



PICANet Statistical Analysis Plan State of the Nation Report

STATISTICAL ANALYSIS PLAN

2022

v1.0

December 2022

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1 Amendments

This is the first version of the Statistical Analyses Plan (SAP) for the 2022 State of the Nation Report analysis and as such there are no amendments to record.

2 Introduction

The Paediatric and Intensive Care Audit Network (PICANet) was established in 2002 to record details of the treatment of all critically ill children admitted for care in a paediatric intensive care unit (PICU) and currently consists of three main datasets: admissions, transports and referrals. Additionally, information on data quality is also recorded. These datasets would be analysed; the results of which would be presented in an annual report.

This year, an Annual Report has been replaced by the State of the Nation report. Similar to past annual reporting, it will be supported by data collected in the previous full three years. The 2022 State of the Nation report will therefore analyse and present data from 2019, 2020 and 2021. This is to make sure data is complete, results are comparable and admission numbers are robust, as focusing on one year only doesn't easily allow examination of time trends and changes in practice.

3 Data

3.1 Datasets

Data manuals for PICANet data can be found online at <https://www.picanet.org.uk/data-collection/data-manuals-and-guidance/>

3.1.1 Admission data

The admissions dataset includes information on all admissions in designated PICUs across the United Kingdom and the Republic of Ireland. Data are collected from admission to discharge with additional data items collected 30 days following discharge such as mortality. Treatment received on the PICU is recorded in terms of daily activities received through the stay in the PICU and CT3 clinical coding (READ codes). Daily activities are defined from the *Paediatric Critical Care Minimum Data Set* (PCCMDS). An admission event is completed by

the admitting unit within three months of the discharge (Standard L3-702 [1]). This was reduced to two months from 1st January 2022 (and will therefore feature in future reports).

Although there is an ongoing process to replace READ codes with SNOMED, READ codes will remain the system for recording diagnoses in the 2022 State of the Nation report until the transition to the SNOMED coding scheme is complete.

3.1.2 Transport data

The transport dataset includes information on all children transported by centralised transport services (CTS) or PICU providing the transport for a retrieval / transfer. A transport event is completed by the team providing the transport. The transport could be from the original admitting hospital to a PICU; between PICUs; or a child requiring paediatric intensive care being moved to a district general hospital, home or a hospice. An event is completed following agreement that PIC transport is required, irrespective of whether the child is transported to another care provider.

Data collection began on 01/01/2012 and was first presented in the annual report in 2014. Prior to 2018 transport events were completed for all children transferred from the original admitting hospital to PICU.

Transport data items include patient demographic information, basic details about the transport team and collection unit, critical incidents during transit, transport times, interventions received by the patient both prior to the arrival of the transport team and while the transport team is in attendance (including PIM variables), and the outcome of the transport event.

3.1.3 Referral data

The referral dataset includes information on all children referred for paediatric intensive care transport and admission. The referrals dataset data collection began on 01/01/2012 and was first presented in the annual report in 2014. A referral event is reported to PICANet for all requests for paediatric intensive care transport and all requests for PIC admission where the clinicians agree that the child requires PIC transport and/or a PICU bed. A child may have multiple referral events for the same episode of care, e.g. if it took several attempts to locate them a PICU bed after agreeing they required transport.

3.1.4 Additional datasets

The PICANet State of the Nation report presents information collected directly through PICANet Web. Additionally, admissions of children to Adult Intensive Care Units (AICUs) are presented. This information is obtained from the Intensive Care National Audit & Research Centre (ICNARC) dataset which mainly consists of children admitted to English AICUs, but also includes admissions to hospitals in Wales and in Northern Ireland who have also agreed to supply data. Data are usually requested from ICNARC by the team at Leeds at the end of March in the report year. For the 2022 report, the variables requested include:

- Unit
- Month and year of admission
- Length of ICU stay (days)
- Discharge destination
- Age of patient
- Discharge status
- Primary reason for admission to ICU

3.2 Key metrics and key data

The NCAPOP Provider Methodology Manual sets out three types of metrics (four if case ascertainment is included). These are Outcomes, Process and Structure. Details of these metrics can be found in Appendix A, and are as follows:

- Mortality in PICU (outcome)
- Emergency readmission to PICU within 48 hours of discharge (outcome)
- Retrieval mobilisation times (process)
- Unplanned extubations (process)
- Case ascertainment

Numbers of nurses providing care per clinical care bed (a structure measure) was previously a key metric, but discontinued in 2022 as the data are no longer collected by the audit.

Other key data are:

- Data items feeding into PIM calculations (required for case-mix adjustment):
 - Elective admission
 - Pupil reaction
 - Mechanical ventilation
 - Absolute values of base excess

- SBP (systolic blood pressure) at admission
- $SBP^2/1000$
- $100x FIO_2/PaO_2$ (mmHg)¹
- Recovery from a bypass cardiac procedure
- Recovery from a non-bypass cardiac procedure
- Recovery from a non-cardiac procedure
- Very high risk diagnosis
- High risk diagnosis
- Low risk diagnosis

3.3 Data processing and quality improvement

3.3.1 Database validations

Data is entered onto the PICANet Web via manual data entry or via data import. The 'live' web based data entry system has automatic validations. All validations run: (i) for data import, at time of upload; (ii) for manual data entry: every time a new field is selected and when the event entry is saved.

There are four categories of validation: missing value, warning, error and reject. Further information on validation categories can be found in Appendix B. Some validations allow for manual override by the person entering/checking the data.

3.3.2 Validation visits

The programme of in-person validation visits has been severely impacted by the COVID-19 pandemic and as such have not taken place since March 2019. During this time and subsequently, virtual validation visits have taken place and replaced the in-person visits. The aim is for each participating organisation to receive a virtual validation visit every 12 – 18 months with members of the PICANet team. The timeliness and completion of data is reviewed and the visit allows the PCC team to compare patient notes and observations with those entered onto PICANet Web, review case ascertainment, and raise any outstanding issues. This ongoing process ensures that any systematic errors with data recording or inputting can be identified and resolved in advance of reporting.

¹ FIO_2 is the fraction of inspired oxygen, and PaO_2 is the arterial partial pressure of oxygen

3.4 Management of datasets

Each dataset is analysed separately. Data management is undertaken at the University of Leeds. The Universities of Leeds and Leicester both assess data quality. Analysis of the admissions data is conducted at the University of Leeds, and transport and referral data analysed at the University of Leicester.

3.4.1 Data freeze (soft lock)

A data freeze (soft lock) occurs on the 31st March of each year. This was delayed until Summer 2022 due to the PICANet server outage (March-June 2022). The usual cut-off of the 31st March is used as sites are required to enter information on an event within 3 months of completion and therefore all events occurring to 31st December of the previous year should be entered by this point (in future reports this will change due to the new PCCS standard of 2 months). The outage affected both PICANet and the units, and so additional time was allowed in 2022 for units to ensure their data were up to date.

3.4.2 Data cleaning

The main data cleaning process is undertaken annually after data freeze (soft lock) mainly in SQL and Stata by the data manager(s) and statistician(s) analysing the data. See Section 3.5 for details of data cleaning undertaken.

3.4.3 Final data download (data hard lock)

Final data download (data hard lock) will take place following data cleaning and querying (usually in Q2 of the Annual Report year). The date of hard lock is agreed within the team and is dependent on the quality and cleanliness of the data to be included in the report. This means the date of hard lock may change each year due to number of working days, Easter etc. The final dataset will contain events beginning on or before 31st December which were entered onto the database on or prior to the soft lock of the data.

3.5 Data cleaning and stats checks

3.5.1 Postcode validation

Address details are collected in order to validate postcode. Units in England, Scotland and Wales provide address whereas those in the Republic of Ireland and Northern Ireland do not provide address details and are asked to enter country of residence into address line 4.

PICANet will conduct manual checks on these postcodes where there is error or ambiguity due to experiencing a technical issue relating to the use of the software afd Postcode Plus (<https://www.afd.co.uk/products/postcode-plus/>). The intention is to re-instate use of this software as soon as possible.

3.5.2 Patient ID matching review

PICANet employ a probabilistic approach to assigning patient IDs to records. The IDs are assigned automatically and an associated confidence score (between 1=low confidence and 3=high confidence) in the matching is provided. Any patient IDs with a confidence score of 1 will be manually reviewed looking at key demographics such as NHS number, date of birth and sex. Following this review, manual adjustment of patient ID or confidence score is undertaken.

Following this process, instances where a Patient ID has multiple NHS numbers assigned are manually checked and corrected.

3.5.3 Admissions dataset checks

Overlapping or duplicate admissions

This check can only be conducted once address validation and patient ID matching review has been undertaken. Overlapping admissions within the same unit are identified and manually reviewed. If these appear to be separate patients given same patient ID in error (for example twins) then the patient ID will be amended accordingly referring the multiplicity field as required. Any discrepancies that cannot be resolved by the PICANet team will be sent to site. If these appear to be duplicate admissions or overlapping admissions for the same patient then these will be queried with the unit. Units are asked to resolve issue on PICANet Web where possible and inform the PICANet team of any alterations.

Events readmitted from theatre as planned admissions within 12 hours

This check can only be conducted once address validation and patient ID matching review has been undertaken. Cases are identified within hospitals and are merged centrally by the PICANet team using the first event for patient demographics and PIM data and the last event for discharge and follow-up data; daily activity data is appended as appropriate. This process was undertaken for the 2018 Annual Report to improve consistency in submissions since we became aware that one PICU (Royal Brompton) submitted data differently to all other PICUs. This work was done in SQL and will be repeated for the 2022 State of the Nation report.

Clinical coding

Unknown READ codes are identified and queried with the unit.

Additional checks

It is known that sometimes a default time (12:00 or 14:00 or similar) is entered for admission, discharge etc. Times will be explored on a unit basis to identify any trends and to allow for appropriate assumptions to be made.

The following checks will be performed on the data for the 2022 State of the Nation report. The following will be examined and queried with units where appropriate:

- NHS number (*nhsno*)– where 9s have been provided
- Type of admission (*adtype*) – where unknown
- Source of admission (*sourcead*) – where unknown
- Care area admitted from (*careareaad*) – where unknown and admitted from same or other hospital (as recorded in *sourcead*)
- Retrieval/Transfer (*retrieval*) – where unknown
- Type of transport team (*atransportorgtype*) – where unknown
- Collection unit (*acollectionorg*) – where unknown
- Main reason for PICU admission (*primreason*) – where unknown
- Surgical procedure (*surgicalprocedure*) – where unknown
- Evidence available to assess past medical history (*medhistevind*) – where unknown
- Blood gas measured (*bgfirsthr*) – where unknown
- Mechanical ventilation (*mechvent*) – where unknown and patient has been discharged
- Tracheostomy performed during this admission (*tracheostomy*) – where unknown; and where *tracheostomy* is recorded as performed during the admission (“Yes”) but tracheostomy cared for by nursing staff is not recorded in daily activities

- Primary diagnosis (*primarydiagnosis*) – where unknown (unless the accepted code for unknown diagnosis has been used) and child has been discharged prior to data freeze
- Discharged for palliative care (*dispalcare*) – where unknown

3.5.4 Transport data cleaning

As a general rule for the cleaning of transport data, we only identify issues of data quality where the owner of the event is a Centralised Transport Service (CTS) or a PICU although in recent years following centralisation of the transport service nearly all events are owned by a CTS. All data cleaning should only be undertaken for the most recent year of data.

Duplicate events

Potential duplicates in the transport dataset are identified in the following ways:

1. Two events (or more) with the same patient ID and the transport was accepted at the same date and time.
2. Same patient ID with two or more transports on the same day from the same collection area (investigated to see if they are potentially transfers for short periods of treatments).
3. Two (or more) events where the transport request was received at the same date and time, by the same transport organisation, for two (or more) differing patient IDs that lived within the same IMD score area (note: these could be twins and so manual review is undertaken).

Where possible potential duplicates are investigated further before feedback, e.g. by checking to see if the (local) transport numbers are identical although this hasn't always been possible.

Potential duplicates should be fed back to data owners, with a request for review and probable deletion of one or more events for each suspected duplicate. We encourage data owners to tell us how they have amended the data or why the data is correct if it is not amended. We can, if desired, check that all requests have been dealt with at a later stage.

Transport times and dates

If an event breaches any of the following rules they are identified and the owner of the event will be encouraged to check all dates and times on the transport record to identify the point of the potential error.

Where possible the comments field should be investigated, and any other useful variables, to allow acceptance of any instances when the entry is actually correct, e.g. a long mobilisation

time due to adverse weather conditions, or a long patient journey time due to a vehicle breakdown or simply a long distance travelled. It should also be investigated if there is an acknowledged delay by the transport team. It is possible to be identified by more than one of these rules at the same time.

- A mobilisation time (difference between time the child was accepted for transport and time when team departed base) which was more than 2 hours and the transport was non-elective and the event is owned by a CTS
- A time to bedside (difference between acceptance for transport and the time of arrival at the collection unit) which was more than 6 hours and the transport was non-elective and the event is owned by a CTS
- A patient journey time which lasted more than 3 hours and the event was owned by a CTS (can be checked for both elective and non-elective events). These are inspected before feedback as there are many journey times that can legitimately last >3 hours.

Events identified for breaching one of these rules, with no clear reason, are reported back to data owners. They are encouraged to check dates and time and if these are correct, to identify if there should be a reason documented for the delay.

Missing dates and times are not investigated further as this is raised as validation query. However, this should be considered for checking in future years.

3.5.5 Referrals data cleaning

As a general rule for the referral data, we only identify issues of data quality where the owner of the event is a Centralised Transport Service (CTS). The exception to this is if a duplicate entry belongs to a PICU, in which case we will feed back to the PICU which events to remove. All data cleaning should only be undertaken for the most recent year of data. All data cleaning requests are fed back to the owners of the data and we encourage them to tell us how they amend their data.

Duplicate events

Duplicates in this dataset are much harder to identify as times and dates are often reported poorly, particularly by non-PIC transport teams, (validation visits have confirmed this issue). Therefore this approach will overlook some, but the ones that are identified are more likely to be true duplicates. Duplicates in the referral data are identified in the following ways:

- Two (or more) events both with the same patient ID where the referral date and time is identical and the transport was accepted and the admission was accepted and the destination unit was the same.

Duplicates are generally one of the following:

- What appears to be the same event, entered by a CTS and by a PICU – we recommend deletion of the PICU owned event (event given to the PICU for deletion)
- The same event entered twice by a CTS and this is 'confirmed' by an apparently identical referral number – one event should be deleted (CTS to decide which to keep)
- The same event entered twice by a CTS but this is not confirmed by the use of the same referral number – investigation needed to identify if truly a duplicate (CTS to investigate)

All potential duplicates are fed back to data owners and we encourage them to tell us how they have amended their data. If desired we can check, at a later stage, that these issues have been dealt with.

Additional checks

The following should also be investigated each year:

- Events where there is an unknown intended destination unit (some of these have been identified as advice only calls and these should be deleted by the event owners as currently PICANet does not collect information about advice calls although this may change)
- Neonatal teams should not be able to accept referrals for paediatric intensive care transport and these should be investigated to see if they are “outside of scope of care” or “transport not requested” or should be removed
- Where the medical history is unknown
- Where there is disagreement as to whether a record is non-elective (or elective) and unplanned (or planned)

Unknown transport organisation in referral dataset

The following rules are used if the transport team name is missing:

- If the event is owned by a CTS, assume it was the CTS who did the transport
- If the event owner is allowed to do referrals, then allow them to be the transport organisation.

3.5.6 ICNARC AICU data

Data received from ICNARC are checked to ensure that there are no new hospitals from Northern Ireland and Wales that will need to be excluded from analyses (as PICANet does not have signed permission to receive AICU data for these hospitals). Range and sense checks are undertaken before analysis as appropriate however queries are not raised with ICNARC and the cleaning process is purely to allow assumptions to be made where necessary. Any assumptions applied will be documented.

3.6 Derivations

3.6.1 Admissions data

Age

Age is calculated as the difference between the date of admission to PICU and the date of birth using the DATEDIFF function in SQL. When date of birth is not provided age is classed as '*unknown*'.

Age in months and age in years are complete months and years respectively, so for example if a child is 14 ½ months old this will be classed as age 14 months or age 1 year.

Bed activity

Bed activity looks at occupancy levels on the unit by day. A bed is counted as occupied if a child was present on a unit for any part of a day. This inevitably results in higher figures than the bed census data as a bed may have more than one child occupying it in any one day.

Bed census

Calculated as the number of children present in a PICU bed at 10 minutes past midnight.

Bed days (total number)

Bed days looks at how many days children are on a unit for (truncated at the start and end of the reporting period). The total number of *bed days* delivered is calculated as the sum of children in a PICU each day.

CCG

Data on the Clinical Commissioning Group (CCG) are obtained by linking the validated home address of children admitted to PICU, to CCG/NHSCR via the National Statistics Postcode

Lookup (NSPL) for the UK

(<https://geoportal.statistics.gov.uk/datasets/aef0a4ef0dfb49749fe4f80724477687/about>).

Children in the Republic of Ireland are identified by a text search of address fields. For the Republic of Ireland the only available geographical breakdown is by county region. All data processing is done in SQL and Excel.

Emergency readmissions within 48hrs of discharge

Calculated for patients readmitted to the same unit as unplanned admissions (admission type 'Unplanned- following surgery' or 'Unplanned- other') within 48 hours of discharge.

Expected probability of mortality

Expected probability of mortality is estimated using the Paediatric Index of Mortality 3 (PIM3) (2), further details on PIM3 variables can be found in Appendix C. Recalibration on PIM3 data will be required as detailed in Section 3.7.

In previous reports a recalibrated version of the Paediatric Index of Mortality 2 (PIM2) (3) was used (recalibration performed using data to be published in the report). In many tables the expected probability of mortality is presented in groups: <1%, 1-<5%, 5%- <15%, 15-<30% and 30+% to reflect those used by the Australian and New Zealand Intensive Care Society (ANZPICS) (4) for comparability.

Level of activity in PICU

Calculated from the daily activities dataset (PCCMDS) which is a section of the admissions dataset but stored in a different table in the database. The purpose of the PCCMDS is to provide the basis for payment by results (PbR) through the establishment of healthcare resource groups (HRGs). They were specified to take into account differing levels of activity in PICU:

- XB09Z - Enhanced Care
- XB07Z - High Dependency
- XB06Z - High Dependency Advanced
- XB05Z - Intensive Care Basic
- XB04Z - Intensive Care Basic Enhanced
- XB03Z - Intensive Care Advanced
- XB02Z - Intensive Care Advanced Enhanced
- XB01Z - Intensive Care - ECMO / ECLS

Prevalence of admission

Calculated with the use of publicly available population data. Mid-year population estimates can be found:

1. For England from ONS website (<https://www.ons.gov.uk/>)
2. For Northern Ireland from NISRA website (<https://www.nisra.gov.uk/>)
3. For Republic of Ireland from CSO website (<https://www.cso.ie/en/index.html>)
4. For Scotland from NRS website (<https://www.nrscotland.gov.uk/>)
5. For Wales from StatsWales website (<https://statswales.gov.wales/Catalogue>)

Primary diagnosis

The primary diagnosis for the whole admission is categorised into 13 diagnostic groups to enable a simple comparison between organisations. Diagnostic group is assigned using a lookup table developed by Roger Parslow (University of Leeds).

Ventilator free days

The number of days free of invasive ventilation in the first four weeks of the admission if the child survives and zero days if they die within that period, representing a combination of ventilation and mortality. No account is taken of re-admission during that period, or of non-invasive ventilation.

3.6.2 Transport data

New CTS teams

As of 01.01.2018 CTS Heartlink Paediatric ECMO transport service are recording transport events (as CTS028). As of 07.04.2021 the Paediatric and Neonatal Decision Support and Retrieval Service (PaNDR) are providing PIC transport in the East of England and submit data to PICANet (as CTS032)

Categorisation of the smaller transport services:

Since 2019 we only report data related to CTS teams and therefore these categorisation will only be found in older reports.

Smaller transport services are categorised as follows in transport data reporting:

PICU Transport team: We no longer receive information about PICU transports (as CTS teams are the majority of transports) and therefore this is no longer applied.

Neonatal team: A specialist neonatal team (e.g. CENTRE) transported the child.

Non-specialist team: A non-specialist team transported the child (e.g. a team from a District General Hospital)

Other specialist team: Another specialist team transported the child. We define another specialist team (not a centralised transport service (PIC) or neonatal transport team), transported the child. This could be a trauma transport team transferring the child or a private specialist transfer service

3.6.3 Referrals data

Categorisation of the smaller transport services

- **PICU transport team:** transports attributed to PICUs where an individual PICU only has one event in a calendar year.

3.7 PIM recalibration

Recalibration of PIM3 will be performed using the data to be published in the report (i.e. for the 2022 report, this would be admission years: 2019, 2020, and 2021). Recalibration is undertaken annually in Stata and the resulting coefficients saved for future reference.

Assessments of the recalibrated model will include examining the area under the Receiver Operating Characteristic (ROC) curve and goodness-of-fit assessments for discrimination ability and calibration. Both values will be reported alongside co-efficient as per the Health Quality Improvement Partnership (HQIP) outlier guidance.

3.8 Assumptions

Standard assumptions made in analysis are listed below. Additional specific assumptions based on stats checks will be documented.

3.8.1 Postcodes

Following the postcode validation processes, including manual review, if the postcode still cannot be validated by the address then the postcode will be treated as unknown for analysis purposes in the State of the Nation report as the data are deemed to not be of sufficient quality for inclusion.

3.8.2 Date and time of death

If date of death is missing and time of death is recorded as 00:00:00, then it will be assumed that time of death is an import error and that the patient survived. The validity of this assumption will be checked using the discharge status field (*unitdisstatus*). Following this confirmation, time of death will be replaced with a missing value for those without a death date.

4 Analysis methods

4.1 Software

Analysis will be performed in SQL or Stata v17 (5) unless otherwise stated. Maps are created in ArcMap unless otherwise stated.

4.2 Statistical program validation

A header should be included in all statistics syntax files; as a minimum the header should include the program name and purpose, the author, date created and date last amended. Additionally, a list of amendments made post review, date of review and reviewers name should ideally be included. Programs can be validated by the author and do not need third party review, unless otherwise stated.

4.3 General analysis methods

Unadjusted Standardised Mortality Ratios (SMRs) are calculated by dividing the observed number of deaths in each organisation by the expected number of deaths, based on the national data for the same admission period.

Risk-adjusted SMRs are calculated by dividing the observed number of deaths in each organisation by the expected number of deaths predicted using the recalibrated version of PIM3 (see Section 3.7). This provides case-mix adjustment based on PIM3.

The benchmark for SMR is 1 (i.e. the number of expected deaths equals the number of observed deaths).

All the Maps are drawn based on the country of residence and not country of admission, unless otherwise stated.

The majority of tables and figures report data on admissions between 0-15 years of age, unless stated otherwise. Descriptive analysis comprises the largest part of the report. In the admissions dataset, most of the tables and figures are usually broken down by admitting PICU and year. Unless stated otherwise, the proportions in tables throughout the report are row percentages, except in the total column where they are column percentages.

The report mainly focuses on year of admission. There are only a few sections of the report that focus on activity in the year rather than year of admission. These are:

- Bed days
- Bed census
- Bed activity
- PCCMDS data

4.4 Potential sources of measurement error and bias

4.4.1 Bias

Sampling bias

This national audit collects information from all UK NHS PICUs and RoI PICUs as well as all UK and RoI PIC transport teams. As such, there is no sampling bias introduced as the entire population is collected. PICANet also collects information both private UK PICUs (Portland; Harley Street until 2020) and as such there is no sampling bias as the whole UK private population is captured.

Selection bias

PICANet has a Section 251 exemption which allows collection of data without individual patient/parental consent. PICANet is exempt from the national data opt-out (for the purposes of audit). As such we collect data on all patients treated within participating PICUs with no selection bias introduced.

Bias introduced through missing data

Data being missing not at random can introduce bias into results. For example, data that are difficult to obtain and are not clearly accessible in patient records may be less likely to be reported. It is not believed that this is likely to apply in many cases and PICANet Web validation, validation visits and emails focus on data completeness as well as quality. Levels and patterns of missing data will be reported as appropriate for transparency.

Bias may also be introduced via assumptions used to exclude any individuals from analysis, assumptions made will be recorded and reported as appropriate alongside analyses.

4.4.2 Measurement error

Transposition error

During the data entry process, data may be entered incorrectly into PICANet Web e.g. due to misreading clinical notes, handwriting legibility or human error. Validation visits (in-person or online) are conducted to check the accuracy and completeness of data in order to detect such errors, data cleaning may also identify issues and the database validations also apply a modulus 11 check on NHS number (where applicable). It is, however, likely that there will be a low underlying level of transposition error that will go undetected.

Interpretation error

Misinterpretation of PICANet definitions may also lead to inaccurate data. Training materials are publically available including data definitions and examples of how to complete PICANet forms. Validation visits are also used to pick up such systematic errors and improve data quality.

4.5 Missing data methods

Database validations flag missing data and validation visits are used to ensure data completeness as well as quality. Patterns of missing data will be explored as appropriate for key data and variables. Missing data will be queried with units where appropriate.

There are no plans to use formal methods for missing data such as multiple imputation. Numbers of missing data items will be presented alongside results as appropriate to aid interpretation.

4.6 Outlier detection

Detection of outliers is undertaken using funnel plots for the key metric of (risk-adjusted) mortality. The process for selecting the Mortality in PICU key metric and responding to outliers can be found in the 2022 update to PICANet's Outlier Policy:

<https://www.picanet.org.uk/about/policies/>.

4.7 Reporting conventions

Percentages will be reported to 1 decimal place (dp) unless otherwise stated. Totals are presented as whole numbers or to 1dp if required (e.g. when reporting FTE).

Any exclusions applied in analysis (e.g. exclusion of unknown age or neonatal teams) will be specified in the footnote of the associated table. Additionally, tables should clearly indicate whether analysis has been performed on based on country of residence or country of treatment (i.e. location of PICU where admissions occurred).

4.7.1 PICANet standard categorisations

The following categorisations will be used in analysis unless otherwise stated.

Age: <1 year; 1-4 years; 5-10 years; 11-15 years; 16+ years.

Age (16+ only): 16 years; 17-20 years; 21-25 years; 26+ years.

Age in months: <1 month; 1-2 months; 3-5 months; 6-11 months.

Diagnostic group: cardiovascular; endocrine/metabolic; gastrointestinal; infection; musculo-skeletal; neurological; oncology; respiratory; other; unknown.

Whenever used, a footnote should be added explaining that 'Other' includes a mixture of diagnoses but also some coding where a non-diagnostic READ code was given e.g. 'Post-surgical wound care' and that this practice varies by organisation.

Ethnicity: Categories defined by the UK census and used by the NHS as a national mandatory standard. 'Other' text box available for further detail if required e.g. for the category 'Mixed other'.

PIM group: <1%; 1%-<5%; 5%-<15%; 15%-<30%; 30%+.

Sex: male; female; ambiguous; unknown.

Admission type: planned following surgery; unplanned following surgery; planned other; unplanned other; unknown.

Source of admission: same hospital; other hospital; clinic; home; unknown.

Care area admitted from: accident and emergency; HDU (step-up/step-down); ICU/PICU/NICU; other intermediate care area (not ICU/PICU/NICU); recovery only; theatre and recovery; ward; x-ray, endoscopy, CT scanner or similar; unknown.

Ventilation status: invasive ventilation only; non-invasive ventilation only; both invasive and non-invasive ventilation; neither; unknown.

Length of stay: <1h; 1h-<4h; 4h-<12h; 12h-<24h; 1d-<3d; 3d-<7d; 7d+.

Discharge destination: normal residence; hospice; same hospital; other hospital; unknown.

Deprivation: Deprivation quintile of patients home address, defined by the Children in Low Income Metric (6). Quintile boundaries are set so that they contain an equal number of children (aged 0-15), as opposed to an equal number of patients in the cohort. Currently calculated for patients resident in England and Wales admitted to PICU in these nations only.

5 State of the Nation report content

5.1 Key metrics

Key findings are agreed upon by: the co-PIs, statistician(s) and relevant clinicians.

The first table in the report will focus on the admissions tables outlined below. It will include a count of admissions by year, broken down by sex, age group ethnicity, deprivation and nation.

The State of the Nation report will also present the key metrics, introduced in section 3.2 and outlined in further detail in Appendix A. The report will make recommendations based on the key metrics, in combination supporting tables and figures in sections 5.2 – 5.5.

5.2 Admissions data

TABLE 1.1 AND FIGURE 1.1 ADMISSIONS BY AGE AND SEX - Produced in SQL

For this analysis age is broken down by each age group, with further breakdowns for those admissions under 1 year old. A 16+ category is also included. Sex follows standard PICANet categorisation (Section 4.7). Patients of ambiguous sex are excluded (in 2022 report, n=1).

TABLE 1.2 ADMISSIONS BY AGE, HEALTH ORGANISATION AND YEAR -Produced in SQL

This table uses the same age categorisation as Table 1. Sex follows standard PICANet categorisation (Section 4.7). Totals are provided for the under 1 year category, under 16 years, and then all ages. Consideration must be given to statistical disclosure, especially in relation to patients over the age of 16, where there are generally very few in each unit.

TABLE 1.3 ADMISSIONS BY YEAR, MONTH AND HEALTH ORGANISATION -Produced in SQL

This table presents number of admissions by year, month of admission and health organisation. It is for patients under the age of 16 at time of admission.

TABLE 1.4 AND FIGURE 1.4 ADMISSIONS BY YEAR, MONTH AND AGE - Produced in SQL

This table shows admissions by year and month by age of the child Age follows standard PICANet categorisation (Section 4.7).

TABLE 1.5 AND FIGURE 1.5 ADMISSIONS BY YEAR, MONTH AND PRIMARY DIAGNOSTIC GROUP - Produced in SQL

Diagnostic group follows standard PICANet categorisation (Section 4.7). It is for patients under the age of 16 at time of admission.

TABLE 1.6 RESPIRATORY ADMISSIONS BY YEAR, MONTH AND AGE GROUP - Produced in SQL

Individuals with unknown age are excluded from this table. Age follows standard PICANet categorisation (Section 4.7).

TABLE 1.7 ADMISSIONS BY ETHNICITY, YEAR AND AGE - Produced in SQL

Children with unknown age are excluded from this table and figure. Ethnicity and age follow standard PICANet categorisation (Section 4.7).

TABLE 1.8 ADMISSIONS BY YEAR, AGE AND DEPRIVATION GROUP - Produced in SQL

Deprivation score is based on the home postcode of the patient of each admission, matched to a Lower Super Output Area (LSOA) and its rating based on Children in low-income families local measure (HMRC, 2014). Admissions are split into five deprivation categories based on the score of the patient LSOA. There will be an equal number (or as close as possible) of child population in each group, however the number of admissions in each of these categories will vary. At present this table covers residents and admissions within England and Wales only (with the intention to expand to the British Isles).

TABLE 1.9 ADMISSIONS BY COUNTRY AND YEAR - Produced in SQL

Country of residence is categorised as: England; Wales; Scotland; Northern Ireland; Republic of Ireland; Other UK; Out of Area; Missing. "Other UK" includes patients resident in the Isle of Man and the Channel Islands; areas are combined for statistical disclosure control.

For children treated in England, Scotland or Wales, postcode is used to identify the patient's country of residence. For patients treated in Northern Ireland only the patient's country of residence is available and so analysis is based on the country provided. For patients treated in the Republic of Ireland, the patient's county and country of residence are provided. Country of residence assigned for analysis for each event ID should be checked manually for those admitted to Northern Ireland and the Republic of Ireland via a list sent to units.

TABLE 1.10 ADMISSIONS BY PREDICTED MORTALITY RISK GROUP, BY HEALTH ORGANISATION - Produced in SQL

PIM group follows standard PICANet categorisation (Section 4.7).

TABLE 1.11 AND FIGURE 1.11 ADMISSIONS BY ADMISSION TYPE AND AGE - Produced in SQL

Children with unknown age are excluded from this table. Age follows standard PICANet categorisation (Section 4.7).

Figure 1.11 is a bar chart (corresponding to Table 1.11) with type of admission on the x-axis and number of admissions on the y-axis; five separate bars are shown, one for each age category and one for the overall total.

TABLE 1.12 AND FIGURE 1.12 ADMISSIONS BY ADMISSION TYPE, BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis (unlike in table and figure 1.11). Admission type is categorised as on the PICANet database (Section 4.7)

Figure 1.12 is a stacked bar chart (corresponding to Table 13) for number of admissions of each admission type expressed as a percentage of all admissions (x-axis) by health organisation for admissions (y-axis), for all admissions in the 3-year reporting period combined.

TABLE 1.13 AND FIGURE 1.13 ADMISSIONS BY SOURCE OF ADMISSION (ADMISSION TYPE UNPLANNED- OTHER), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis (unlike in table and figure 1.10). Admission source is categorised as on the PICANet database (Section 4.7).

Figure 1.13 is a stacked bar chart (corresponding to Table 1.13) for number of admissions from each source expressed as a percentage of all 'unplanned-other' admissions (x-axis) by health organisation (y-axis), for all admissions in the 3-year reporting period combined.

TABLE 1.14 AND FIGURE 1.14 ADMISSIONS BY CARE AREA ADMITTED FROM (ADMISSION TYPE UNPLANNED- OTHER, ADMITTED FROM HOSPITAL), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis (unlike in table and figure 12). Care area admitted from is categorised as on the PICANet database (Section 4.7).

Table 15: Number of admissions from hospital (i.e. source of admission 'same hospital' or 'other hospital') with an admission type 'unplanned – other', by care area admitted from, for each health organisation and for each year of admission.

Figure 15: Stacked bar chart (corresponding to Table 15) for number of admissions from each care area expressed as a percentage of all 'unplanned-other' admissions from hospital (i.e. source of admission 'same hospital' or 'other hospital') (x-axis), for each health organisation (y-axis), for all admissions in the 3-year reporting period combined.

TABLE 1.15 AND FIGURE 1.15 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP AND AGE - Produced in SQL

Children with unknown age are excluded from this analysis. Age and primary diagnosis follows standard PICANet categorisation (Section 4.7). Includes a total for all admissions, as well as a split between <16 and >=16 years

TABLE 1.16 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP, YEAR AND HEALTH ORGANISATION - Produced in SQL

Primary diagnostic group follows standard PICANet categorisation (Section 4.7).

TABLE 1.17 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP (PLANNED FOLLOWING SURGERY), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis (unlike in table and figure 12). Primary diagnosis follows standard PICANet categorisation (Section 4.7).

TABLE 1.18 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP (PLANNED OTHER), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis.

TABLE 1.19 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP (UNPLANNED - OTHER), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis. Primary diagnosis follows standard PICANet 5 categorisation.

TABLE 1.20 ADMISSIONS BY PRIMARY DIAGNOSTIC GROUP (UNPLANNED FOLLOWING SURGERY), BY HEALTH ORGANISATION - Produced in SQL

Children with unknown age are included in this analysis (unlike in table and figure 12). Primary diagnosis follows standard PICANet categorisation (Section 4.7).

TABLE 2.1 AND FIGURE 2.1 RETRIEVALS/TRANSFERS BY TEAM TYPE AND AGE - Produced in SQL

Children with unknown age are excluded from this analysis. Age follows standard PICANet categorisation (Section 4.7).

TABLE 2.2 AND FIGURE 2.2 SPECIALIST TEAM RETRIEVALS/TRANSFERS BY DIAGNOSTIC GROUP AND AGE - Produced in SQL

Children with unknown age are excluded from this table. Diagnostic group follows standard PICANet categorisation (Section 4.7). Counts, percentages and totals presented.

Figure 2.2 is a bar chart corresponding to Table 2.2 for number of admissions retrieved/transferred by diagnostic group (x-axis) for admissions in the 3-year reporting period combined.

TABLE 2.3 AND FIGURE 2.3 NON-SPECIALIST TEAM RETRIEVALS/TRANSFERS BY DIAGNOSTIC GROUP AND AGE - Produced in SQL

Children with unknown age are excluded from this analysis. Diagnostic group follows standard PICANet categorisation (Section 4.7).

Figure 2.2 is a stacked bar chart (corresponding to Table 2.1) for number of admissions (y-axis) retrieved/transferred by a non-specialist team by diagnostic group (x-axis) for admissions in the 3-year reporting period combined.

TABLE 2.4 AND FIGURE 2.4 ADMISSIONS BY TRANSPORT TEAM TYPE FOR RETRIEVALS AND TRANSFERS - Produced in SQL

Children with unknown age are excluded from this table.

Figure 2.4 is a horizontal stacked bar chart corresponding to Table 2.4 for number of admissions retrieved/transferred by transport type, expressed as a percentage of all retrieved/transferred admissions per unit, (x-axis), by health organisation (y-axis), for admissions in the 3-year reporting period combined.

TABLE 2.5 INTERVENTIONS RECEIVED BY HEALTH ORGANISATION AND YEAR - Produced in SQL

Interventions are categorised as: invasive ventilation; non-invasive ventilation; tracheostomy; ECMO; IV vasoactive drugs; LVAD; ICP device; renal support; high flow nasal cannula therapy. Interventions are not mutually exclusive. They are expressed as counts and percentages of all admissions for that PICU and year

TABLE 2.6 ADMISSIONS BY VENTILATION STATUS AND AGE – Produced in SQL

Children with unknown age are excluded from this table. Age group and ventilation status follow standard PICANet categorisation (Section 4.7).

TABLE 2.7 ADMISSIONS BY VENTILATION STATUS BY HEALTH ORGANISATION – Produced in SQL

Children with unknown age are excluded from this table. Ventilation status follow standard PICANet categorisation (Section 4.7).

TABLE 2.8 ADMISSIONS BY HIGH FLOW NASAL CANNULA THERAPY BY HEALTH ORGANISATION – Produced in Stata

Number of admissions where high flow nasal cannula therapy was provided and percentage of total admissions, number of days of high flow nasal cannula therapy; median, minimum and maximum dose, by health organisation for each year of admission.

TABLE 3.1 AND FIGURE 3.1 BED DAYS BY AGE AND SEX – Produced in SQL

Age is broken down by each year of age up to 16 for admissions in the 3-year reporting period combined. Sex follows standard PICANet categorisation (Section 4.7).

Figure 3.1 is a stacked bar chart corresponding to Table 3.1 with age in years on the x-axis and number of bed days on the y-axis, with bars coloured for male and female admissions separately.

TABLE 3.2 BED DAYS BY AGE, HEALTH ORGANISATION AND COUNTRY OF ADMISSION – Produced in SQL

Children with unknown age are excluded from this table. Age group follows standard PICANet categorisation (Section 4.7). Totals are provided of each PICU, and for each UK nation and ROI separately.

TABLE 3.3 AND FIGURE 3.3 BED CENSUS BY MONTH AND YEAR, ALL ADMISSIONS – Produced in Stata

Median and interquartile range (25th-75th percentile) of bed census data by month of activity, for each year separately. The bed census is the number of children in PICU at 10 minutes past midnight. Patients 16 years and over are included.

Figure 34 is a box plot corresponding to Table 34 with month and year on the x-axis and the number of children in PICU on the y-axis, for the 3-year reporting period combined.

TABLE 3.4 AND FIGURES 3.4a-c BED CENSUS BY HEALTH ORGANISATION AND YEAR, ALL ADMISSIONS – Produced in Stata

Median and interquartile range (25th-75th percentile) of bed census data, for each health organisation and for each year separately.

Figures 35a-c are three box plots corresponding to Table 3.4 with daily bed census on the x-axis and health organisation on the y-axis, for each year of the reporting period in turn.

TABLE 3.5 AND FIGURE 3.5 BED ACTIVITY BY MONTH, ALL ADMISSIONS – Produced in Stata

Median and interquartile range (25th-75th percentile) of bed activity by month of activity for each year separately. Bed activity differs from the census insofar as a bed is counted as occupied if a child was present on a unit for any part of a day. This results in higher figures than the bed census as a bed may have had more than one child occupying it in any one day.

Figure 36 is a box plot corresponding to Table 3.5 with month and year on the x-axis and the number of children on the y-axis, for the 3-year reporting period combined.

TABLE 3.6 AND FIGURES 3.6a-c BED ACTIVITY BY HEALTH ORGANISATION, ALL ADMISSIONS – Produced in Stata

Median and interquartile range (25th-75th percentile) of bed activity data, for each health organisation and for each year separately.

Figure 3.6a-c are box plots corresponding to Table 3.6 with daily bed activity on the x-axis and health organisation on the y-axis, for the first year of the reporting period.

TABLE 3.7 LENGTH OF STAY BY AGE, BY HEALTH ORGANISATION – Produced in Stata

Children with unknown age are excluded from this table. Age group follows standard PICANet categorisation (Section 4.7). This table presents median length of stay and IQR, by age group in years, for each health organisation and for admissions in each year of the reporting period.

TABLE 3.8 LENGTH OF STAY BY PRIMARY DIAGNOSTIC GROUP BY HEALTH ORGANISATION – Produced in Stata

Length of stay and diagnostic group follow standard PICANet categorisation (Section 4.7). Patients who had not been discharged by the time of final database lock are not included in this table. Data are presented as counts, median and IQR.

TABLE 3.9 ADMISSIONS BY LENGTH OF STAY BY HEALTH ORGANISATION – Produced in SQL

Length of stay (hours) follows standard PICANet categorisation (Section 4.7). Unknown length of stay includes those not discharged from PICU at the time of final database lock.

TABLE 4.1 ADMISSIONS BY UNIT DISCHARGE STATUS, YEAR, AGE GROUP AND SEX– Produced in SQL

Children with unknown age are excluded from this table. Age group follows standard PICANet categorisation (Section 4.7).

This table presents both counts and percentages. Percentages are calculated across rows. Totals for under 16 and 16+ ages are presented separately.

TABLE 4.2 ADMISSIONS BY UNIT DISCHARGE STATUS, HEALTH ORGANISATION AND COUNTRY OF ADMISSION – Produced in SQL

Admissions with unknown discharge status are excluded from this table. Percentages calculated by row.

TABLE 4.3 DEATH IN PICU, AS A PROPORTION OF ALL CHILD DEATHS, BY COUNTRY OF ADMISSION AND YEAR – Produced in Stata

Country of PICU is categorised as: UK or ROI.

For country of PICU and for each year of the reporting period, the number child deaths the population are presented per year, alongside the number of deaths in PICU and the proportion of child deaths this represents.

TABLE 4.4 ADMISSIONS BY UNIT DISCHARGE DESTINATION AND AGE – Produced in SQL

Children with unknown age are excluded from this table. Age and discharge destination follow standard PICANet categorisation (Section 4.7). Presents number of admissions for children discharged alive from PICU, by destination at discharge and age group in years, for admissions in the 3-year reporting period combined.

TABLE 4.5 VENTILATOR FREE DAYS, BY PIM3 GROUP, BY HEALTH ORGANISATION – Produced in Stata

Median and interquartile range of ventilator free days by PIM3 group (recalibrated) for each health organisation, and for each year of admission. PIM3 category follows standard PICANet categorisation (Section 4.7).

TABLE 4.6 EMERGENCY READMISSIONS WITHIN 48 HOURS OF DISCHARGE BY ADMISSION TYPE, BY HEALTH ORGANISATION – Produced in Stata

Number of emergency readmissions with 48 hours of discharge (or 2 days where time of admission or discharge not available), by admission type of the first admission, for each health organisation for the reporting period.

TABLE 4.7 RELATIVE RATE OF EMERGENCY READMISSIONS WITHIN 48 HOURS OF DISCHARGE, BY HEALTH ORGANISATION – Produced in Excel

Average rate over all units calculated in Excel for each year and overall. Calculation is unit rate divided by overall rate for that year.

TABLE 4.8 EMERGENCY READMISSIONS WITHIN 48 HOURS OF DISCHARGE, BY COUNTRY OF ADMISSION

Number of admissions and readmissions by country (England NHS and non-NHS combined) and year, as well as total over all reporting years.

TABLE 4.9 AND FIGURE 4.9a-b UNPLANNED EXTUBATION RATES FOR ALL ADMISSIONS BY HEALTH ORGANISATION – Produced in Stata

Number of activity days; number of unplanned extubations; intubated days; and rate of unplanned extubations per 1000 intubated days, for each health organisation and for each year of admission

Figure 4.9a is a bar chart (corresponding to Table 4.9) for rates of unplanned extubations (y-axis) by health organisation (y-axis), for all admissions by each year of the reporting period. Figure 4.9b is for admissions under 16 years of age, and in addition to rates for each year, includes a rate for all three reporting years combined.

TABLE 4.10 UNPLANNED EXTUBATION RATES FOR ALL ADMISSIONS COUNTRY OF ADMISSION – Produced in Stata

Table 4.10 presents unplanned extubations for patients under 16 years of age and by country of admission (where England NHS and non-NHS are combined into one category). It also presents intubated days, and rate of unplanned extubations per 1,000 days. This is for each year of admission, and all reporting years combined.

TABLE 4.11 SINGLE YEAR STANDARDISED MORTALITY RATIOS BY HEALTH ORGANISATION – Produced in Stata

Table 4.10 presents standardised mortality ratios (SMRs) calculated using the unadjusted PIM3 parameters (Straney et al, 2013), as well as SMRs calculated using a recalibrated PIM3 model for the data. 95% confidence intervals are presented in each case. This is calculated for the last year of the reporting period only.

FIGURE 4.11a-b SINGLE YEAR STANDARDISED MORTALITY RATIOS BY HEALTH ORGANISATION – Produced in Stata

Figures 4.11a and 4.11b are funnel plots of the data presented in table 4.10. They present the unadjusted and recalibrated results respectively.

TABLE 4.12 ALL YEAR STANDARDISED MORTALITY RATIOS BY HEALTH ORGANISATION – Produced in Stata

Table 4.10 presents standardised mortality ratios (SMRs) calculated using the unadjusted PIM3 parameters, as well as SMRs calculated using a recalibrated PIM3 model for the data. 95% confidence intervals are presented in each case. This is calculated for all three years of the reporting period.

FIGURE 4.12a-b ALL YEAR STANDARDISED MORTALITY RATIOS BY HEALTH ORGANISATION – Produced in Stata

Figures 4.11a and 4.11b are funnel plots of the data presented in table 4.10. They present the unadjusted and recalibrated results respectively.

TABLE 4.13a COEFFICIENTS (LOG-ODDS RATIOS) FOR PIM3 – FROM PIM3 PAPER

The PIM3 co-efficient for each factor will be reported to 4 decimal places.

TABLES 4.13b RECALIBRATED COEFFICIENTS (LOG-ODDS RATIOS) FOR PIM3 – Produced in Stata

Recalibrated PIM3 co-efficient for each factor as obtained through a logistic regression model will be reported to 4 decimal places.

TABLE 4.14 NUMBER OF INDIVIDUAL CHILDREN BY HEALTH ORGANISATION AND DIAGNOSTIC GROUP OF FIRST ADMISSION – Produced in SQL

Number of children (rather than number of admissions) in each diagnostic group of their first admission, by health organisation, for admissions in the 3-year reporting period combined.

TABLE 5.1 AGE-SEX SPECIFIC PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE IN THE UK AND THE REPUBLIC OF IRELAND – Produced in Stata

Prevalence for admissions, expressed as a rate per 100,000 children, with a 95% CI, by age group in years and sex, for each year of admission and for the 3-year reporting period combined.

Children with unknown age are excluded from this table. Age group and sex follow standard PICANet categorisation (Section 4.7).

A footnote needs adding explaining that the calculation of prevalence uses populations obtained from the Office of National Statistics and Regional Offices and that adjustments have been made to match PICANet age groups.

TABLE 5.2 AND FIGURE 5.2 AGE-SEX ADJUSTED PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE BY NATION IN THE UK AND THE REPUBLIC OF IRELAND – Table produced in Stata; Figure numbers produced in Stata and map in ArcMap

Table 5.2 presents age-sex adjusted prevalence, expressed as a rate per 100,000 children, with a 95% CI, by country of residence, for each year of admission and for the 3-year reporting period combined. It is based on the child's place of residence, rather than admissions to PICUs within each CCG.

A footnote needs adding explaining that the calculation of prevalence uses populations obtained from the Office of National Statistics and Regional Offices.

Figure 5.2 is a map showing the prevalence values from Table 5.2: country of residence showing age-sex standardised prevalence for admission, for admissions in the 3-year reporting period combined. Each CCG/health board/county is shaded according to the age-sex adjusted prevalence in those areas. The values used for this are presented in tables 5.3 to 5.6.

A footnote needs to be added explaining that this figure contains National Statistics data with the associated Crown copyright statement and also that the figure contains Ordnance Survey data with the associated Crown copyright statement.

For the table and figure, children with unknown age are excluded. Country is categorised as: England; Wales; Scotland; Northern Ireland; Republic of Ireland.

TABLE 5.3 AGE-SEX ADJUSTED PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE IN ENGLAND BY CCG – Table produced in Stata

Table 5.3 presents the age-sex prevalence for all CCGs in England, using the 2019 CCG geography. Where a child's residence could not be determined, it was treated as missing and excluded from the analysis

TABLE 5.4 AGE-SEX ADJUSTED PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE IN WALES BY HEALTH BOARD – Table produced in Stata

Table 5.3 presents the age-sex prevalence for all 7 health boards in Wales. It is calculated similarly to the data presented in table 5.3, using relevant geographies and population data (provided by StatsWales)

TABLE 5.5 AGE-SEX ADJUSTED PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE IN SCOTLAND BY HEALTH BOARD – Table produced in Stata

Table 5.3 presents the age-sex prevalence for all health boards in Scotland. It is calculated similarly to the data presented in table 5.3

TABLE 5.6 AGE-SEX ADJUSTED PREVALENCE (PER 100,000 PER YEAR) FOR ADMISSIONS TO PAEDIATRIC INTENSIVE CARE IN REPUBLIC OF IRELAND BY COUNTY – Table produced in Stata

Table 5.3 presents the age-sex prevalence for all health boards in Scotland. It is calculated similarly to the data presented in table 5.3

TABLE 5.7 ADMISSION OF CHILDREN TO AICUs BY AGE AND SEX IN ENGLAND, NORTHERN IRELAND AND WALES – Produced in Stata

This table presents the number of admissions of children aged 0-15 years to Adult Intensive Care Units in England, Northern Ireland and Wales by sex and age group in years, for each year of admission. Age group and sex follow standard PICANet categorisation (Section 4.7). The table is based on a dataset provided by the Intensive Care National Audit Research Centre (ICNARC).

TABLE 5.8 ADMISSION OF CHILDREN TO AICUs BY AGE AND MONTH OF ADMISSION IN ENGLAND, NORTHERN IRELAND AND WALES – Produced in Stata

This table shows the number of admissions of children aged 0-15 years to Adult Intensive Care Units in England, Northern Ireland and Wales, by age group in years and month of

admission, for each year of admission. Age group follows standard PICANet categorisation (Section 4.7). The table is based on a dataset provided by ICNARC.

TABLE 5.9 ADMISSION OF CHILDREN TO AICUs BY AGE AND DIAGNOSTIC GROUP – Produced in Stata

This table shows the number of admissions of children aged 0-15 years to Adult Intensive Care Units in England, Northern Ireland and Wales, by age group in years and diagnostic group, for each year of admission. Age group follows standard PICANet categorisation (Section 4.7). The table is based on a dataset provided by ICNARC.

TABLE 5.10 DISCHARGE DESTINATION FOR CHILDREN ADMITTED TO AICUs IN ENGLAND, NORTHERN IRELAND AND WALES – Produced in Stata

Discharge destination for children admitted to English AICUs, for each year of admission. Discharge destination is categorised as: discharged to PICU; discharged elsewhere; died. The table is based on a dataset provided by ICNARC.

TABLE 5.11 LENGTH OF STAY FOR SURVIVING CHILDREN ADMITTED TO AICUs IN ENGLAND, NORTHERN IRELAND AND WALES – Produced in Stata

Median and IQR of length of stay in days for children admitted to AICUs and discharged alive, by age group in years for each year of admission. Age group follows standard PICANet categorisation (Section 4.7). The table is based on a dataset provided by ICNARC.

FIGURE PCCMDS 1 ACTIVITY BY HEALTH ORGANISATION – Produced in Stata

Stacked bar chart for level of activity as a percentage of activity (x-axis) provided by health organisation (y-axis), for the 3-year reporting period combined.

Level of activity is derived as in Section 4.6 as above and is categorised as: XB09Z - Enhanced Care; XB07Z - High Dependency; XB06Z - High Dependency Advanced; XB05Z - Intensive Care Basic; XB04Z - Intensive Care Basic Enhanced; XB03Z - Intensive Care Advanced; XB02Z - Intensive Care Advanced Enhanced; XB01Z - Intensive Care - ECMO / ECLS.

TABLE PCCMDS 2 ACTIVITY BY HEALTH ORGANISATION – Produced in Stata

Number of days provided for each level of activity, for the 3-year reporting period combined.

Level of activity is derived as in Section 4.6 as above and is categorised as in Figure PCCMDS 1 with the addition of UZ01Z - Unable to group. 'Unable to Group' are mostly those with combinations of activities no longer regarded as high dependency, as well as some where problems arise in aspects of the grouper other than activity e.g. Diagnosis.

TABLE PCCMDS 3 NUMBER OF ACTIVITIES PER DAY – Produced in Stata

The number of days a given number of activities were received (0-17 activities per day), for the 3-year reporting period combined.

FIGURE PCCMDS 4 PREDICTED AND OBSERVED DEATH RATES BY INITIAL HRG – Numbers produced in Stata and graph in Excel

Bar chart for predicted (with PIM3) and observed death rates by initial HRG, for the 3-year reporting period combined.

5.3 Referrals data**TABLE R1 NUMBER OF REFERRALS FOR TRANSPORT BY TRANSPORT ORGANISATION AND OUTCOME – Produced in Stata**

This table reports the number of referrals for transport by their transport outcome for each year and transport organisation. If a child is referred and accepted, but it then it takes multiples attempts to find them a PICU bed, this is still only counted as one referral. To do this, 'duplicates' are identified (and removed from this table) as an event for the same patient ID on the same date and time where the child was accepted for transport on every event.

The following exclusions are made:

- Transport not requested
- Unknown transport and admission outcome

TABLE R1a NUMBER OF REFERRALS FOR TRANSPORT BY PIC TRANSPORT ORGANISATION AND OUTCOME – Produced in Stata

This table shows the number and proportion of requests for referral to PIC CTS for specialist transport and the subsequent outcome (accepted/not accepted). This is presented by transport team for all three years.

TABLE R2 NUMBER OF REFERRALS FOR PICU ADMISSION BY PICU AND OUTCOME – Produced in Stata

This table reports the number of referrals for PICU admission. An individual child could be accepted for transport once in Table R1 but could contribute multiple referrals for admission if it took multiple attempts to locate them a PICU bed.

The following exclusions are made:

- PICU admission not requested

- Unknown transport and admission outcome

5.4 Transport data

For the 2022 State of the Nation report, these tables were sent by Sarah Seaton (University of Leicester) via Biscom in November 2022.

TABLE T1 NUMBER OF TRANSPORTS BY YEAR, TRANSPORT ORGANISATION & OUTCOME– Produced in Stata

Reports the total number of transports and outcome by the organisation who undertook the transport. No exclusions are made.

TABLE T1A NUMBER OF TRANSPORTS, NON ELECTIVE AND ELECTIVE, BY DESTINATION & ORGANISATION - Produced in Stata

The table reports a breakdown of the number of elective vs non-elective transports to different locations. The column indicating the number of non-elective transports to the PICU provides the denominator for many of the remaining transport tables throughout the report. Unless indicated otherwise, tables report for non-elective transports to PICU only.

TABLE T2 AND FIGURE T2 NON ELECTIVE TRANSPORTS BY YEAR, TRANSPORT ORGANISATION & MOBILISATION TIMES (MINUTES) – Produced in Stata

Table T2 reports the mobilisation times (difference between the time the transport was accepted and the time the team departed base) in bandings of: 0-30 minutes; 31-60 minutes; 61-180 minutes; 181+ minutes and missing/not recorded.

Figure T2 is a box plot (corresponding to Table T2) of minutes to mobilisation (x-axis) by transport organisation (y-axis) for non-elective transports with recommend time shown. Exclusions apply if missing/not recorded for all 3-years of the reporting period combined.

TABLE T3 AND FIGURE T3 NON ELECTIVE TRANSPORTS BY YEAR, TRANSPORT ORGANISATION & TIME TO BEDSIDE (MINUTES) – Produced in Stata

This table reports the time to bedside (difference between the time the transport was accepted and the team arriving at the collection site) in bandings of: 0-60 minutes; 61-120 minutes; 121-240 minutes; 241+ minutes and missing/not recorded.

Figure T3 is a box plot (corresponding to Table T3) of time to bedside in minutes (x-axis) by transport organisation (y-axis) for non-elective transports with recommend time shown. Exclusions apply if missing/not recorded for all 3-years of the reporting period combined.

TABLE T4A AND FIGURE T4A NON ELECTIVE TRANSPORTS BY YEAR, TRANSPORT ORGANISATION & PATIENT JOURNEY DURATION (MINUTES) – Produced in Stata

Table T4a reports the journey time of the non-elective transports to PICU. A journey is measured from when the team leave the collection unit with the child until they arrive at the destination unit. It is reported in bandings of: 0-30 minutes; 31-60 minutes; 61-180 minutes; 181+ minutes and missing/not recorded.

Figure T4a is a box plot (corresponding to Table T4a) of time to the destination unit in minutes (x-axis) by transport organisation (y-axis) for non-elective transports with recommend time shown. Exclusions apply if missing/not recorded for all 3-years of the reporting period combined.

TABLE T4B ELECTIVE TRANSPORTS BY YEAR, TRANSPORT ORGANISATION AND PATIENT JOURNEY DURATION (MINUTES) – Produced in Stata

This table presents the journey time of the elective transports to any location. Journey is measured from when the team leave the collection unit with the child until they arrive at the destination unit. It is reported in bandings of: 0-30 minutes; 31-60 minutes; 61-180 minutes; 181+ minutes and missing/not recorded.

TABLE T5A NON ELECTIVE TRANSPORTS BY TRANSPORT ORGANISATION AND INTERVENTIONS PRIOR TO THE ARRIVAL OF THE TRANSPORT TEAM – Produced in Stata

Table T5a reports the number of interventions provided prior to the arrival of the transport team. Some groupings are amalgamations of details collected via the transport forms (e.g. ‘airway related’ refers to primary intubation and also need for re-intubation). Neonatal; other specialist and non-specialist teams are excluded from this table as they are not required to record information about interventions.

TABLE T5B NON ELECTIVE TRANSPORTS BY TRANSPORT ORGANISATIONS & INTERVENTIONS WHILST TRANSPORT TEAM PRESENT – Produced in Stata

This table reports the number of interventions provided whilst the transport team was in attendance. Some groupings are amalgamations of details collected via the transport forms (e.g. ‘airway related’ refers to primary intubation and also need for re-intubation). Neonatal; other specialist and non-specialist teams are excluded from this table as they are not required to record information about interventions.

TABLE T6 NON ELECTIVE TRANSPORTS TO PICU BY PIM3 GROUP - Produced in Stata

This table presents the PIM3 scores as calculated after the first contact with the transport team. PIM provides an indication of the probability of mortality for a child, calculated from information about their physiological condition (2). Neonatal; other specialist and non-specialist teams are excluded from this table as they are not required to record information about the variables which contribute towards the calculation of PIM3.

TABLE T7a NON - ELECTIVE TRANSPORTS, GRADE OF CLINICAL TEAM LEADER OF TRANSPORT TEAM BY HEALTH ORGANISATION – Produced in Stata

This table provides information about the grade or role of the team leader for the transport.

TABLE T7b NON - ELECTIVE TRANSPORTS, GRADE OF MOST SENIOR NURSE ON TRANSPORT TEAM BY HEALTH ORGANISATION – Produced in Stata

This table provides information about the grade or role of the most senior nurse for the transport.

TABLE T8 NON - ELECTIVE TRANSPORT BY COLLECTION AREA BY HEALTH ORGANISATION – Produced in Stata

Reports the collection area from which the transport team retrieved the child.

TABLE T9 NON - ELECTIVE TRANSPORTS, PARENT PRESENT DURING TRANSPORT BY TRANSPORT ORGANISATION – Produced in Stata

Reports whether the parent accompanied the child on the transport.

TABLE T10 NON ELECTIVE TRANSPORTS, CRITICAL INCIDENTS BY TRANSPORT ORGANISATION – Produced in Stata

Reports the critical incidents, both to the child or to the vehicle, which occur during the transport. Neonatal; other specialist and non-specialist teams are excluded from this table as they are not required to record information about critical incidents.

TABLE T11 NON ELECTIVE TRANSPORTS, CRITICAL INCIDENTS BY TRANSPORT ORGANISATION – Produced in Stata

Reports the number of transports by air for each section of the journey

5.5 Data quality reporting

TABLE DQ1, DATA COMPLETENESS BY DATA ITEM - REFERRAL– Produced in Stata

This table presents completeness by data item for referral events, for the three year reporting period combined. The number of expected data items is presented alongside the number of these records that were complete and valid at the point of final data lock. The number of data items with unresolved database validation queries are also presented with the proportion of all expected items this represents. The final two columns relate to missing data items: one shows the number of records which have been left blank without explanation, the other shows the number of data items which have been left blank but it has been confirmed that this data is not available or another explanation has been given. Percentages in both of these final columns show the proportion of expected data items these represent.

TABLE DQ2, DATA COMPLETENESS BY DATA ITEM - TRANSPORT – Produced in Stata

This table shows completeness by data item for transport events, for each of the three years in the reporting period separately. It reports the expected number of data items, and breaks these down by the categories used in table DQ1 (Complete and valid; Unresolved validation, Blank field; Missing value).

TABLE DQ3, DATA COMPLETENESS BY DATA ITEM – ADMISSION – Produced in Stata

This table shows completeness by data item for admission events, for each of the three years in the reporting period separately. The table headings are identical to those in DQ2.

TABLE DQ4, COMPLETENESS FOR NHS/CHI NUMBER BY ORGANISATION – REFERRAL – Produced in Stata

This table shows completeness of NHS/CHI number for referral events, by organisation, for the three year reporting period combined. The table headings are identical to those in DQ2.

TABLE DQ5, COMPLETENESS FOR NHS/CHI NUMBER BY ORGANISATION – TRANSPORT – Produced in Stata

This table shows completeness of NHS/CHI number for transport events, by organisation, for the three year reporting period combined. The table headings are identical to those in DQ2.

TABLE DQ6, COMPLETENESS FOR NHS/CHI NUMBER BY ORGANISATION – ADMISSION – Produced in Stata

This table shows completeness of NHS/CHI number for transport events, by organisation, for the three year reporting period combined. The table headings are identical to those in DQ2.

TABLE DQ7, COMPLETENESS FOR 30 DAY FOLLOW-UP BY ORGANISATION – Produced in Stata

Table DQ7 shows completeness of 30 day follow-up (which is recorded for admission events), by organisation, for the three year reporting period combined. It uses the standard DQ table headings

TABLE DQ8 EVENT DATA SUBMISSION STATUS WITHIN 3 MONTHS OF DISCHARGE BY HEALTH ORGANISATION – REFERRALS – Produced in SQL

Number of complete records submitted to PICANet within 3 months of patient discharge by year of discharge (according with PICS Standard T-701). This is split by Country and Organisation. The headings on the table show the total discharged, whether the record is complete, and then whether the record was completed within 3 months. Percentages are also presented.

TABLE DQ9 EVENT DATA SUBMISSION STATUS WITHIN 3 MONTHS OF DISCHARGE BY HEALTH ORGANISATION – TRANSPORT – Produced in SQL

As DQ8, split by transport organisation rather than health organisation.



TABLE DQ10 EVENT DATA SUBMISSION STATUS WITHIN 3 MONTHS OF DISCHARGE BY HEALTH ORGANISATION – ADMISSIONS– Produced in SQL

As DQ8, split by transport organisation rather than health organisation.

TABLE DQ11 PIM VARIABLE AVAILABILITY BY YEAR– ADMISSIONS– Produced in SQL

This table presents each PIM variable by year. It included the number of expected data items (defined by the number of admissions for that year) and a count and percentage of whether a PIM item was complete and valid, or not available. This is for admissions under 16 years old.

6 Signatures of approval

Name	Role	Signature	Date
Elizabeth Draper	Co-Principal Investigator		07 Dec 2022
Richard Feltbower	Co-Principal Investigator		07 Dec 2022

7 References

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Appendix A – Key Metric Definitions

Metric 1 Case ascertainment and timeliness of data submission

What does the metric measure?

Case ascertainment is a measure of the proportion of total admissions to PICU that are reported to PICANet. A case ascertainment of 100% would mean that we received information for all admissions to paediatric intensive care units (PICU). 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.

We also measure the timeliness of data collection and present how many of the admission events are completed on the PICANet database within two months of discharge – a requirement of the Paediatric Critical Care Society (PCCS) Quality Standards (L3-702, 2021)(8).

How do we calculate case ascertainment?

In the past case ascertainment was calculated during validation visits from the number of admissions recorded locally compared to the number of admissions included on the PICANet web database (ascertainment check).

From June 2021, case ascertainment is obtained by asking each individual PICU to undertake a count of admissions for a two month period out of 12 months. These are then cross matched against the number of admissions entered on to the PICANet web database. This ascertainment check is carried out on a yearly basis. In addition, case ascertainment is a feature of the virtual validation meetings held with each organisation, scheduled to be undertaken every 12 – 18 months.

How do we calculate timeliness of data submission?

An admission record is defined as complete when all validation checks relating to PICU admission, discharge and care have been fulfilled (i.e. excluding any validation checks on 30 day follow-up).

Why is this metric 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.

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 does the metric measure?

Some children need to be transported to a PICU in a different hospital for urgent care (non-elective transports). PICANet have calculated how long it takes for a specialised paediatric transport service (SPTS) to mobilise and start their journey to retrieve a child needing urgent PIC admission once the decision has been made that PIC transport is required. The Care Quality Commission and the NHS England Quality Dashboard monitor the timeliness of emergency transports and mobilisation times.

How is the metric calculated?

We measure the time from the point at which the clinicians agree that the child requires PIC transport to the time the SPTS team set off in the ambulance (or helicopter / plane) for what are called 'non-elective' or urgent transports.

Standards for mobilisation time are applied to SPTS in all countries although standards have not been defined for the devolved nations and ROI.

Why is this metric 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 mobilisation may also serve to highlight pressures on transport organisations such as busy periods during the year, and also insufficient resources or organisational issues that need to be addressed.

Metric 3 Emergency Readmissions within 48 hours

What does the metric measure?

For each PICU we record the frequency of emergency readmissions to the discharging PICU within 48 hours of discharge. An emergency admission is defined as an unplanned admission where the unit was not expecting or had planned for this admission.

How is the metric calculated?

Admission events are ordered chronologically for each patient. Therefore, using the admission and discharge dates and times, any admissions within 48 hours of discharge are considered emergency readmissions.

Why is this metric important?

Emergency readmission within 48 hours is an undesirable outcome. From an individual child's perspective, it suggests their health has deteriorated in a short space of time and that they require further intensive care treatment. This can cause stress to their child and their carers, and increases demand upon the PICU. This may not be a reflection of the care provided but it is monitored on a regular basis.

Metric 4 Unplanned Extubations

What does the metric measure?

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.

How is the metric calculated?

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.

Why is this metric 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. 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 (7).

Metric 5 Mortality in PICU

What does the metric measure?

This metric considers death of children whilst they are an inpatient on PICU. Mortality (death) rates are assessed for every PICU based on a statistical approach that accounts for the child's severity of illness at the time of admission using a risk-adjusted standardised mortality ratio (SMR). This compares the number of deaths within a PICU compared to how many deaths were expected to happen given how poorly children were when they were admitted to PICU.

How is the metric calculated?

We measure how poorly children were at the point when they were admitted to PICU using the Paediatric Index of Mortality 3 (PIM3). PIM3 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. The number of children who actually die (the 'observed' number) is compared to the number we predict to die (the 'expected') to derive the risk-adjusted Standardised Mortality Ratio (SMR).

Why is this metric 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

Appendix B – Database validation categories

Code	Validation type	Fires when	Example	Impact on manual data entry	Impact on data import	Manual override possible
4	Reject	Data type error	Text character in a numerical only field or incorrect length	Cannot save entry & flagged to user	Whole data import will be rejected & flagged to user	No
3	Error	Logical impossibility – data entered does not make logical sense	User tries to enter a date in the future	Can save the entry but error flagged to user	Import successful but user must amend erroneous data to clear the validation error	No
2	Warning	Unlikely value	Value outside expected range	Warning flagged to user	Warning flagged to user	Where specified; have to amend or confirm data are correct
1	Missing value*	Data is not completed	No value entered	Can save the entry but must amend data to fix the validation error	Can save but must amend data to fix the validation error	Where specified; state data unobtainable

* N.B. 9s are the given way of recording 'not available'. If 9s are entered then the missing value validation query will not fire as the field is completed with a defined acceptable value. There may be cases where a warning validation query fires where 9s are entered.

Appendix C – PIM3 variables

PIM3 comprises of the following variables:

Elective admission	
Pupil reaction	
Mechanical ventilation	
Absolute values of base excess	
SBP (systolic blood pressure) at admission	
SBP ² /1000	
100x FIO ₂ /PaO ₂ (mmHg)	
Recovery from a bypass cardiac procedure	
Recovery from a non-bypass cardiac procedure	
Recovery from a non-cardiac procedure	
Very high risk diagnosis	Includes: Cardiac arrest preceding ICU admission Severe combined immune deficiency Leukaemia or lymphoma after first induction Bone marrow transplant recipient Liver failure is the main reason for ICU admission
High risk diagnosis	Includes: Spontaneous cerebral haemorrhage

	<p>Cardiomyopathy or myocarditis</p> <p>Hypoplastic left heart syndrome</p> <p>Neurodegenerative disorder</p> <p>Necrotizing enterocolitis is the main reason for ICU admission</p>
<p>Low risk diagnosis</p>	<p>If any of the below is the main reason for ICU admission</p> <p>Asthma</p> <p>Bronchiolitis</p> <p>Croup</p> <p>Obstructive sleep apnoea</p> <p>Diabetic ketoacidosis</p> <p>Seizure disorder</p>