

Postoperative PICU Utilisation Following Paediatric Oncology Surgery: National Trends Across Two Policy Eras in England (2008-2022)

Rowan Wilson

St George's University Hospitals NHS Foundation Trust

Aleksandra Nowak

Morrison Hospital

Rebecca A Ward

University Hospital Southampton NHS Foundation Trust

Matthew R Solomons

University Hospital Southampton NHS Foundation Trust

Jack C Barton

Auckland City Hospital

Amber E Corrigan

King's College Hospital NHS Foundation Trust

Jonathan Round

jround@citystgeorges.ac.uk

St George's University Hospitals NHS Foundation Trust

Research Article

Keywords: Paediatric Intensive Care, Paediatric Surgery, Paediatric Oncology, Patient Admission, Centralisation, Policy

Posted Date: October 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11167984/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Purpose

To describe trends in postoperative oncological PICU utilisation, and to assess variations in case-mix and outcomes between 2008-2017 and 2018-2022.

Methods

We conducted a national retrospective cohort study using PICANet data from English PICUs between 2008 and 2022. The study was divided into two policy eras (2008-2017 and 2018-2022) based upon the 2018 NHS England review. Admissions of postoperative PICU patients aged from 1 month to 16 years, with malignant diagnoses, were included. Trends in PICU utilisation were assessed using Mann-Kendall tests, while Cochran-Armitage testing was used for trends in organ support. Inter-epoch associations were examined using bias-reduced logistic regression.

Results

The final cohort comprised 1,412 admissions from 1,250 patients. PICU utilisation increased across the study period: annual admissions rose from 76 to 107 ($\tau=0.40$; $p=0.042$), aggregate PICU bed-days from 164 to 623 ($\tau=0.71$; $p<0.001$), median LOS from 1.0 to 1.9 days ($\tau=0.66$; $p<0.001$), and mean LOS from 2.2 to 5.8 days ($\tau=0.56$; $p=0.004$). Meanwhile, vasoactive-support use was the only organ-support metric assessed to increase ($p = 0.005$). Following multivariable adjustment, admission in the later epoch was associated with a significant increase in the likelihood of receiving vasoactive support (OR 2.06, 95% CI 1.46–2.90; $p<0.001$), but not invasive ventilation (OR 1.09, 0.87–1.37; $p=0.436$) or mortality (OR 0.87, 0.30–2.56; $p=0.802$).

Conclusion

Postoperative paediatric oncology care in the PICU has become increasingly resource intensive. These changes have occurred during the continued reconfiguration of paediatric surgery, highlighting increasing demands on PICU capacity.

What is Known

- Over the last 30 years paediatric surgery has become increasingly centralised, with a greater role for PICU support for postoperative care.
- However, national trends in postoperative paediatric oncology PICU utilisation and outcomes remain poorly defined.

What is New:

- Postoperative oncological PICU utilisation has increased, with bed-days increasing faster than admissions.
- This increasing resource utilisation occurred despite lower predicted mortality in the later epoch and no difference in adjusted mortality, suggesting that rising PICU use was not driven by greater illness

severity at admission alone.

Introduction

Paediatric surgical care within the United Kingdom has become increasingly concentrated within specialist centres, alongside evolving service configuration and successive national guidance. The NCEPOD (1989) report ^[1] introduced requirements for surgical unit competencies, training, and caseloads. The NHS England Paediatric Critical Care and Specialised Surgery in Children Review, presented by the British Association of Paediatric Surgeons in 2018 ^[2] and summarised nationally in 2019 ^[3], continued this direction of travel towards networked specialist surgical services and post-operative paediatric intensive care provision.

Centralisation has been associated with benefits but has also brought new challenges ^[2, 3, 4, 5]. For example, concentrating demand in tertiary centres pressurises waiting lists and may delay surgery if dependent on paediatric intensive care (PICU) bed availability. PICUs have finite bed capacity and face competing demands from other services ^[6, 7, 8]. Changes in postoperative PICU use will also affect non-surgical PICU capacity. The implications of increasing PICU post-operative workload on wider PICU utilisation and outcomes remain poorly characterised.

Postoperative paediatric oncology patients are particularly vulnerable to the effects of surgical centralisation and changes to PICU use. They often require level 3 care, face higher risk from treatment complications, and frequently require complex operative interventions ^[9–14]. Over the two decades there has been an increased use of PICU for non-surgical oncology patients, alongside lower illness severity at admission, and declining overall mortality ^[13]. However, this analysis did not specifically examine postoperative oncological admissions.

This analysis explores national trends in postoperative PICU utilisation, workload, and outcomes following surgery among children with oncological diagnoses in England between 2008 and 2022. Additionally, we have compared outcomes between 2008–2017 with those from 2018–2022, epochs before and after the substantial reconfiguration in response to landmark policy changes.

Materials and Methods

Study Design, Population, and Setting

A retrospective cohort study was performed utilising data from PICANet ^[15]. Participants were between 1 month and 16 years, with at least one oncological diagnosis, admitted to an English PICU, between 1 January 2008 and 31 December 2022. Data for Wales, Scotland and Northern Ireland were not sought, as each required separate data sharing arrangements and these together made up only 15% of the UK total. Strengthening the Reporting of Observational Studies in Epidemiology guidelines were followed ^[16] (Online Resource 1).

Cohort Derivation

The study period was divided into two epochs: 2008-2017 and 2018-2022, using the NHS England Paediatric Critical Care and Specialised Surgery Review as a policy landmark to explore the impact of service reconfiguration [2, 3].

Planned and unplanned postoperative PICU admissions were included. Oncological diagnoses were coded using the World Health Organisation's International Childhood Cancer Classification Criteria (ICCC-3) [17]. Benign, indeterminate, and unmapped diagnoses were excluded. Where more than one eligible diagnosis was recorded, the first recorded diagnosis was used. Primary admission diagnoses were grouped using PICANet diagnostic classification [18]. For analysis of variations in oncological case-mix, synonymous diagnostic terms within the PICANet dataset were grouped. All eligible admissions were analysed as discrete episodes, including readmissions. The exclusion criteria resulting in the final analytic cohort are outlined in the flowchart below (Figure 1).

Clinical Variables and Outcomes

Baseline patient characteristics analysed included age, admission type (elective/non-elective), and Paediatric Index of Mortality 3 (PIM3) score [19]. Primary outcomes with PICU utilisation metrics: annual admissions, aggregate PICU bed-days, median LOS, and mean LOS. Here, aggregate bed-days are the total LOS of all eligible patients within each year while the mean LOS metric is defined as aggregate bed-days divided by annual admissions. Secondary outcomes were vasoactive support, invasive ventilation, and mortality in the PICU.

Statistical Analysis

Patient characteristics were outlined using the median (IQR) for continuous variables and counts (%) for categorical data, using Wilcoxon rank-sum and Fisher's exact test, respectively. Welch's T-test was used for assessing the differences in LOS means. Trends in primary and secondary outcomes were assessed using Mann-Kendall and Cochran-Armitage tests, respectively. Bias-reduced logistic regression was implemented to ascertain associations between epoch and secondary outcomes. PIM3 score, a variable in the logistic regression analysis, underwent further modelling, as outlined in Supplementary Table 1 (Online Resource 2). To assess the possibility of readmissions disproportionately impacting secondary outcomes, a second logistic regression model also assessed just first admissions (Supplementary Table 2; Online Resource 2).

Statistical analysis, data cleaning, and visualisation were performed in Microsoft Excel (version 2606) and RStudio (Posit team, 2026) [20]. There were no missing data for variables included in the final analysis.

Ethics and Approvals

Data use was approved by the PICANet Data Access Review Group and the Healthcare Quality Improvement Partnership (HQIP, reference P082). No NHS Research Ethics Service and Committee review was required according to the Health Research Authority decision tool ^[21].

Results

Baseline Characteristics and epoch Comparisons

The final analytic cohort comprised 1,412 postoperative PICU admissions from 1,250 unique patients (Figure 1). The six most common diagnoses on admission were the same across the two epochs, however the proportion of admissions they contributed differed significantly (Supplementary Fig. 1; Online Resource 2). The 2018-2022 epoch saw an increase in annual surgical PICU admissions (Table 1). Age, admission type, PIM3-predicted mortality, length of stay, and crude mortality differed significantly between epochs (Table 1).

Characteristic	Overall	2008-2017	2018-2022	p-value
Total admissions, n (mean annual)	1,412	887 (88.7)	525 (105)	
Readmissions, n (% of total admissions)	162 (11.5)	97 (10.9)	65 (12.4)	0.437
Age, months	63 (28-129)	55 (26-119)	79 (33-139)	<0.001
Age categories, n (%)				<0.001
<1 Year	111 (7.9%)	79 (8.9%)	32 (6.1%)	
1-5 Years	653 (46.2%)	437 (49.3%)	216 (41.1%)	
>5 Years	648 (45.9%)	371 (41.8%)	277 (52.8%)	
Sex, n (%)				0.2
Male	789 (55.9%)	485 (54.7%)	304 (57.9%)	
Female	623 (44.1%)	402 (45.3%)	221 (42.1%)	
Admission type, n (%)				0.024
Planned following surgery	1,102 (78.0%)	675 (76.1%)	427 (81.3%)	
Unplanned following surgery	310 (22.0%)	212 (23.9%)	98 (18.7%)	
PIM3 predicted mortality, %, median (IQR)	0.88 (0.42-2.50)	1.26 (0.72-3.41)	0.46 (0.19-0.87)	<0.001
Length of stay (days), median (IQR)	1.6 (0.9-3.0)	1.2 (0.9-2.9)	1.8 (0.9-3.1)	<0.001
Length of stay (days), mean (SEM)	3.38 (0.21)	3.07 (0.21)	3.90 (0.43)	0.088
Invasive ventilation, n (%)	675 (47.8%)	427 (48.1%)	248 (47.2%)	0.8
Vasoactive support, n (%)	224 (15.9%)	131 (14.8%)	93 (17.7%)	0.2
Mortality, n (%)	25 (1.8%)	21 (2.4%)	4 (0.8%)	0.035

Table 1: Baseline Characteristics of Postoperative PICU Admissions for Children with Malignancy. Inter-epoch variables were compared using the Wilcoxon rank-sum test and Fisher's exact test for continuous and categorical variables respectively. Welch's T-test was used for difference of the means.

Trends in Postoperative PICU Admissions

Postoperative PICU admission volume increased modestly across the study period (Kendall's $\tau = 0.40$; $p = 0.042$), while aggregate PICU bed-days showed a substantially stronger increasing trend ($\tau = 0.71$; $p < 0.001$). Median LOS ($\tau = 0.66$; $p < 0.001$) and mean LOS ($\tau = 0.56$; $p = 0.004$) also increased, suggesting that rising total bed use reflected both greater admission volume and longer postoperative stays (Figure 2). From 2019, median LOS remained relatively stable (1.9–2.0 days), while mean LOS reached 5.8 days

by 2022. In 2008, the 90th and 95th percentiles were 4.0 and 5.9 days, respectively. These had risen to 10.4 and 23.9 days by 2022, consistent with a lengthening upper tail of the LOS distribution.

Trend in Organ Support Over Time

There was no trend in the use of invasive ventilation seen across the study period ($\chi^2 = 0.09$; $p = 0.766$), however a significant increase in vasoactive support use was observed ($\chi^2 = 8.03$; $p = 0.005$).

Clinical Outcomes in the two epochs

Mortality was lower in the 2018-2022 epoch (0.8%) when compared with the 2008-2017 period (2.4%), although numbers were too small to support further analysis. The PIM3-predicted mortality was considerably lower in the second epoch yet both time periods saw a similar proportion ventilated, with a trend towards more vasoactive support in the second epoch. After adjustment for case mix, epoch 2 was associated with higher odds of vasoactive support but not invasive ventilation or mortality (Table 2).

Table 2: Adjusted odds ratios for clinical outcomes by study epoch ($n = 1,412$)

Outcome	Adjusted OR	95% CI	p-value
Invasive ventilation	1.09	0.87-1.37	0.436
Vasoactive support	2.06	1.46-2.90	<0.001
Mortality	0.87	0.30-2.56	0.802

Discussion

Between 2008 and 2022, admission numbers increased modestly, while associated total resource-use increased substantially, particularly through longer stays and greater aggregate bed-day use. Resource utilisation was greatest during the later years of the study, overlapping with epoch 2. The rise in admission volume was predominantly among planned postoperative admissions and those over 5 years old, whilst PIM3-predicted mortality was substantially lower in epoch 2. This pattern suggests that increasing PICU resource utilisation may reflect changes in perioperative pathways, case selection, oncological case-mix, or postoperative care, rather than there being greater physiological severity at admission. These changes in PICU utilisation have implications for care delivery, staffing, and resource use. While crude mortality was lower in epoch 2, adjusted mortality odds did not differ.

Our findings provide national-level evidence that PICU resource use is increasing during a period of continued reconfiguration of paediatric surgery ^[2,3]. This mirrors changes in non-surgical oncology admissions, where a cohort within the same dataset also demonstrated increasing admissions and longer stays, while predicted mortality declined ^[13]. The lower PIM3-predicted mortality observed in the postoperative cohort could signal changes in admission threshold, although direct attribution is hard to assign when other factors could be present. For instance, evolving perioperative and anaesthetic

practice^[22,23], surgical case selection^[24], and evolving PICU practices^[25,26] all could result in enhanced patient physiology at admission, with consequently lower PIM3 risk.

The substantial growth in postoperative PICU bed-days, driven both by increased admissions and longer stays has implications for service planning. Lack of planning will cause delays in elective surgery and limit PICU availability for non-surgical unplanned admissions.

Strengths and limitations

The principal strength of this study is its national scope and use of a robust, prospectively collected, validated dataset, while the 15-year timespan enables long-term trend analysis. The inclusion of resource-use metrics in parallel with clinical outcomes provides a broad assessment of service utilisation.

However, limitations include the observational design, precluding causal inference. Evolving surgical techniques, oncology protocols, and admission thresholds are likely to affect admission numbers, alongside policy changes. Barriers to PICU discharge were not captured by the dataset; the observed increase in PICU utilisation may reflect changes in downstream patient flow rather than clinical need. The cohort describes postoperative oncological PICU admissions in England, rather than all surgical PICU admissions, so may not be generalisable. Repeat admissions were retained as separate episodes and may introduce within-patient correlation; however, estimates were similar when analyses were restricted to the first eligible postoperative admission per patient (Supplementary Table 2).

PIM3 was excluded from the invasive ventilation regression model as ventilation at admission forms part of its calculation. PIM3 is designed as a general paediatric intensive-care mortality estimator^[18] and has been externally validated in other national PICU populations^[27], but its performance has not been specifically established in postoperative paediatric oncology. Furthermore, the wider-ability of generic critical-care severity scores to assess the risk of children with cancer has been questioned^[28,29]. Finally, the second epoch included the COVID-19 period. Evidence has shown that the pandemic disrupted cancer diagnostic and treatment pathways^[30] including paediatric oncology care^[31]. Despite this, a UK multicentre paediatric service evaluation found no evidence of delayed presentation for paediatric cancer cases^[32]. Paediatric critical care provision was also substantially altered; some English PICUs were repurposed to provide adult critical care, and there was a marked reduction in planned postoperative PICU admissions during 2020^[33,34], contrary to the trends we described from 2018-2022. Finally, increased demand for paediatric hospital and critical care services in 2021-2022 has been noted, and is thought to be due to an increase in respiratory infections following relaxation in social isolation^[35]. These disruptions may have influenced patterns of elective postoperative admission to PICU during the second epoch.

Conclusion

Over the past 15 years, postoperative paediatric oncology care in England became more resource intensive. Aggregate PICU bed-days, median LOS, and mean LOS increased alongside a more modest rise in admission numbers. Vasoactive support also increased, despite no change in the use of invasive ventilation. These shifts occur during the continued reconfiguration of surgical services and highlight a growing interrelation between critical care and surgical capacity.

Sustaining specialised paediatric surgery requires PICU resources as well as surgical expertise. National planning needs to address the increasing resource requirements, with integrated strategies for staffing, bed capacity, and perioperative pathways to meet escalating utilisation.

Declarations

The authors received no financial support for the study. St George's NHS trust kindly covered the administration fee for HQIP, the data analytics partner of the NHS. PICANet provided advice and the data without cost.

Authors' contributions: All data cleaning and confidential analysis was performed by authors Rowan Wilson, Aleksandra Nowak, Matthew Solomons and Rebecca Ward. Manuscript compiled by Rowan Wilson, Aleksandra Nowak, Jonathan Round, Jack Barton, Matthew Solomons, Rebecca Ward, Amber Corrigan. All authors read and approved the final manuscript.

Funding: The authors received no financial support for the study. St George's NHS trust kindly covered the administration fee for the HQIP, the data analytics partner of the NHS. PICANet provided advice and the data at no cost

Data availability: The project was approved by two UK bodies: The PICANet Data Access Review Group and the Healthcare Quality Improvement Partnership. The reference numbers for these approvals are P082 and HQIP410 respectively. The data was provided after application and scrutiny of the project. Due to the sensitive nature of the data, restrictions apply to its storage, handling and use. Administrative expenses were applied by HQIP.

Competing Interests: The authors declare no competing interests

Consent to participate: Not applicable. This study used routinely collected PICANet data provided under approved data-access arrangements; individual consent was not required under PICANet's approved governance framework.

Consent to publish: Not applicable. No identifiable individual participant data are presented.

References

1. Campling EA, Devlin HB, Lunn JN (1990) The 1989 Report of the National Confidential Enquiry into Perioperative Deaths. National Confidential Enquiry into Perioperative Deaths (NCEPOD), London

2. Paediatric Critical Care and Specialised Surgery in Children Review: BAPS Briefing. October 2018. London: NHS England, England NHS (2018) <https://www.baps.org.uk/wp-content/uploads/2018/09/BAPS-Paeds-Review-Presentation-Oct-18.pdf>. Accessed 16 Aug 2026
3. NHS England and NHS Improvement (2019) Paediatric Critical Care and Surgery in Children Review: Summary Report. 5 November 2019. NHS England and NHS Improvement, London
4. Cogo PE, Poole D, Codazzi D, Boniotti C, Capretta A, Langer M, Luciani D, Rossi C, Bertolini G (2010) Outcome of children admitted to adult intensive care units in Italy between 2003 and 2007. *Intensive Care Med* 36:1403–1409. <https://doi.org/10.1007/s00134-010-1914-5>
5. Tanner S (2007) Trends in children's surgery in England. *Arch Dis Child* 92:664–667. <https://doi.org/10.1136/adc.2006.099705>
6. van Hasselt TJ, Kanthimathinathan HK, Kothari T, Plunkett A, Gale C, Draper ES, Seaton SE (2023) Impact of prematurity on long-stay paediatric intensive care unit admissions in England 2008–2018. *BMC Pediatr* 23:421. <https://doi.org/10.1186/s12887-023-04254-0>
7. Kanthimathinathan HK, Plunkett A, Scholefield BR, Pearson GA, Morris KP (2020) Trends in long-stay admissions to a UK paediatric intensive care unit. *Arch Dis Child* 105:558–562. <https://doi.org/10.1136/archdischild-2019-317797>
8. Chalom R, Raphaely RC, Costarino AT Jr (1999) Hospital costs of pediatric intensive care. *Crit Care Med* 27:2079–2085. <https://doi.org/10.1097/00003246-199910000-00001>
9. Soeteman M, Fiocco MF, Nijman J, Bollen CW, Marcelis MM, Kilsdonk E, Nieuwenhuis EES, Kappen TH, Tissing WJE, Wösten-van Asperen RM (2023) Prognostic factors for multi-organ dysfunction in pediatric oncology patients admitted to the pediatric intensive care unit. *Front Oncol* 13:1192806. <https://doi.org/10.3389/fonc.2023.1192806>
10. Pritchard-Jones K, Lewison G, Camporesi S, Vassal G, Ladenstein R, Benoit Y et al (2011) The state of research into children with cancer across Europe: new policies for a new decade. *Ecancermedalscience* 5:210. <https://doi.org/10.3332/ecancer.2011.210>
11. Herd F, Sastry J, Kidson C (2012) Overview of patients with malignancy admitted to PICU. *Arch Dis Child* 97(Suppl 1). <https://doi.org/10.1136/archdischild-2012-301885.199>. A82-A83
12. Al Haj Moussa A, Maaz AUR, Faqih N, Sundaram M (2020) Critically ill pediatric oncology patients: What the intensivist needs to know? *Indian J Crit Care Med* 24:1256–1263. <https://doi.org/10.5005/jp-journals-10071-23693>
13. Ward RA, Solomons MR, Chatterjee A, Barton JC, Mallah M, Nowak AM, Allen-Tejerina AM, Corrigan AE, Round JEC (2026) Trends in unplanned non-surgical paediatric oncology admissions to paediatric intensive care units in England between 2008 and 2022. *Eur J Pediatr* 185:479. <https://doi.org/10.1007/s00431-026-07023-0>
14. RR P, Tan EEK, Sultana R, Thoon KC, Chan MY, Lee JH, Wong JJM (2020) Critical illness epidemiology and mortality risk in pediatric oncology. *Pediatr Blood Cancer* 67:e28242. <https://doi.org/10.1002/pbc.28242>

15. PICANet Paediatric Intensive Care Audit Network for the UK and Ireland. Available at: <https://www.picanet.org.uk/>. Accessed 20 Aug 2026
16. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, STROBE Initiative (2007) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med* 147:573–577. <https://doi.org/10.7326/0003-4819-147-8-200710160-00010>
17. Steliarova-Foucher E, Stiller C, Lacour B, Kaatsch P (2005) International Classification of Childhood Cancer, third edition. *Cancer* 103:1457–1467. <https://doi.org/10.1002/cncr.20910>
18. PICANet. PICANet Web Admission Dataset Manual. Version 5.9 (2024) March Available at: <https://www.picanet.org.uk/wp-content/uploads/sites/25/2024/03/PICANet-Web-AdmissionDataset-Manual-v5.9-2024-03.pdf>. Accessed 21 Jul 2026
19. Straney L, Clements A, Parslow RC, Pearson G, Shann F, Alexander J, Slater A (2013) Paediatric Index of Mortality 3: an updated model for predicting mortality in pediatric intensive care. *Pediatr Crit Care Med* 14:673–681. <https://doi.org/10.1097/PCC.0b013e31829760cf>
20. RStudio: Integrated Development Environment for R. Posit Software, PBC, Posit team, Boston (2026) MA. URL <http://www.posit.co/>
21. Health Research Authority (2020) Does my project require REC review? Version 2.0. Health Research Authority. Available from: <https://www.hra-decisiontools.org.uk/ethics/docs/Algorithm%20-%20Does%20my%20project%20require%20REC%20review%20v2.0%20200304.pdf>. Accessed 15 Aug 2026
22. Habre W, Disma N, Virag K, Becke K, Hansen TG, Jöhr M et al (2017) Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. *Lancet Respir Med* 5:412–425. [https://doi.org/10.1016/S2213-2600\(17\)30116-9](https://doi.org/10.1016/S2213-2600(17)30116-9)
23. Roberts K, Brindle M, McLuckie D (2020) Enhanced recovery after surgery in paediatrics: a review of the literature. *BJA Educ* 20:235–241. <https://doi.org/10.1016/j.bjae.2020.03.004>
24. Smith ER, Butler WE, Barker FGII (2004) Craniotomy for resection of pediatric brain tumors in the United States, 1988 to 2000: effects of provider caseloads and progressive centralization and specialization of care. *Neurosurgery* 54:553–563. <https://doi.org/10.1227/01.NEU.0000108421.69822.67>
25. Ramnarayan P, Thiru K, Parslow RC, Harrison DA, Draper ES, Rowan KM (2010) Effect of specialist retrieval teams on outcomes in children admitted to paediatric intensive care units in England and Wales: a retrospective cohort study. *Lancet* 376:698–704. [https://doi.org/10.1016/S0140-6736\(10\)61113-0](https://doi.org/10.1016/S0140-6736(10)61113-0)
26. Slater A, Beca J, Croston E, McEniery J, Millar J, Norton L et al (2022) Association Between Centralization and Outcome for Children Admitted to Intensive Care in Australia and New Zealand: A Population-Based Cohort Study. *Pediatr Crit Care Med* 23:919–928. <https://doi.org/10.1097/PCC.0000000000003060>

27. Wolfler A, Osello R, Gualino J, Calderini E, Vigna G, Santuz P et al (2016) The importance of mortality risk assessment: Validation of the Pediatric Index of Mortality 3 score. *Pediatr Crit Care Med* 17:251–256. <https://doi.org/10.1097/PCC.0000000000000657>
28. Wittmann Dayagi T, Nirel R, Avrahami G, Amar S, Elitzur S, Fisher S et al (2024) A Need for a Novel Survival Risk Scoring System for Intensive Care Admissions Due to Sepsis in Pediatric Hematology/Oncology Patients. *J Intensive Care Med* 39:484–492. <https://doi.org/10.1177/08850666231216362>
29. Wösten-van Asperen RM, van Gestel JPJ, van Grotel M, Tschiedel E, Dohna-Schwake C, Valla FV et al (2019) PICU mortality of children with cancer admitted to pediatric intensive care unit: A systematic review and meta-analysis. *Crit Rev Oncol Hematol* 142:153–163. <https://doi.org/10.1016/j.critrevonc.2019.07.014>
30. Maringe C, Spicer J, Morris M, Purushotham A, Nolte E, Sullivan R, Rachet B, Aggarwal A (2020) The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *Lancet Oncol* 21:1023–1034. [https://doi.org/10.1016/S1470-2045\(20\)30388-0](https://doi.org/10.1016/S1470-2045(20)30388-0)
31. Majeed A, Wright T, Guo B, Arora RS, Lam CG, Martiniuk AL (2022) The Global Impact of COVID-19 on Childhood Cancer Outcomes and Care Delivery – A Systematic Review. *Front Oncol* 12:869752. <https://doi.org/10.3389/fonc.2022.869752>
32. Williams G, McLean R, Liu JF, Ritzmann TA, Dandapani M, Shanmugavadivel D et al (2021) Multicentre service evaluation of presentation of newly diagnosed cancers and type 1 diabetes in children in the UK during the COVID-19 pandemic. *BMJ Paediatr Open* 5:e001078. <https://doi.org/10.1136/bmjpo-2021-001078>
33. Sinha R, Aramburo A, Deep A, Bould EJ, Buckley HL, Draper ES et al (2021) Caring for critically ill adults in paediatric intensive care units in England during the COVID-19 pandemic: planning, implementation and lessons for the future. *Arch Dis Child* 106:548–557. <https://doi.org/10.1136/archdischild-2020-320962>
34. Kanthimathinathan HK, Buckley H, Davis PJ, Feltbower RG, Lamming C, Norman L et al (2021) In the eye of the storm: impact of COVID-19 pandemic on admission patterns to paediatric intensive care units in the UK and Eire. *Crit Care* 25:399. <https://doi.org/10.1186/s13054-021-03779-z>
35. Williams TC, Marlow R, Hardelid P, Lyttle MD, Lewis KM, Mpamhanga CD, Cunningham S, Roland D, Paediatric Emergency Research in the UK and Ireland (PERUKI) (2024) Clinical Impact of Serious Respiratory Disease in Children Under the Age of 2 Years During the 2021–2022 Bronchiolitis Season in England, Scotland, and Ireland. *J Infect Dis* 230:e111–e120. <https://doi.org/10.1093/infdis/jiad551>

Figures

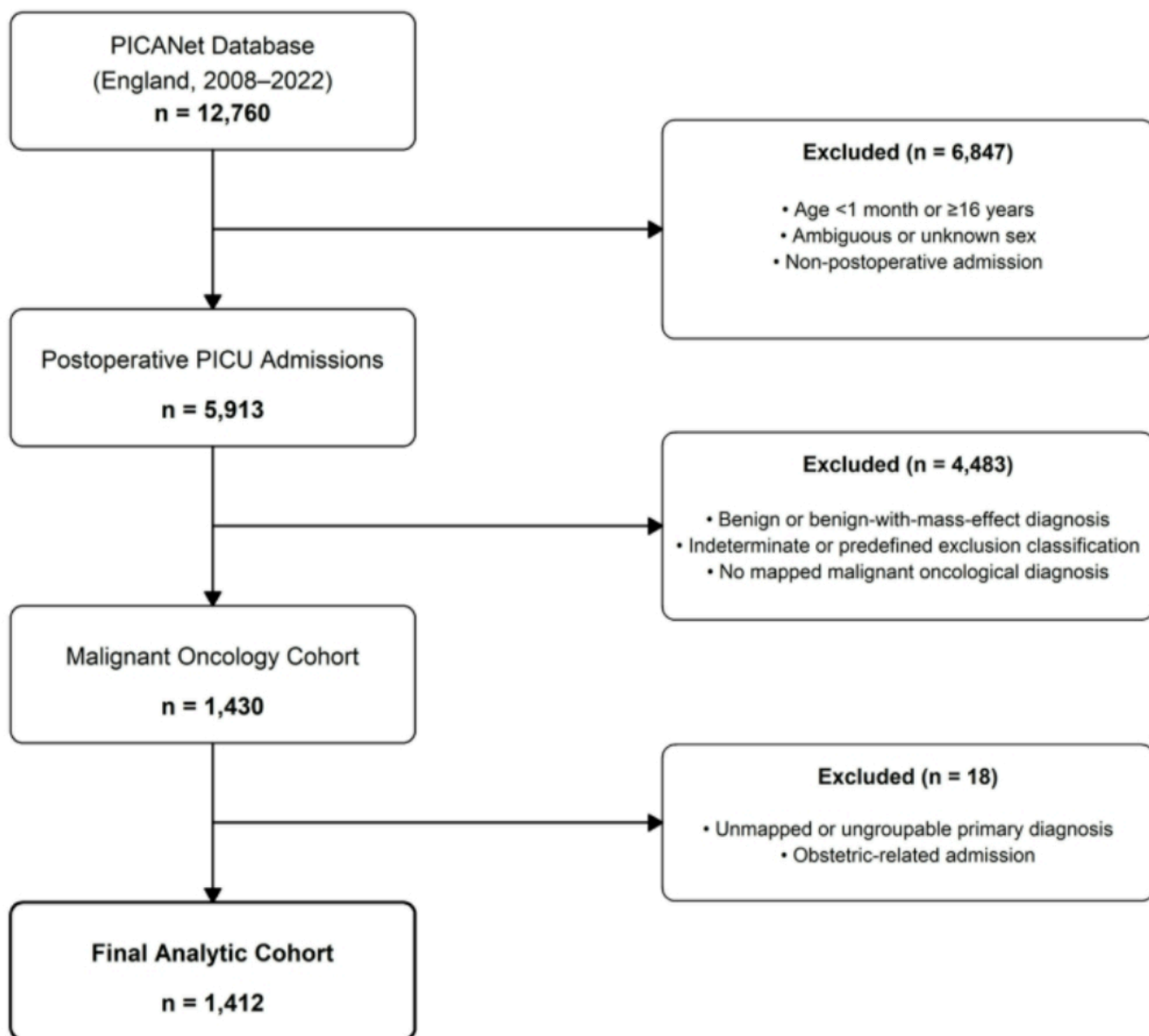


Figure 1

Study Cohort Derivation Flowchart

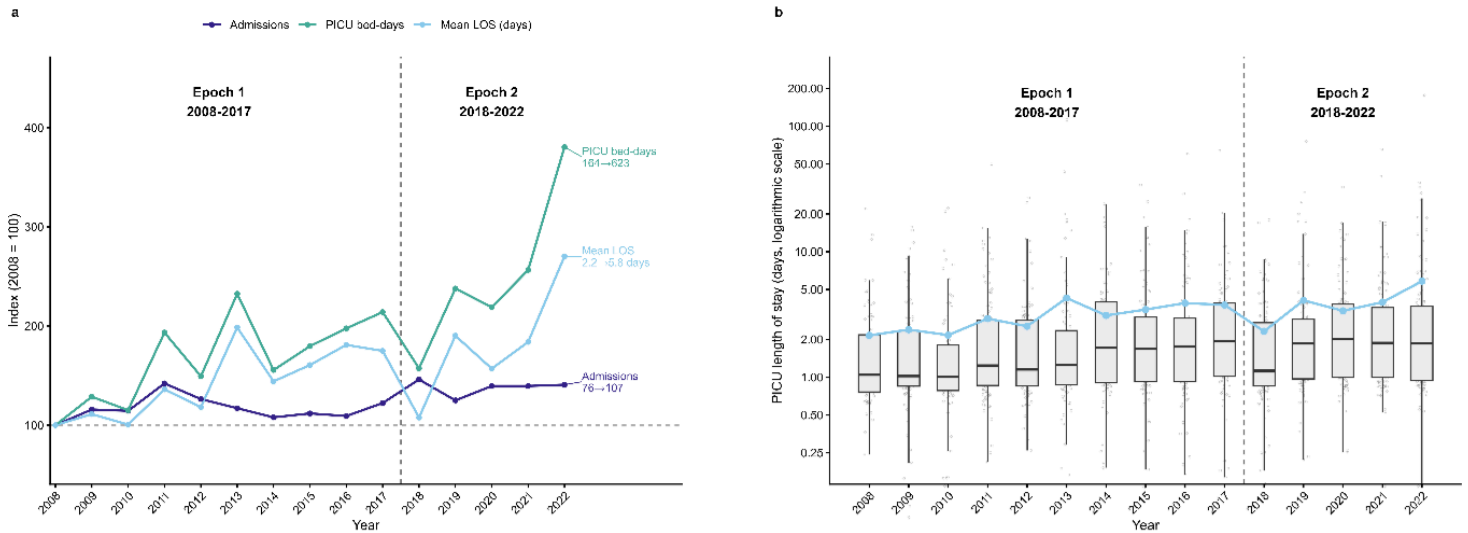


Figure 2

Trends in postoperative PICU utilisation and length of stay, 2008–2022.

(a) Annual postoperative PICU admissions, aggregate PICU bed-days and mean PICU length of stay (LOS), indexed to 2008 (=100). Lines connect observed annual values without smoothing. (b) Distribution of admission-level PICU LOS by year on a logarithmic scale. Boxes represent median and interquartile range, grey points represent individual admissions, and the blue line represents annual arithmetic mean LOS.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [ESM1SupplementaryFile.pdf](#)
- [ESM2SupplementaryFigureandTables.pdf](#)