **all child deaths** in the UK and the Republic of Ireland.

Why is this important?

Death on PICU is rare and the rate of PICU death has reduced year on year since PICANet started collecting data in 2002: It is important to record the number of deaths to facilitate the investigation of these trends over time. It also highlights any differences in death rates between countries. Where there are very small numbers of deaths we need to be cautious about 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 down their throat connected to a machine: this is called **invasive ventilation**. If the tube is accidentally dislodged, this is referred to as **unplanned extubation**. Here we measure the number of unplanned extubations for every thousand days of invasive ventilation.

What did we find?

In 2017 the number of unplanned extubations in the UK and Republic of Ireland was 260 out of a total of 68,000 days of invasive ventilation. This is equivalent to a rate of 4 unplanned extubations for every 1,000 days of invasive ventilation. Figure 3 shows the rate of unplanned extubation by organisation.

Table 5: Unplanned extubations per 1,000 days of invasive ventilation: UK and Republic of Ireland, 2017

Country	2017	
	Number	Rate
England (NHS)	210	4
England (non-NHS)	0	0
Wales	3	3
Scotland	21	5
Northern Ireland	5	3
Republic of Ireland	21	4
Total	260	4

Figure 3: Unplanned extubation ratios by health organisation 2017
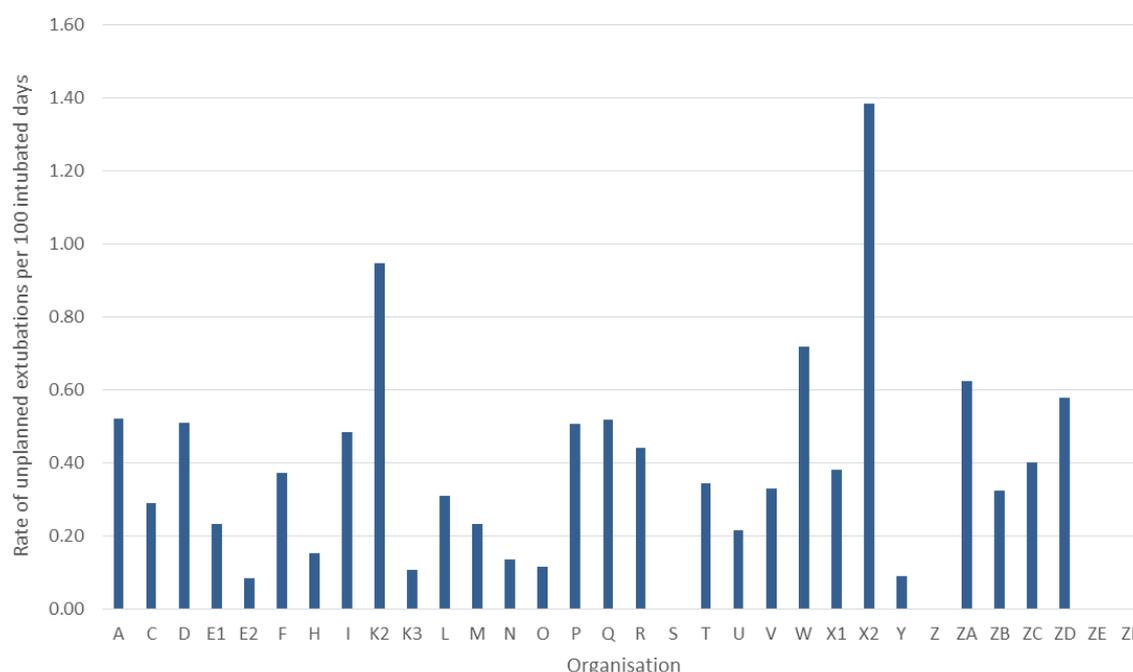
What does this mean?

Unplanned extubation remains a relatively rare event within paediatric intensive care services with a recorded annual rate of 4 per 1,000 days of invasive ventilation on average.

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 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. That makes comparisons between units with different volumes of invasive ventilation possible. Unplanned extubation is referred to as an 'adverse event'. Data for this analysis was limited to 2017 admissions only.

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[1]. 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[2]. Kanthimathinathan and colleagues do refer to a notional threshold of 1/100 invasive ventilation days, which is equivalent to 10/1000 days[1]. 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[1]).

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 2015–2017, 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?

We recorded details of the 17,395 referrals for PIC transport, of which 92% (15,978) were accepted for transport. Less than 1 in 10 (1,408) were not accepted for transport and of these just over half (53.5%) were refused because no PIC transport team was available (Figure 4). Reasons for the remaining refusals were due to the condition of the child being assessed as time critical (22.2%) or that the transport of the child could be delivered appropriately by another team (24.3%) known as being 'out of scope', for example a neonatal transfer team who provide transport for small babies.

Figure 4: Reason transport not undertaken following referral for urgent paediatric intensive care transport: UK and Republic of Ireland 2015–2017

Reason for refusal

Reason for refusal	Percentage
No transport team available	53.5%
Out of scope of care	24.3%
Time critical transfer	22.2%

Number of referrals
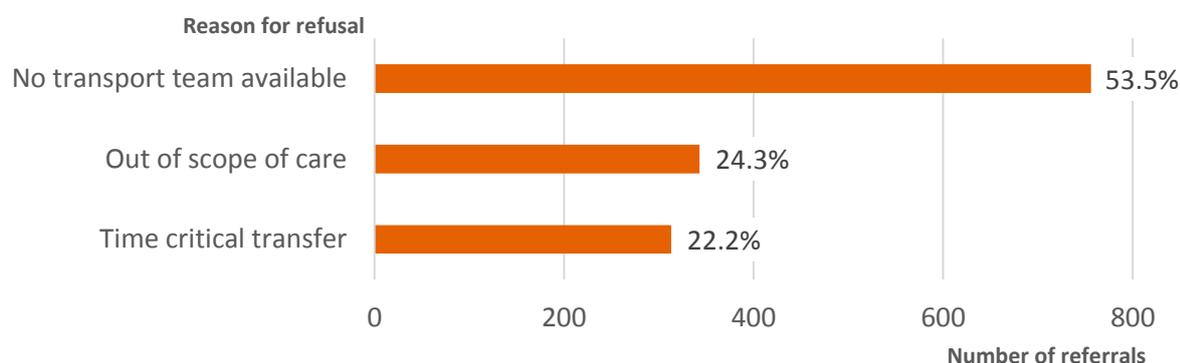
What does this mean?

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 2015–2017 the specialist PIC transport service were able to provide a rapid response to over 90% of requests for transport.

When the transport team refuse the referral because they are already busy with other transfers (53.5%), 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, we have recorded the reasons given by the transport teams.

Why is this important?

In 2015 to 2017 15,978 (91.9%) referrals were accepted for urgent transfer to PIC. Of the 1,408 refusals 753 (53.5%) were refused because there was no PIC team available. 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).

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: Use of bank and agency nurses

What are we measuring?

In the PICANet annual staffing survey we record the proportion of qualified nursing staff that were from a bank or agency on duty in PICUs during 'normal hours' and 'out of hours'. Here we present these results for a Wednesday and a Sunday at midday in November 2015, 2016 and 2017 for the UK countries and the Republic of Ireland.

What did we find?

The largest proportion of bank and agency nursing staff working during both 'normal hours' and 'out of hours' in 2017 was in the London PICUs: 13.7% midday Wednesday and 19.8% midday Sunday. No bank and agency staff were used in Wales, Northern Ireland and the Republic of Ireland at the 'normal hours' midday census point on a Wednesday. However, at the 'out of hours' census point on midday Sunday Northern Ireland reported using 8.3% of bank and agency staff.

Figure 5: Percentage of bank and agency nursing staff working on PICU midday Wednesday ('normal hours') and midday Sunday ('out of hours'), November 2015–2017
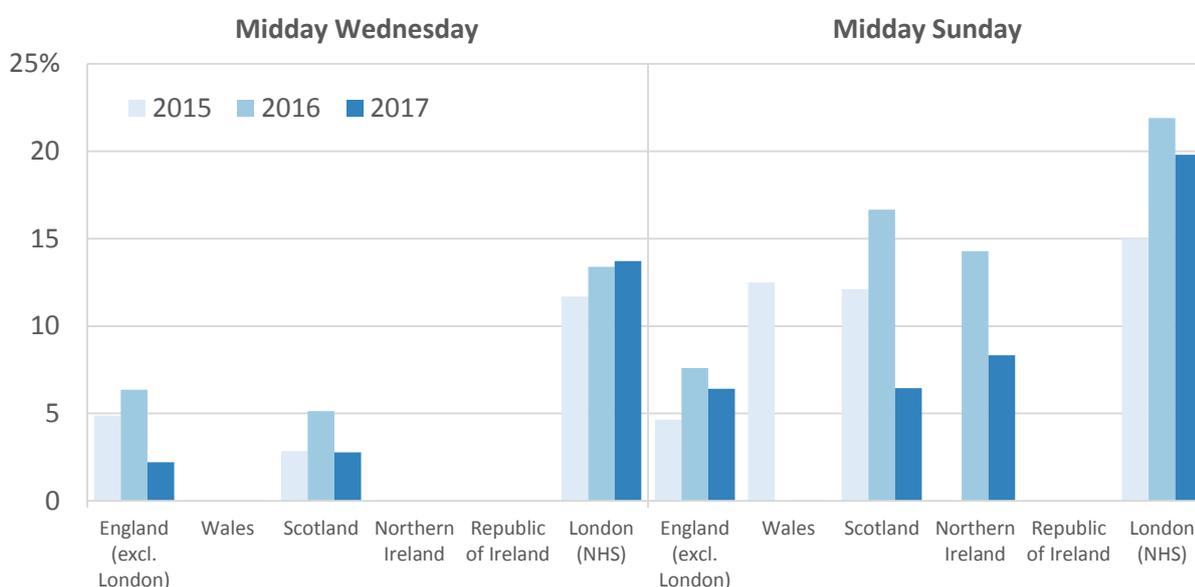
What does this mean?

At both presented census time points the main use of bank and agency nursing staff is in the London PICUs where at midday Wednesday they comprised just under one eighth of the nursing workforce and at midday Sunday this was even higher at around one fifth of the nursing workforce. Use of agency and bank staff may be a reflection of the additional pressures on nurse staffing in London. There is a large demand for staff in London where around one third of English PICUs are located.

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 is collected in the November of each year. Figure 5 compares the findings from 2017 with the two previous years: 2015 and 2016.

In 2017 questionnaires were sent to the lead doctor and senior nurse in each PICU. Information was collected on the medical and nurse establishment for each PICU including details of any vacant posts due to illness, maternity leave or if posts are unfilled during the week beginning 20 November. Completed questionnaires were received from all PICUs.

Details were collected about the number of staff working at four 'snapshot' time periods: a weekday and weekend at noon and midnight including the use of any bank and agency nursing staff. For the purposes of calculating the 'normal hours' use of bank and agency nursing staff, information was analysed using the data from Wednesday at noon (Figure 5). 'Out of hours' use of bank and agency staff was recorded for a Wednesday at midnight, Sunday at midday and Sunday at midnight (Figure 5). Determination of whether each PICU met the appropriate PICS standard are calculated using information about the number of children being cared for on each PICU and the level of care they required.

Why is this important?

PICUs need to be able to monitor whether they have adequate nursing staff available to run their unit efficiently. Use of bank and agency staff highlights problems with current staffing levels which may be due to staff illness or problems with staff recruitment and/or retention.

Many PICUs use regular hospital bank staff who are familiar with unit policies, working practices and equipment.

Use of staff provided by an external agency may compromise the efficiency of the unit in terms of team working and a lack of continuity of care. In addition these staff may have limited knowledge about unit policies, working practices and equipment and may not be able to administer medication until they have been assessed as competent. The use of bank and agency staff places an additional financial burden on the hospital.

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

What are we measuring?

The annual staffing study for PICANet also 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 20 November 2017 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 2017 at least 90% of intensive care beds were occupied in England (NHS), Scotland and Northern Ireland and 100% of high dependency beds were occupied in England (NHS) and Wales.

At the 'out of hours' census point at midday on a Sunday similar levels of IC bed occupancy were reported for England (NHS) and Northern Ireland (more than 90%) although these occupancy levels were only around one third for Wales. 'Out of hours' occupancy for HD beds was reported as 100% in the Republic of Ireland and 90% in England (NHS) with low rates of around a quarter being reported for Wales.

Figure 6: Percentage of funded critical care beds occupied at midday Wednesday and midday Sunday in November 2017
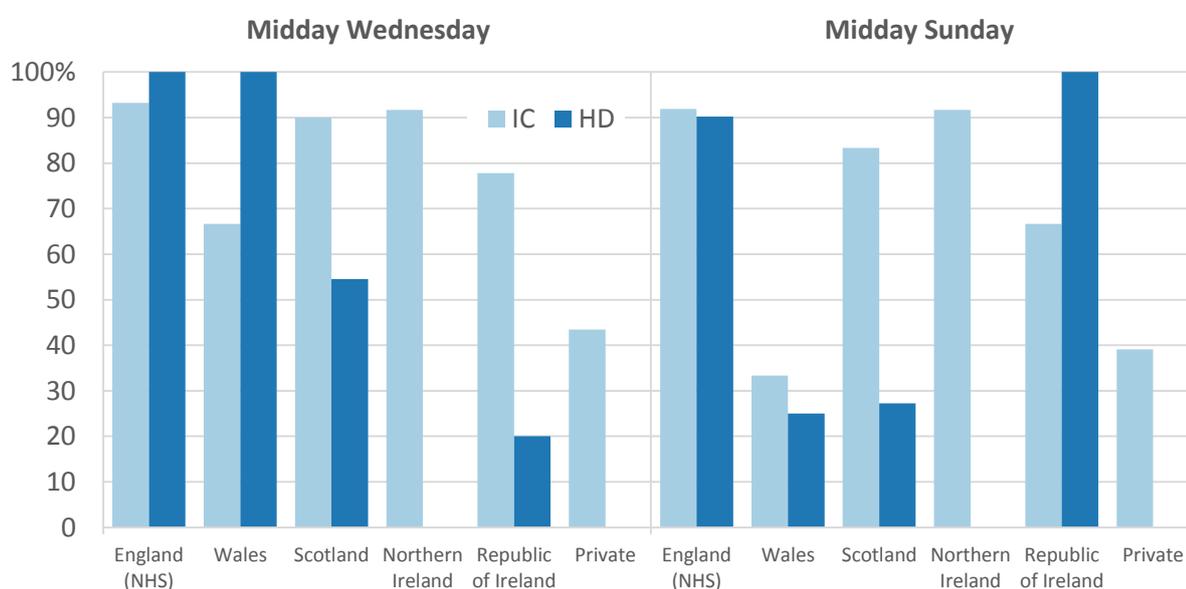
What does this mean?

Across the UK reported bed occupancy rates in PIC remain high both during 'normal hours' and 'out of hours'. This reflects the ongoing increase in activity in PICUs observed over since the start of PICANet in 2002–03. PICANet data is being analysed and used to inform the current paediatric critical care review in England.

Further details

Definition and methods

Information about bed occupancy is collected each year as part of the PICANet staffing study. The survey collected details about the total number of open and funded 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) were then calculated. In Figure 6 we present the data for midday on a Wednesday and Sunday.

Why is this important?

Information about levels of bed occupancy are important for both the commissioners and providers of PIC to ensure that there is adequate provision of paediatric critical care beds and is important information for the current paediatric critical care review being carried out in England. PICS standard 180 (2010) states that average bed occupancy on the unit should not exceed 80%. 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 80% 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 how many admissions 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 within 3 months of discharge – a requirement of the PICS standards.

What did we find?

In the 15 PICUs visited in 2017, we found that almost all admissions were reported to PICANet. In 2017 our case ascertainment was estimated to be 99.4%. The completeness of patients' admission data within 3 months of their discharge from the unit was 79.9% for the three year period from 2015 to 2017. There was some variation in 3 month completeness between PICUs in different countries (Figure 7).

Figure 7: Proportion of records completed within 3 months of discharge by country of admission 2015–2017
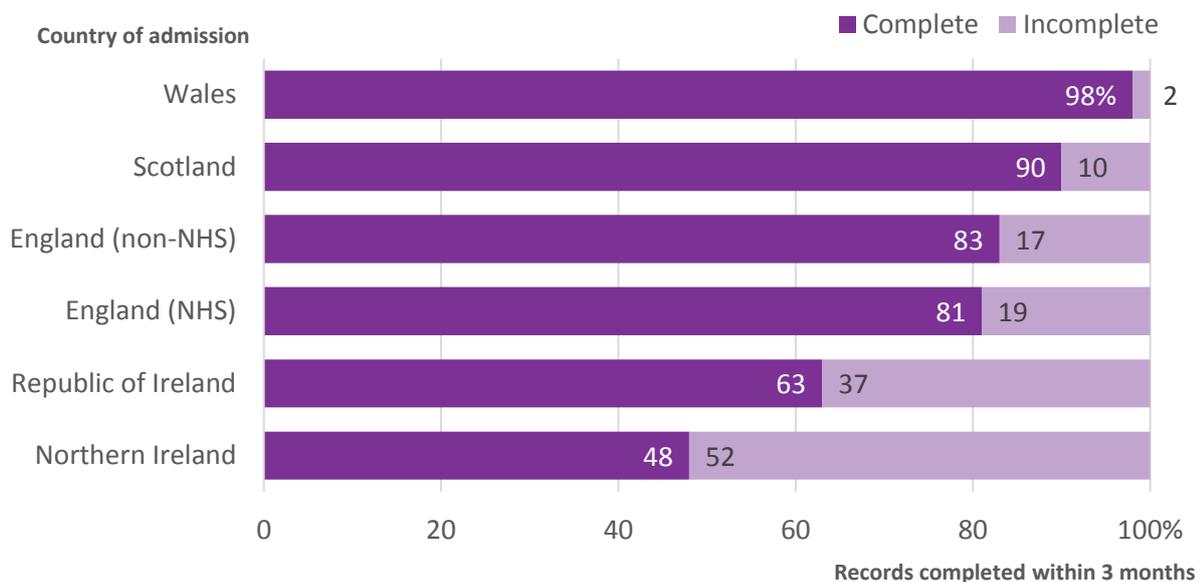
What does this mean?

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 and Scotland had high or very high standards of timeliness of submission of admission data, although Northern Ireland and the Republic of Ireland displayed lower levels of data timeliness.

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. We also monitor the timeliness of data completion, benchmarking against the PICS standard for reporting admissions to PICANet within 3 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 are 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 rates 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 is 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 2017 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. We present the proportion of these journeys that started within 30 minutes, 31 to 60 minutes, 61 to 180 minutes and over 180 minutes for the UK and Republic of Ireland overall. This information is summarised for the individual PIC transport teams.

What did we find?

Overall, just under four fifths of journeys (78.2%) were started within 1 hour, with just over 1 in 20 journeys started more than 3 hours after the decision was made that the child required urgent transport (Figure 8).

Of the specialist PIC transport services, eight out of 14 organisations (Figure 9) mobilised their team within 1 hour for more than three quarters of urgent transports in 2017. Of these journeys for urgent transport 60.2% were mobilised within 30 minutes.

Figure 8: Number of non-elective PIC CTS transports mobilised by time to mobilisation: UK and Republic of Ireland, 2017
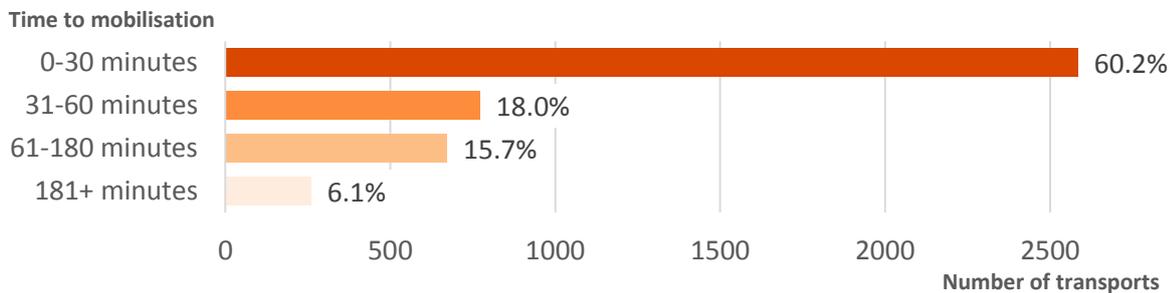

Figure 9: Proportion of non-elective transports mobilised by PICU CTS team by time to mobilisation: UK and Republic of Ireland, 2017
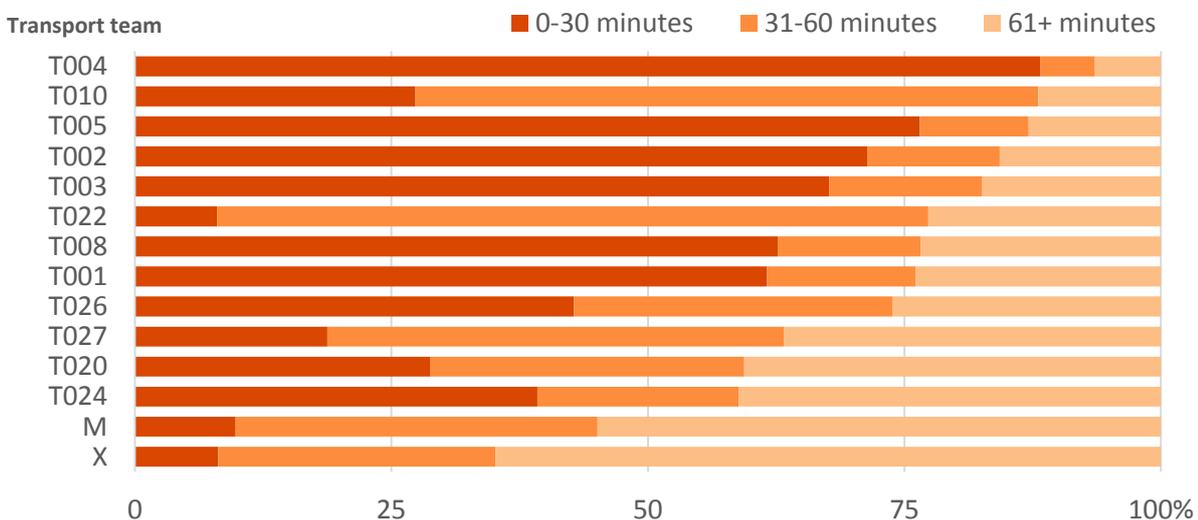
What does this mean?

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 Care Quality Commission have said that the target should be under 1 hour although most 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.

Some journeys may require road and air transport which will require 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 1 hour. 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.

Prior to the launch of COMET (T027) in March 2017 the East Midlands Paediatric Transport Service provided the transport for X1 and X2. This is represented as X in Figure 9.

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 performance, enabling the transport organisations to make changes to improve the quality of their service if appropriate.

Metric 3: Number of qualified nurses per bed

What are we measuring?

In November of each year we ask PICUs to record how many qualified nursing 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 nurses are needed to staff one level 3 critical care bed (2015). 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 2017 few units meet either of the PICS standards: 3 (9%) PICUs meet 7.01 WTEs per bed and 7 (22%) PICUs meet the previous standard of 6.4 WTEs.

However if all the recorded vacancies for qualified nurses were filled 6 (18%) PICUs would meet the standard of 7.01 WTEs per bed and 17 (53%) of PICUs would meet the previous standard of 6.4 WTE.

Figure 10: Number of clinically qualified nursing staff in post (WTE) per bed by health organisation, November 2015–2017
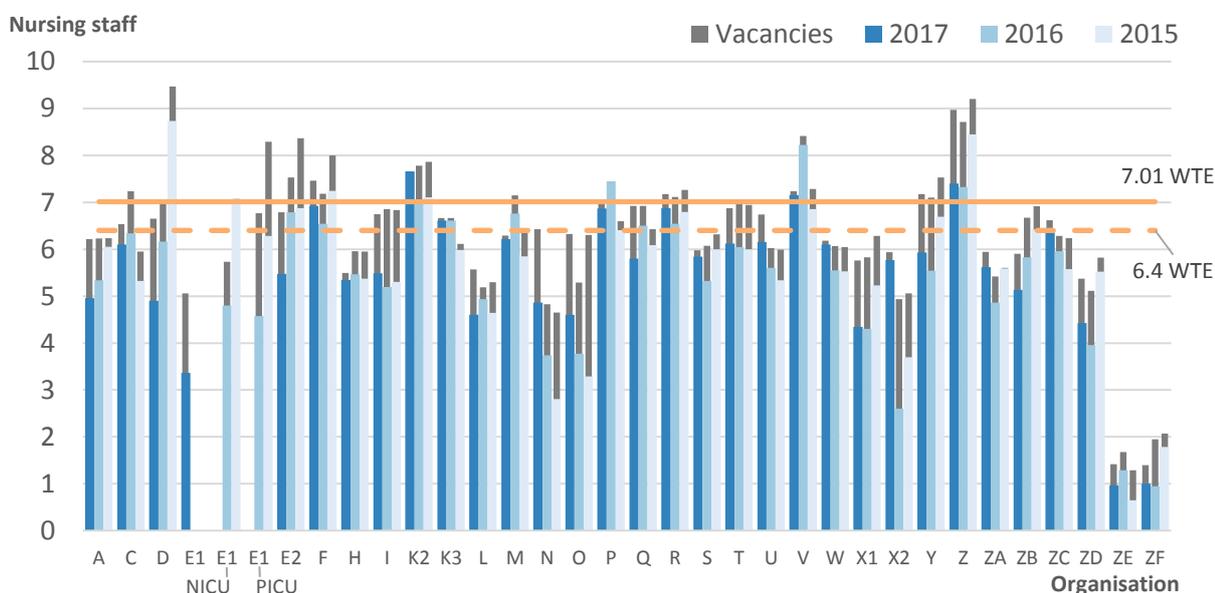
What does this mean?

Based on the data provided by UK and Republic of Ireland PICUs in November 2017, the establishment of very few PICUs meets the recommended standard of Paediatric Intensive Care Society. 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.

This 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 is collected in the November of each year: the week beginning 20 November in 2017. Figure 10 presents 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 2 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'. 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 4 health care assistants to support qualified staff in critical care units.

Metric 4: Emergency readmissions within 48 hours

What are we measuring?

For each PICU, we record the frequency of emergency readmissions within 48 hours in comparison to the average for the UK and Republic of Ireland. This is calculated using the admission and discharge dates and times. This relative re-admission rate (Figure 11) allows us to compare PICUs with each other.

What did we find?

Around 300 children per year (or 1.6 out of every 100 admissions) were discharged from PICU but then readmitted as an emergency within 48 hours (Table 6). Rates of emergency readmissions varied by country with Scotland having slightly higher rates in 2016 and 2017 (2.2–2.4%) whilst Wales, Northern Ireland and Republic of Ireland had lower rates. No outliers were evident when relative emergency readmission rates were compared across all PICUs (Figure 11).

Table 6: Number of emergency readmissions within 48 hours 2015–2017

Country	2015	2016	2017
England (NHS)	250 (1.6%)	250 (1.6%)	261 (1.7%)
England (non-NHS)	2 (0.7%)	2 (0.6%)	3 (0.6%)
Wales	14 (3.0%)	6 (1.1%)	5 (1.0%)
Scotland	17 (1.3%)	37 (2.5%)	33 (2.4%)
Northern Ireland	8 (1.3%)	10 (1.8%)	5 (1.0%)
Republic of Ireland	19 (1.4%)	21 (1.5%)	19 (1.3%)
Total	310 (1.6%)	326 (1.6%)	326 (1.6%)

Figure 11: Relative 48 hour emergency readmission rate by health organisation 2015–2017
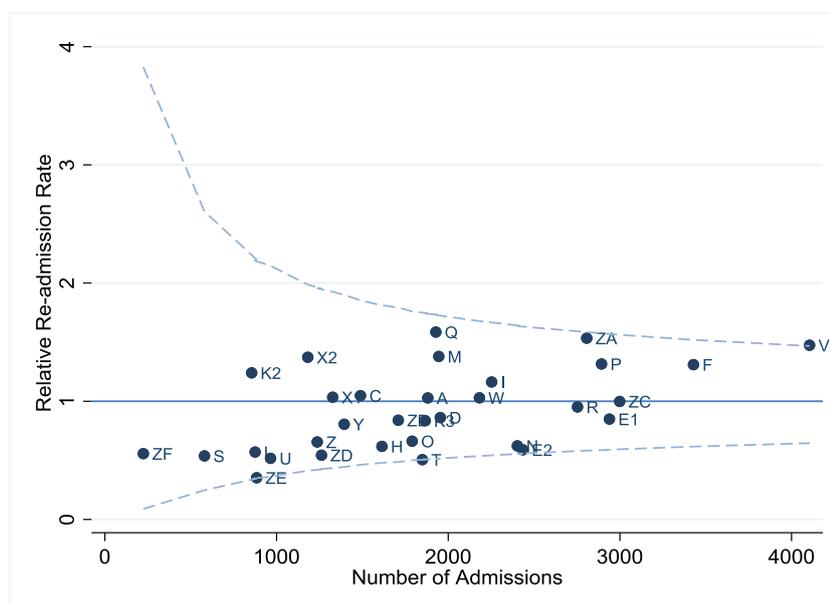
What does this mean?

There is no evidence that children are being discharged from PICU too early during the reporting period of 2015 to 2017.

Further details

Definitions and methods

We defined an emergency readmission within 48 hours as any unplanned admission to the same PICU or another 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) on 4 March at 04:30, they would have been counted in our analysis as they returned to PICU after 35½ hours. We then counted 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 maximum acceptable rate of emergency readmissions within 48 hours so we used the average for all PICUs contributing to PICANet. We then used the funnel plot method described at the beginning of this report to assess if any PICU has a higher rate than expected, based on the ratio of observed to expected numbers of readmissions.

Why is this important?

Emergency readmission within 48 hours is an undesirable outcome. From the patient 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 patient, their families and their carers. For a busy PICU, each admission also creates additional demand on a service which usually operates close to capacity.

It should be noted that although emergency readmission is used as a quality indicator, we do not know the cause of the readmission therefore PICANet is 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.

Metric 5: Mortality in PICU

What are we measuring?

Mortality (death) rates are assessed for every PICU based on a statistical approach which 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 we predict to die is calculated and then compared to the number who actually die to derive the risk-adjusted Standardised Mortality Rate (SMR).

What did we find?

The risk-adjusted SMR for each PICU in the UK and Republic of Ireland is plotted in Figure 12 according to the number of admissions for the period from 2015 to 2017. There was no evidence that any PICU had an excess mortality rate compared to what we would expect during the three year reporting period.

Figure 12: Risk-adjusted SMR by health organisation 2015–2017
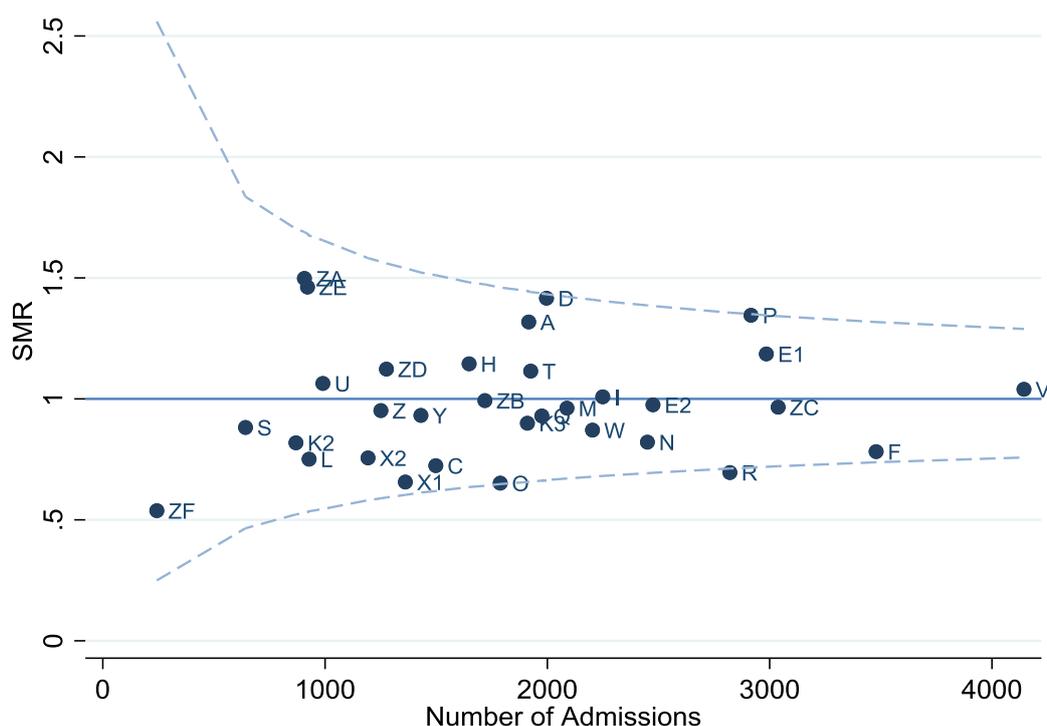
The 'risk-adjustment' method used to calculate expected mortality was the Paediatric Index of Mortality 3 (PIM3)

What does this mean?

Compared with the overall mortality for the UK and Republic of Ireland there were no PICUs for which mortality rates were higher than expected during the three year reporting period, after allowing for the level of sickness at the time of admission.

Further details

Definitions and methods

Clinical data collected on admission is used in a statistical model to predict the probability that each child might die: the worse their 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 called a Standardised Mortality Ratio 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 on PICU is quite 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.

Referral and transport winter pressures

PICANet collects a referrals and transport dataset to supplement the admission dataset for paediatric intensive care (PIC) activity. This referral and transport data has been collected since 2012 and includes information about referral calls and associated retrieval or transfer activities.

In this first detailed analysis of the referral and transport data we investigate the impact of 'winter pressures' on the number of referral, transport and admission events submitted to PICANet to inform the commissioners and providers of specialist services.

Respiratory illnesses in winter, particularly in infants and small children, are known to be responsible for the peaks in PICU bed demand[3–5]. At times of high demand PICUs are often at capacity and therefore in order to find a PICU bed children may be transferred many miles away from their home. This results in additional demands on the PIC specialised transport services as well as PICUs.

Method

When specialist PIC clinicians agree that a child requires PIC transport and/or a paediatric intensive care bed a PICANet Web referral form is completed. Once the child is accepted for PIC transport the PIC specialist transport team will then call a PICU to request a bed. If the first PICU is full then the team will contact other PICUs until an available bed is found. For each PICU contacted that is unable to accept the child a referral form is completed recording the admission outcome of "Refused – no staffed bed available". So for each referral episode there can be multiple referral forms generated for any one child which may eventually result in one acceptance for PICU admission.

A referral event should also be completed for other transport requests where the child will be receiving intensive care during the journey, e.g. transportation to a secondary transport service, hospice or home.

Following acceptance for PIC transport a PICANet Web transport form is completed by the PIC centralised transport service (CTS) or PICU team providing the transport for a retrieval or transfer.

Data from the referral and transport dataset for 2016–2017 for the UK and the Republic of Ireland have been analysed to investigate variation in the seasonal frequency of these events in relation to overall PIC admissions. In addition the mobilisation times for specialist PIC transport services for urgent (non-elective) cases are investigated to assess the potential impact of the "winter pressure" on the service. For this purpose summer has been defined as the months of June, July and August and winter as November, December and January. The definition of mobilisation time is the time from which a PIC specialist agrees that PIC transport is necessary for a child to the time the PIC CTS departs from the team base. The Care Quality Commission has set a target of one hour for this to be carried out and NHS England Clinical Reference Group for Paediatric Critical Care Transport Dashboard uses a target of 30 minutes[6].

Referral data for the STRS PIC CTS was not available for 2017 and therefore is excluded from the analysis of referral data but is included in the transport data.

Results

Over the two-year period 2016 to 2017 there was a total number of 17,637 referrals across the UK and the Republic of Ireland. For the vast majority of children accepted for PICU admission by a PIC CTS only one PICANet referral form was completed, representing 85.8%

of the total: median=1, range 1 to 24. Figure 13 presents the monthly number of referral, transport and admission forms completed on PICANet Web over the period 2016 to 2017. The lowest number of both referral and transport forms were completed in the August of each year (referrals: 396, 390 and transports: 311, 310, respectively). Peaks in both referrals and transport can be seen in the November and December of each year (referrals: 853 in November 2016 and 991 in December 2017; and transports: 521 November 2016 and 556 in December 2017).

The pattern of admissions for PIC is similar to the referral and transport data although the summer plateau is less well defined due to planned admission for elective procedures which may have been delayed over the winter period.

Similar patterns were found for the individual countries of the UK and in the Republic of Ireland.

Figure 13: Number of PICANet Web referral, transport and admission forms recorded: UK and Republic of Ireland 2016–2017
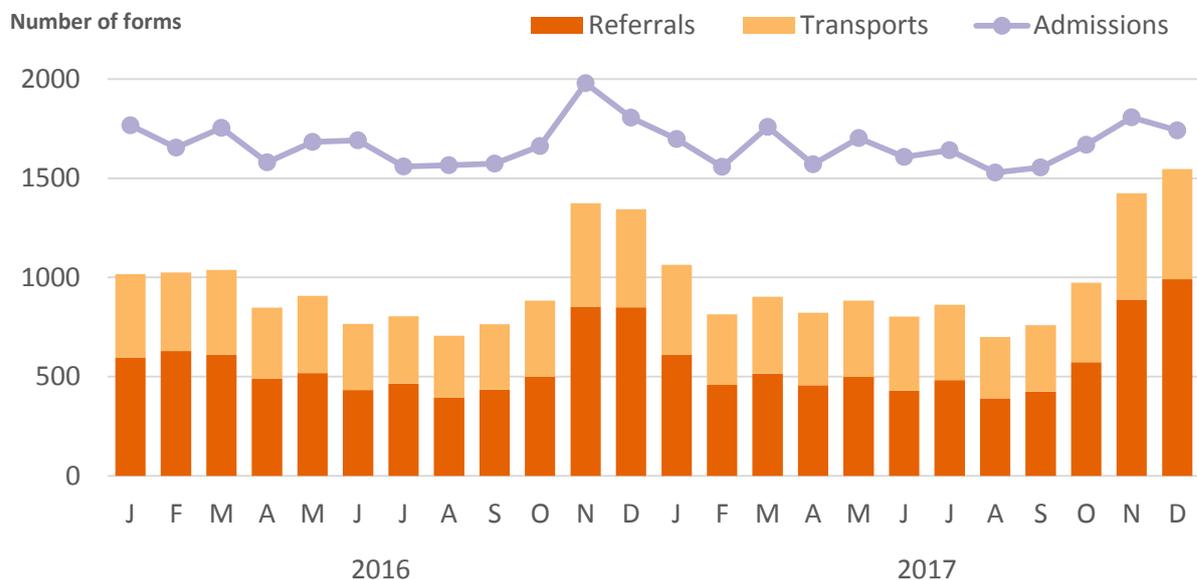
The potential impact of winter pressures on mobilisation times for the PIC CTS is shown in Figure 14 where the variation in mobilisation times is presented for the individual PIC CTS teams. In the winter months the proportion of transports mobilised within 30 minutes ranged from 4.8% to 82.8% and within 60 minutes (the CQC target) from 23.8% to 89.5%. Overall the median time to mobilisation in the winter was 30 minutes (interquartile range: 16 to 74 minutes). In the summer months the proportion of transports mobilised within 30 minutes ranged from 10.3% to 88.7% and within 60 minutes (the CQC target) from 29.2% to 94.0%. Overall the median time to mobilisation in the summer was 25 minutes (interquartile range: 15 to 47 minutes), slightly faster than in the winter which may reflect a level of reduced pressure on the service during the summer months.

Figure 14: Proportion of urgent transports by mobilisation time and PIC CTS: Summer and Winter UK and Republic of Ireland 2016–2017
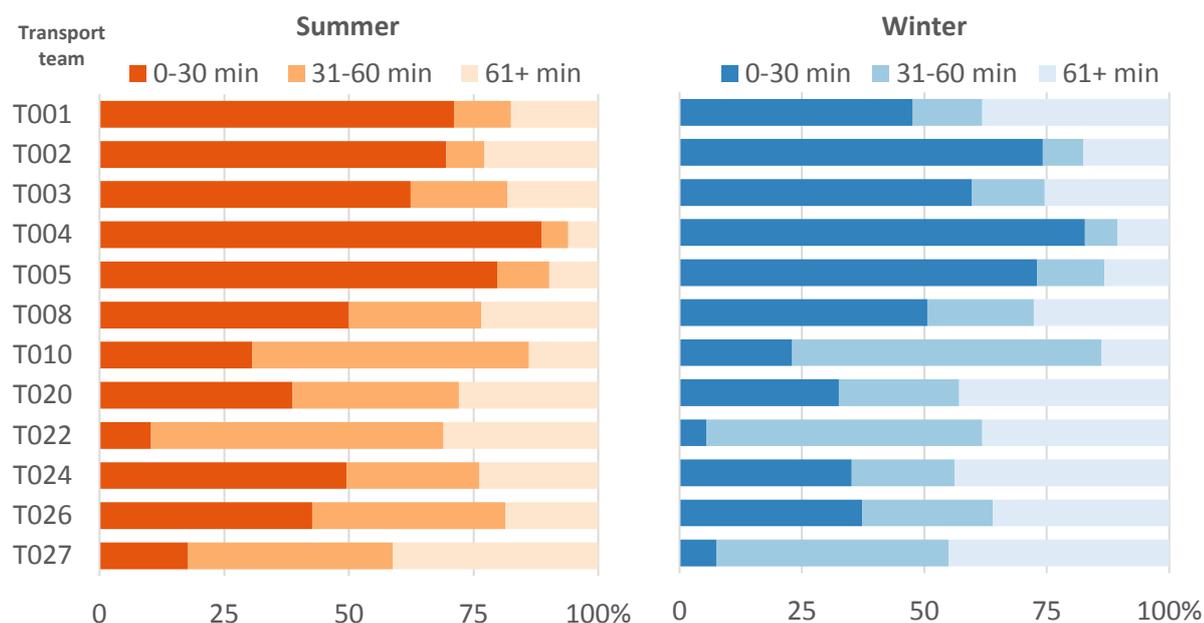
Despite the winter peaks in referral, transports and admissions for PIC in the UK and Republic of Ireland in 2016 and 2017, this increased workload does not seem to have a major impact on the vast majority of mobilisation times. However at times of highest demand children may have to be transported over long distances and it may take many referrals before an available PIC bed is identified. This situation is illustrated in the vignette below.

Vignette

In December 2017 an infant was admitted to the local district general hospital with bronchiolitis, a viral respiratory illness. Coughs and colds are common in children over winter. A common viral respiratory infection responsible for increased admissions in the winter is respiratory syncytial virus (RSV). For certain groups of children, especially premature infants with other medical conditions, RSV can be quite serious.

The infant's condition deteriorated and the paediatrician at the local hospital called the specialist PIC transport service to discuss the situation. The hospital were advised to insert a breathing tube to help the infant breathe and at 09:35 hours the paediatric intensive care transport service (PIC CTS) agreed to collect the infant for transfer to a paediatric intensive care unit (PICU). The PIC CTS called the local PICU to request a bed but the PICU was full. A further 16 PICUs were contacted before a bed was found at a hospital located 132 miles from the original admitting hospital.

The PIC CTS departed base at 11:04 to travel by road to collect the infant from the district general hospital, arriving at 12:40. The infant was stabilised for transfer by helicopter, and was then admitted to the PICU at 16:00.

The transport team left the admitting PICU at 16:45 to travel by road and arrived back at the transport team base at 18:50.

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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 Our Lady's Children's Hospital, Crumlin and the Temple Street Children's University Hospital, both based in Dublin, have submitted anonymised data to PICANet since 2010. 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/1409/piag-register-master-2018.xls)

Ethics approval has been granted by the Trent Medical Research Ethics Committee, ref. 05/MRE04/17 +5.

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 new 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. We also have a PIC Families Group to consider the impact of admission to intensive care on children and their families. Appendices B, C and D provide a full list of CAG, SG and PIC Families group 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: Specialist Health Service Commission for Wales (SHSCW)
- Scotland: NHS Lothian/National Services Division of NHS National Services Scotland
- Northern Ireland: Health and Social Care Board

In the Republic of Ireland, Our Lady's Children's Hospital, Crumlin is governed by a Board of Directors and is a company limited by guarantee. Temple Street Children's University

Hospital (TSCUH) is incorporated as a private limited company. Both receive funding from the Health Services Executive, charitable and private sources.

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. The Royal Alexandra Hospital, Brighton, and Hull Royal Infirmary are no longer submitting data because they are no longer commissioned as paediatric intensive care units.

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/H&C 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 about 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** is 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 Republic of 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[7].

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 is validated on-line 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 has 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. We have provided baseline data for the two largest clinical trials in paediatric intensive care (CHiP (Control of Hyperglycaemia in Paediatric Intensive Care) and CATCH (CATheter infections in Children)). PICANet has also 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. Over the next few years we will be working closely with the NIHR funded DEPICT study, which is investigating the effect of differences in access to emergency paediatric intensive care and care during transport on clinical outcomes and patient experience.

Small number policy

Publication of PICANet data is subject to scrutiny for 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 (https://www.picanet.org.uk/wp-content/uploads/sites/25/2018/05/PICANet_Policy_on_Units_lying_outside_the_control_limits-5_oct2015.pdf), which relates specifically to assessment of risk-adjusted mortality. We also follow the more detailed guidance on outliers subsequently developed by HQIP published in 2017. On three specific occasions, 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

The PICANet PICU Families Group comprises 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. 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.

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