PICA Net

# 2013 Annual Report

## Summary Report

Paediatric Intensive Care Audit Network

January 2010 – December 2012

University of Leicester

University of Leeds

# KEY

| | | |
|---|---|---|
| A | | Cambridge University Hospitals NHS Foundation Trust |
| B | | Brighton & Sussex University Hospitals NHS Trust |
| C | | Cardiff & Vale University Health Board |
| D | | Central Manchester University Hospitals NHS Foundation Trust |
| E | | Great Ormond Street Hospital for Children NHS Trust |
| | E1 | PICU/NICU |
| | E2 | CCCU |
| F | | Guy's & St. Thomas' NHS Foundation Trust |
| G | | Hull & East Yorkshire Hospitals NHS Trust |
| H | | King's College Hospital NHS Trust |
| I | | Leeds Teaching Hospitals NHS Trust |
| J | | The Lewisham Hospital NHS Trust (finished reporting in Aug 2010) |
| K | | Newcastle upon Tyne Hospitals NHS Foundation Trust |
| | K1/K3 | Great North Children's Hospital |
| | K2 | Newcastle Freeman Hospital |
| | | (In 2010 Newcastle General and Royal Victoria Infirmary PICUs merged within the Great North Children's Hospital) |
| L | | University Hospital of North Staffordshire NHS Trust |
| M | | Queens Medical Centre Nottingham University Hospitals NHS Trust |
| N | | Oxford University Hospitals NHS Trust |
| O | | Royal Brompton & Harefield NHS Foundation Trust |
| P | | Royal Liverpool Children's NHS Trust |
| Q | | Sheffield Children's NHS Foundation Trust |
| | Q1 | Sheffield Children's Hospital (NICU) |
| | Q2 | Sheffield Children's Hospital (PICU) |
| R | | Southampton University Hospitals NHS Trust |
| S | | South Tees Hospitals NHS Trust |
| T | | St. George's Healthcare NHS Trust |
| U | | Imperial College Healthcare NHS Trust (SMH) |
| V | | Birmingham Children's Hospital NHS Trust |
| W | | University Hospitals Bristol NHS Foundation Trust |
| X | | University Hospitals of Leicester NHS Trust |
| | X1 | Leicester Glenfield Hospital |
| | X2 | Leicester Royal Infirmary |
| Y | | NHS Lothian – University Hospitals Division |
| Z | | Barts and the London NHS Trust |
| ZA | | NHS Greater Glasgow and Clyde – Women and Children's Division |
| ZB | | The Royal Group of Hospitals and Dental Hospitals HSS Trust |
| ZC | | Our Lady's Hospital for Sick Children, Dublin |
| ZD | | The Children's University Hospital, Dublin |
| ZE | | Harley Street Clinic (non-NHS) |



PICANet- Paediatric Epidemiology Group, Centre for Epidemiology and Biostatistics
The Leeds Institute of Genetics, Health and Therapeutics
Room 8.49, Worsley Building
University Of Leeds
Leeds, LS2 9JT
Telephone: 0113 343 8125
E-mail: picanet@leeds.ac.uk

# CONTENTS



FOR THE TABLES AND FIGURES AND APPENDICES TO THIS REPORT PLEASE VISIT:

www.PICANet.org.uk


ISBN 978 0 85316 3268

# ACKNOWLEDGEMENTS

The ongoing success of this international clinical audit is dependent on the hard work and commitment of a large number of individuals working within the paediatric intensive care community. We are very grateful to all the audit clerks, secretaries, nurses and doctors who support and contribute to the Paediatric Intensive Care Audit Network (PICANet) from their own paediatric intensive care units (PICUs).

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

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

For the period of this report PICANet was funded by the National Clinical Audit & Patient Outcomes Programme, administered by the Healthcare Quality Improvement Partnership (HQIP), Welsh Health Specialised Services Committee, NHS Lothian/National Service Division NHS Scotland, the Royal Belfast Hospital for Sick Children, Our Lady's Children's Hospital, Crumlin and the Children's University Hospital, Temple Street from Dublin, Ireland and The Harley Street Clinic.

# FOREWORD

Welcome to the 10th annual report from PICANet providing baseline information on PICU activity and risk adjusted outcomes covering all PICU admissions in the UK and Ireland.

This year the design of the report has changed and we present more data than ever before. Our tables and figures are presented in a separate section of the report and are produced in excel format to allow organisations to download the data for their own purposes. The summary report highlights a few key areas including a preliminary analysis of the new referral and transport datasets. We have also refined the analysis of our annual staffing survey to compare staffing levels against bed occupancy by level of care, allowing closer assessment against professional standards. In addition we have presented two new outcome measures – Ventilator Free Days and the proportion of emergency readmissions within 48 hours.

Reports based on these new measures will be implemented in PICANet Web, the web-based data entry and reporting system used by nearly all PICUs contributing to PICANet. Expanding and enhancing the reporting capabilities of PICANet Web will enable PICUs to benchmark their performance against national data and to provide their own organisations and commissioning boards with the level of information required to support the service. Over the next year we aim to consult with PICUs about making this data publicly available on our website.

PICANet is the prime source of clinical audit and commissioning information for paediatric intensive care in the UK and Ireland. The integration of clinical audit and commissioning data makes good sense as standards set by commissioning boards are based on clinical performance indicators. We are confident that PICANet data will continue to be used to improve clinical standards in paediatric intensive care and inform the commissioning process to optimise the service provided to children receiving care, and their carers, via national and local feedback.

Roger Parslow
Liz Draper

Principal Investigators

PICANet

# EXECUTIVE SUMMARY

Data are presented on 57,949 paediatric intensive care admissions (aged under 16 years) and 1328 admissions 16 years and over to 30 NHS trusts and Health Organisations and one non NHS paediatric intensive care unit in the UK and Ireland over the three year period January 2010 to December 2012.

Admission numbers have increased by nearly 5% between 2011 and 2012.

It is extremely rare for a child to die in paediatric intensive care and over 96% of children were discharged alive in 2010-2012. Crude mortality was at an all-time low of 3.8% in 2012. Risk-adjusted performance of all participating health organisations fell within acceptable limits in each individual year and aggregated across the three year period.

Two thirds (67%) of admissions received invasive ventilation. This varied from 7% to 87% of patients by Health Organisation in 2012. Invasive ventilation rates also varied by geographical region reflecting the different patient case-mix admitted to PICUs.

Over 349,000 bed days were delivered between 2010 and 2012. The year on year increase appears to reflect increased activity in some units. Just under one third of patients have a length of stay of less than 24 hours and a further third stay between one and three days. Seventeen percent of patients remain within one PICU for seven or more days.

Staffing data are collected in two ways in the PICANet annual staffing survey. Firstly, reported establishment against funded beds (7.01 WTE per critical care bed) and also actual staffing levels at four selected time points during one week in November 2012: Wednesday and Sunday at midday and midnight. Although the PICS standard for reported nurse establishment is only achieved in 15% of PICUs the actual nurse staffing level at midday on Wednesday of the survey week showed that over 70% of PICUs reached the recommended nurse staffing levels required for the levels of care and patient dependency on the unit at that time.

Almost all PICUs (90%) achieved the medical consultant staffing levels recommended by the PICS standards (one consultant per 8 to 10 beds available at all times) during daytime hours. Night cover was somewhat lower with 60% of PICUs achieving recommended levels of cover.

Preliminary analysis of the new Referrals and Transport dataset reveals that 84% of referrals were accepted by the initial PICU. Critical incidents were reported in 13% of transport events although specific details have yet to be analysed.

Crude rates of emergency readmission to PICU within 48 hours are presented by Health Organisation for the first time. There are no established standards for this measure in paediatric intensive care but we report an average emergency readmission rate of 1.7%, varying between 0% and 4% in the three years 2010-2012.

# RECOMMENDATIONS

- NHS Trusts and other Health Organisations should take the necessary steps to ensure that staff levels meet minimum standards laid down by the professional society, both in relation to overall establishment and to meet the needs of critically ill children on a daily basis.

- Emergency readmission rates should be monitored closely as a key quality indicator.

- Complete data about individual PICU admissions should be submitted to PICANet within 3 months of the date of discharge to comply with the Paediatric Intensive Care Society standards and, for English units, as a key Data Quality Dashboard quality indicator.

- NHS trusts, other Health Organisations and specialist commissioners should be aware of the increasing demand for paediatric intensive care driven by increased birth rates and improved survival for some complex paediatric conditions.

# LAY SUMMARY

It is difficult to write a lay summary for something as esoteric as the annual report of the clinical audit network for paediatric intensive care. By definition it will be data heavy, crammed with densely packed tables, bristling with jargon and oozing acronyms. But then that is it's job, to inform the specialist paediatric intensive care fraternity and the academic, clinical and commissioning teams that support them how the last year has looked performance wise. If you know what you are looking for you can establish how risk adjusted mortality rates looked across the network, (reassuringly at an all time low of 3.8%); what transit times to intensive care were like for children who fell ill or were injured outside hospital environments (86% received intensive care within 3 hours of the need arising), and so on. The data is there to establish the profile of children needing intensive care this year, the actual level of demand and how this compares to previous years. All this constitutes a fantastic evidence base for planning health provision and striving towards excellence in care standards, but for lay people, even interested ones, it presents a superfluity of data.

As a lay person it is reassuring to know that there is a solid evidence base behind the provision, staffing and clinical decision making informing the delivery of paediatric intensive care services. It is great that both service providers and academic researchers are interrogating this database on a regular basis to help monitor existing practice and drive up standards going forwards. It is good to know that wherever in the country a child is injured or falls severely ill the system has the capacity to transport them safely and effectively to specialist care within a reassuringly short time frame. Similarly it is good to know there is no increase in mortality risk out of hours or in relation to the size of unit a child is admitted to. In contrast it is of concern that there has been a rise in demand of 5% between 2011 and 2012, leading to an increase in pressure on beds and staff, particularly in winter, that is at times acute. This rise appears to follow an increase in birth rate and since 48% of admissions are for children under one will presumably stay high until the birth rate drops. There is also a relentless increase in pressure following the survival of children with increasingly complex paediatric conditions needing extended periods of critical care.

Lucy Wheeler

Lay Representative

PICANet Steering Group

But I suspect almost no lay people will discover these things by reading this document as they will not know it exists or be able to engage with it constructively if they did. Perhaps what is needed is the edited highlights of this excellent dataset expressed in accessible language on a webpage in a way that is helpful to an interested but non clinical audience, such as parents of very sick children. If these families were lucky enough to have healthy families before this point they may not even know that dedicated paediatric intensive care facilities even exist until their child is admitted to one, and the knowledge that the care their child is receiving is evidence based and driven by best practice is what they need to hear at a difficult time. Hopefully PICANet might be able to provide something of this sort in the future and thereby share this data with a genuinely lay audience for the first time.

# BACKGROUND & INTRODUCTION

Since November 2002, all NHS PICUs within England and Wales outside the Pan Thames region have been collecting data on consecutive admissions to their units. The Pan Thames units began data collection in March 2003, and the PICU at the Royal Hospital for Sick Children, Edinburgh in December 2004. The Royal Hospital for Sick Children, Glasgow in March 2007 and The Royal Belfast Hospital for Sick Children in April 2008. Our Lady's Children's Hospital, Crumlin and the Children's University Hospital, Temple Street, both based in Dublin, have submitted anonymised data to PICANet from 2010. The non-NHS Harley Street Clinic PICU started contributing data in September 2010 to allow them to compare their performance against the national benchmark provided by PICANet. A full list of participating Health Organisations can be found in Appendix A of the online annual report section of the PICANet website.

PICANet receives support and advice from a Clinical Advisory Group (CAG) drawing on the expertise of doctors and nurses working within the speciality and a Steering Group (SG), whose membership includes Health Services Researchers, representatives from the Royal Colleges of Paediatrics and Child Health, Nursing and Anaesthetics, a lay member and commissioners. We also have a PICU Families Group to consider the impact of admission to intensive care on children and their families. Appendices B, C and D provide a full list of CAG, SG and PICU Families group members. Additional support from the clinical community is provided through the Paediatric Intensive Care Society.

This 10th annual report from PICANet retains the format of a short printed summary report and the bulk of the report containing the data tables, appendices and descriptions of methods is available on the PICANet website (www.picanet.org.uk). This enables the public, patients, clinicians and commissioners to have free access to data on PICU activity and performance and reflects government policy on transparency. We have changed the layout and formatting to improve readability and allow printing of colour figures in grayscale without loss of information. As all units in England and Wales will have contributed a full 10 years of data for our next report we are already planning a special 10 year edition and are happy to consider ideas for topics and analyses for this report.

This year, all contributing organisations made a superb effort to submit data on time. This makes the production of the annual report much easier for the PICANet team.

We continue to attract high quality commissioned articles for the report that reflect the different views of the PIC community and, we hope, provide interesting new perspectives for our readers.

## DATA AND INFORMATION REQUESTS

There were 118 requests for data and information since last year's annual report was prepared, more than double than last year (n=44). All the research oriented requests are sent to the chair of the Paediatric Intensive Society Study Group to ensure that there is good collaboration in the clinical community and no overlap of effort. The chair, currently Dr Mark Peters from Great Ormond Street, is able to give constructive advice to applicants where there are opportunities for collaboration.

PICANet publishes all data and information requests on our website (www.picanet.org.uk) and the requests for this year are published in the online appendices to this report. These requests vary substantially - from those that require information on a specific condition to queries about patient flows to help plan service delivery. Anyone who requests and receives data or information from PICANet must provide a written response on how the data has been used and must acknowledge PICANet and our funders, HQIP, in all presentations and reports. In the case of publication, it is expected that a member of the PICANet team will be included as an author and

therefore will have reviewed the manuscript and contributed to the analysis and interpretation. Our document, *Data and information requests: policy on use of data, publication and authorship. Version 1.2.1 February 2011*, available from www.picanet.org.uk contains more details.

We are working with HQIP to align the use of PICANet data with the rest of the National Clinical Audit Programme. This will mean that all applicants seeking identifiable data will need to complete additional forms for HQIP (the official owners of PICANet data). We will be formulating a new data request procedure that reflects these new requirements in the coming year. In the meantime, we intend to expand the reporting facility on PICANet Web to allow better access to more complex data for individual PICUs.

## International collaboration

Our successful collaboration with ANZPICS, the Australia and New Zealand Paediatric Intensive Care Society has resulted in the development of a refinement to the Paediatric Index of Mortality 2 (PIM2), imaginatively named PIM3. This has been published in Pediatric Critical Care Medicine (1).

Unfortunately the bid for European Union funding to develop a Europe wide PIC database and associated programme of work (the PICTURE project) was not successful. However, this is hopefully only a temporary setback and at a recent meeting of the PICTURE group at the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) in Rotterdam we developed a staged plan to develop this work starting with the development of a Europe wide standardised data collection led by PICANet with some funding from ESPNIC whilst a new funding bid is developed for the rest of the programme of work.

## New outcome measures

This year we have added two new outcome measures (emergency readmissions within 48 hours of discharge and Ventilator Free Days) which will contribute to the development of quality indicators that are required for commissioning. There is no standard set for emergency readmissions, although it is the intention of the Clinical Reference Group to use data from 2012/2013 to establish a baseline. Currently the use of Ventilator Free Days as a quality indicator has not been included in the proposed Data Quality Dashboard; we invite comment on its potential utility.

## Out of hours and winter admissions and capacity modelling

Our recent paper in Pediatrics (2) concerning out of hours admissions is a good example of the use of our large dataset to assess quality of care across the whole PIC service. The findings indicate that the quality of the service (assessed by risk-adjusted mortality) is consistent throughout the day and week, with no excess mortality for emergency admissions out of normal working hours. The excess mortality seen in the winter months may be as a result of changing patient case-mix at times of maximum occupancy and highlights the need to ensure that service capacity is able to cope with the winter peak demand. PICANet is currently carrying out a capacity modelling exercise for the Specialist Commissioning Board to enable appropriate evidence-based decisions to be made about resource allocation. This work is being carried out in the context of rising admission rates reflecting increased birth rates in parts of the UK.

## Funding

PICANet has received core funding from the Healthcare Quality Improvement Partnership to 31st March 2016.

## References

1. Straney, L, Clements, A, Parslow, R.C, Pearson, G, Shann, F,Alexander, J, Slater, A, for the ANZICS Paediatric Study Group and the Paediatric Intensive Care Audit Network. (2013) Paediatric Index of Mortality 3: An Updated Model for Predicting Mortality in Pediatric Intensive Care. DOI: 10.1097/PCC.0b013e31829760cf

2. McShane, P, Draper, E. S, McKinney, P. A, McFadzean, J, Parslow, R. C, & Paediatric Intensive Care Audit Network (PICANet). (2013). Effects of Out-of-Hours and Winter Admissions and Number of Patients per Unit on Mortality in Pediatric Intensive Care.. J Pediatr. DOI:10.1016/j.jpeds.2013.03.061

# CLINICIAN'S COMMENTARY

## 'THE YEAR OF DATA'

### DATA AND OUTCOMES

'Data' and 'Outcomes' are much in the news of late, with a widely publicised commitment to openness and transparency in the NHS culminating in the recent publication of mortality rates for individual surgeons and cardiologists in a number of clinical areas (1). The intention is that this data will allow users of the health service to make informed choices about where to go for their health care, and allow health care providers to identify areas of poor practice, on the presumption that outcomes significantly different from the average do actually mean that 'poor practice' has occurred. However, benefits in health care rarely come without some risk. Concerns have been expressed about the quality and risk adjustment of the individual operator data (2), and some clinicians have refused to allow their data to be released. Closer to home, incomplete and unvalidated data was recently released that appeared to show poor performance in one paediatric cardiac surgery unit. Although the conclusions were subsequently withdrawn and the data re-analysed (3), confidence in the database was shaken and concerns about the data remain.

PICANet aims to continually support the improvement of paediatric intensive care throughout the UK through the analysis of similar clinical data based on risk adjusted outcomes. It has been undeniably successful in doing this over the past eleven years. How has PICANet avoided the difficulties that have befallen others?

Firstly by having high quality data. The prime responsibility for this rests with individual units and individual clinicians. Experience tells us that inter-observer variability occurs in PIC data collection, and that this variability is reduced by training and strict guidelines. Dedicated administrative staff are more likely to produce complete datasets than rotating junior doctors or hard-pressed bedside nurses, but these posts may be seen as superfluous to hospitals who need to find money for the incessant demands of cost improvement programmes. PICANet also ensures complete and high quality data by the system of visits and data validation outlined in Appendix G.

Dr Peter Barry

Consultant Paediatric Intensivist

University Hospitals of Leicester NHS Trust

Secondly, PICANet avoids criticism by having a widely accepted and validated risk adjustment model. The Paediatric Index of Mortality (PIM) was first described in 1997, and updated in 2003 (PIM2). The model was originally based on results from seven intensive care units in Australia and one in the UK, with the revision taking data from more units from the UK and New Zealand. It has subsequently been evaluated in many different countries and clinical areas, and is recalibrated each year to reflect the performance of the model in the population under study. There is a suggestion that PIM under predicts observed mortality in patients requiring the highest level of care, and it is not discriminatory for patients receiving certain therapies, such as respiratory ECMO. Although the number of patients included in PICANet has increased from fewer than 14,000 in 2004 to just under 20,000 in 2012, much of this increase has been in the lower risk of mortality groups, with the number of children with the highest predicted risk actually falling. Nevertheless, PIM2 is simple, intuitive, and remains the best tool for the job.

PICANet has the trust of its contributors and is widely regarded as independent. The events surrounding the discredited review of paediatric cardiac surgery in England and Wales have strained relationships between units, which, in some cases, appear to have completely broken down. PICANet's strong governance, led by a wide ranging and non-partisan steering group and clinical advisory group, and its transparent, even-handed approach, have allowed it to stay above these disputes. PICANet also has formal policies for dealing with data anomalies and outliers, which are applied consistently and fairly.

PICANet benefits from the fact that the main outcome measure, mortality on PICU, is relatively easy to define and measure, and is of obvious importance. However, as Kevin Morris wrote in last year's commentary, the relative infrequency of death on PICU makes it a poor discriminator of quality. The challenge remains for us to discover what makes a unit 'high quality', and to define the factors beyond mortality that are important to our patients and their families. So far the Quality Dashboards introduced by the various clinical reference groups in the NHS contain measures chosen for ease of collection and have been largely of administrative interest, but have potential to drive improvement. Future measures need to be well defined, relevant and written in such a way that promotes outcomes rather than structures. If asked 'what does good intensive care for children look like?' most clinicians will point to their own unit, or to one of the international flagship units. And yet 'good intensive care' can be delivered in a range of situations, and we need to better define what we mean by 'good intensive care' before we can determine where it occurs. PICANet work in this area is keenly awaited, but the challenge is to promote outcome measures that have validity and are widely accepted.

## Reconfiguration and centralisation

More than 30 units return data to PICANet, containing in total nearly 370 ITU beds and ranging from large 26 bedded units offering a complete range of interventions and services to one bedded facilities undertaking less complex work. Since the publication of the 'Framework for the Future' document in 1997 (4), the provision of intensive care services has changed, but not by the closures and rationalisation of PIC into a small number of large 'super units' as some envisaged. In 1996, the available dedicated general paediatric intensive care beds were spread across England in 29 centres of differing sizes. In 2012, 27 English PICUs sent data to PICANet. Unit size has increased, but due to changes in use and a reduction in the number of critically ill children cared for outside of paediatric facilities rather than the centralisation of PIC beds into a smaller number of PIC units. The incentive for proposing centralisation of care came from retrospective studies of UK PICUs, extrapolation from other specialties, and observational studies of a

different model of care than that provided in the UK, using administrative rather than clinical data. However, a more recent study using PICANet data from English and Welsh PICUs has shown no evidence of a relationship between unit volume and outcome [5]. Similar conclusions can be drawn from an analysis of UK congenital cardiac surgery data [3].

And yet it seems intuitive that more frequent practice leads to better outcomes – after all, 'practice makes perfect'. This simplistic analysis ignores the fact that some relatively small units appear to provide excellent care with good outcomes, in some cases better than the larger units. *'Volume is, in effect, a surrogate marker which subsumes a wide range of process and system characteristics which have yet to be identified or analysed for their association to outcome'* (6). As discussed in the previous section, the challenge is for us to identify these characteristics and describe them adequately so that they might be included in future PICANet audits.

## Children in Adult units

Data on children cared for in Adult ICUs is given in tables 56-59. The absolute number of these children has remained constant between 2004 and 2012, but given that the overall number of children included in PICANet has increased by a third, the relative number of children in adult ICUs has probably fallen. Apart from the overall number, sex, age and diagnostic group, we have very little information about these children. Two thirds have an underlying respiratory or neurological diagnosis, and over half are transferred to PICU, an increase from 2004, when it was 40%. Does this mean that children who would have spent a brief time in adult ICU before recovery and transfer to the paediatric ward are now being transferred at an earlier stage to the regional PICU? Does the fact that number of children admitted to Adult ICU has not increased in line with the other PICANet admissions data suggest that children who become ill in a non-specialist hospital are stabilised in the emergency department or recovery room, rather than being admitted to AICU, to await the arrival of the retrieval team. These questions can only be answered by linking data from different databases, such as PICANet and ICNARC.

## More on Data and what we do with it

Appendix M of the report details 118 requests for data since the last annual report was published. These range from simple requests to support audit of local activity to much more complex ones requiring linked data and permissions from several units before data can be released. The requests are dealt with by Phil McShane and Lee Norman with great skill and care, and it is remarkable that the median time from receiving the request to responding is only five days, with 28 of the 118 requests answered the same day! Over half of the data requests were for internal audit of activity or to support the returns for the recently introduced quality dashboards. The ability to download individual units' data should reduce the number of requests that need to be dealt with by the PICANet team. A third of the requests were to inform research, publications or presentations. Appendix K of the report lists 27 publications and 25 abstracts produced by members of the PICANet team arising from the database, and Medline includes the citations for ten listed publications. This is perhaps a disappointing total from such a great resource, and is an area that we could all contribute to improving.

Data requests are handled according to a comprehensive protocol (http://www.picanet.org.uk/Documents/General/Data_and_Info_use_policy_February2011v1_2_1.pdf) which deals with issues such as the release of patient identifiable data and the release of data to third parties that identifies an individual unit or Trust without the express permission of the clinical lead/Trust CEO or their representative. These are important safeguards which help to maintain the confidence of patients and clinicians

in the database. The other side of this coin is that if data is withheld by an individual unit, this devalues the whole database and encourages suspicion and mistrust. Neither of these are good for patients. Concerns about the misinterpretation and misrepresentation of a complex data set are well found, especially in parts of the popular media, but we do ourselves no favours by appearing to want to hide information. Units need to have the discretion to restrict the release of unit identifiable data, but such discretion should be exercised lightly and with good reason.

## Previously in 'Clinicians' commentaries'

Looking back on the clinicians' commentaries that have appeared in the annual report over the last few years, a number of common themes have emerged, many of which are repeated this year:

In 2010, Jillian McFadzean noted that the quality and credibility of this report is dependent on the accuracy of the raw data submitted to PICANet. Data accuracy continues to be a strength of PICANet and a potential weakness that demands our constant vigilance.

In 2009, Peter Davis noted that mortality was a fairly poor arbiter of performance, and recommended the collection of morbidity data. This was repeated in 2012, when Kevin Morris suggested moving beyond mortality as an outcome measure and developing measures centred on delivery of a high quality and safe service, and measures of morbidity. PICANet is ideally placed to lead on this, and clinicians should drive this process, rather than having it imposed on them.

In his commentary, Peter Davis also noted that the provision of intensive care had not proceeded along the lines of a smaller number of larger units, but predicted that changes in the system of payments and reconfiguration of specialist services would drive further centralisation. This has not, so far, happened, and in 2010 Jillian McFadzean noted the lack of a relationship between unit size and mortality, again noted in this report. We wait to see if measures of morbidity, as opposed to process, are equally unaffected by unit size in the UK and Ireland.

In 2006, Gale Pearson noted the difference in case-mix between units, suggesting that PICANet should produce risk adjusted outcome data for invasively ventilated patients as a separate group in the future, a suggestion echoed by Kevin Morris in 2012. A problem with this is that it would disadvantage general units that manage early respiratory failure well by the use of non-invasive ventilation or high flow humidified oxygen therapy compared to the unit that manages their patients differently. This illustrates how complex things become as we move away from the simple outcome of all unit mortality.

## Conclusion

PICANet goes from strength to strength, and we should rightly be proud of what has been achieved. But we should not forget how vulnerable the structure is. In times of austerity, it is all too easy to cut the data clerk post, and funding of the national PICANet team is continually under scrutiny. Greater threats arise from the misuse of data, from the selective release of data, or restricting its analysis. We take PICANet for granted at our peril, for open data is a fragile flower that needs to be protected and cherished.

## References

1. NHS England. 'Major breakthrough in NHS Transparency as consultant mortality data goes online for first time' http://www.england.nhs.uk/2013/06/28/mjr-brkthgh-nhs-transp-cons/ (Accessed 30/6/2013)

2. Daily Telegraph. 'Surgeons' mortality rates are meaningless, say patient groups' http://www.telegraph.co.uk/health/healthnews/10151716/Surgeons-mortality-rates-are-meaningless-say-patient-groups.html. (Accessed 30/6/2013)

3. NICOR statement - Paediatric cardiac surgery http://www.ucl.ac.uk/nicor/nicor/NICOR_statement_paediatric_cardiac_surgery. (Accessed 30/6/2013)

4. Department of Health. Paediatric Intensive Care - A Framework for the Future. London: Department of Health; 1997.

5. McShane, P, Draper, E. S, McKinney, P. A, McFadzean, J, Parslow, R. C, & Paediatric Intensive Care Audit Network (PICANet). (2013). Effects of Out-of-Hours and Winter Admissions and Number of Patients per Unit on Mortality in Pediatric Intensive Care.. J Pediatr. doi:10.1016/j.jpeds.2013.03.061

6. Ewart, H. The Relation Between Volume and Outcome in Paediatric Cardiac Surgery; Public Health Research Unit – A Literature Review for the National Specialised Commissioning Group (2009). Available at http://www.specialisedservices.nhs.uk/document/developing-model-care. (Accessed 30/6/2013)

# Referral and transport data in Yorkshire and the Humber

The Referral and Transport data are described in the Tables and Figures section of this report; however, to provide a more detailed example of how the data can be used, we have concentrated here on the Yorkshire and the Humber region. The region has three PICUs (Leeds, Hull and Sheffield) and one transport organisation called Embrace (1).

We have examined the events forming a series (based on NHS number, as described in the Tables and Figures section) involving any of these organisations at any stage. In 2012 there were 2,254 events (403 each referral and transport and 1,448 admissions) in 1,495 series involving 1,057 children.

Most series were isolated admissions to one of the regional PICUs, but there were 309 consisting of one of each type of event, these were the second largest group of series. In addition some series involved other PICUs and transport services as well as those in Yorkshire. Twenty two events did not have an NHS number recorded and so could not be put into a matched series. Of 342 series where both referral and transport events indicated that a child was transported, matching admissions could be found in all but 12. We are reviewing the matching process to optimise match rates and will establish a procedure to follow up unmatched referrals and transport events. These early results do suggest, however, that the matching process is generally successful.

In the region, 98% of referrals resulted in a decision to admit, and 95% of transport events record that the child was delivered to the destination. There were 14 deaths, none of which occurred during the journey.

A critical incident was recorded in 46 (11%) transport events. Of 20 possible types of incident the most common is *other* and is often unspecified.

In the 396 admissions recorded as *retrievals*, transport events could be linked in 342, suggesting that some such events may be missed, or at least not linked.

The median patient journey time was 55 minutes (IQR 40-80). Other time intervals can be calculated from the data.

## PICS standards for retrievals

The data collected will be used to audit transport activities against the Paediatric Intensive Care Society Standards, two of which are relevant.

Standard 123 states: *The retrieval team should arrive at the referring unit within three hours of the decision to retrieve the child*. This may be assessed from transport events, which show that in the region it was met in 86% of cases in 2012.

Standard 124 states: *Wherever possible, a child should undergo one retrieval journey only*. In the region in 2012, only five out of the 395 series (1.3%) including transport events, had more than one retrieval journey, suggesting a good level of compliance with this standard.

The referral and transport datasets are still under review and at this early stage extra caution must be taken in interpreting these results.

## References

1. http://www.sheffieldchildrens.nhs.uk//downloads/embrace/Embrace_AnnualReport2011-12.pdf

# STAFFING WITHIN PICUS

PICANet works closely with the Paediatric Intensive Care Society (PICS) to monitor the standards that apply to staffing levels within PICUs. Each year in November, a staffing questionnaire is sent to all PICUs in the UK. In the report this year we present data collected in November 2012 compared with similar data obtained in 2010 and 2011.

In this chapter a summary of number and proportion of units meeting the appropriate PICS Standards (PIC Standards for the Care of Critically Ill Children (4th Edition); Version 2, June 2010) is presented with the full results presented in the Tables and Figures of this report. Figure 1 on the following page presents the details of the PICS Standards assessed by the PICANet Staffing questionnaire.

The questionnaires were sent to the lead doctor and senior nurse in each PICU requesting information concerning the numbers of nursing staff and medical staff employed during a specified week in November 2012 and on duty at four 'snapshot' time periods (a weekday (Weds) at noon(A) and midnight(B) and a weekend (Sunday) at noon(C) and midnight(D). Data are analysed in two ways: by the reported staffing establishment against funded beds and the actual staffing levels at the four time periods to provide the level of care requirements for the children.

Table 1 overleaf provides a summary of the data indicating the number and proportion of units meeting the nursing and medical PICS Standards analysed by unit size (≤10 beds or >10 beds) in November 2012. Although only five units (15%) are reported as meeting Standard 164 Appendix 13 of the PICS guideline which states that the nurse establishment requires at least 7.01 WTE of qualified nurses to staff one critical care bed; when the nurse staffing levels are analysed for the actual requirement for in patients at the four time periods then between half and three quarters of units have adequate staffing levels (PICS Appendix 1).

Many units use additional Bank / Agency staff to meet their nursing requirements, partially explaining the difference between reported nurse establishment and actual working practice. This is evident out of hours, particularly weekends. Eleven (33%) of units reported a nurse establishment that meets the previous standard of 6.4 WTE. The higher staffing levels reported by some units at midday on Wednesday may be due to planned elective surgical admissions expected after noon.

Medical consultant staffing levels showed high levels of compliance with Standard 157 during a weekday at noon: 90% (n=29) with at least one consultant available to the unit at all times for every eight to ten beds. However, night cover is reported as being significantly lower with 60% of units achieving the PICS recommended standards.

Guidelines in Standards 158 and 159 cover medical trainee rostering, 75% of units met Standard 158 for medical trainee cover allocation to five patients or less during normal working hours. However only half the units met Standard 159; one specialist trainee (ST) 4 or above grade doctor outside normal working hours at noon on Sunday and around one third of units at midnight on a weekday and weekend.

Low levels of compliance with up to date paediatric resuscitation training are reported both by medical and nursing staff. This data requires further investigation as reporting structures vary widely between hospitals.

Figure 1. Standards of the Paediatric Intensive Care Society.

| Standards of the Paediatric Intensive Care Society | |
|---|---|
| 144 | The following support services should be available: Interfaith and spiritual support, Social workers, Interpreters, Bereavement support, Patient advice and Advocacy Services, Psychological support for families and children, Psychological support for families and staff. |
| 157 | For every 8 to 10 beds there should be at least one consultant available to the unit at all times. |
| 158 | During normal working hours one medical trainee or equivalent grade doctor should not normally be allocated more than five patients. |
| 159 | Outside normal working hours, for every eight PICU beds there should be at least one ST4 or above grade doctor available to the unit at all times. |
| 162 | All medical staff working on the unit should have training in advanced paediatric life support. |
| 164 | The unit's nursing establishment and nursing rosters should be appropriate to the anticipated number and dependency of patients. Staffing levels should be based on the ratios in Appendix 13:- the minimum number of qualified nurses required to staff 1 critical care bed is, at least 7.01 whole time equivalents (WTE). |
| 167 | All nurses should have up to date paediatric resuscitation training. Senior nurses should have up to date advanced paediatric resuscitation training. |
| 170 | Daily sessional support should be available to the Paediatric Intensive Care Unit from pharmacy, physiotherapy and dietetic staff with competencies in the care of critically ill children who have time in their job plans allocated for their work on the unit. |
| Appendix 1 | Levels of Care & Patient Dependency, Level 1 High Dependency Care (nurse to patient ratio of 0.5:1), Level 2 Intensive Care (1:1), Level 3 (1.5:1), Level 4 (2:1). |

Table 1. Proportion of units who are meeting the PICS Standards relating to Medical and Nurse staffing by unit size.

| Standards of the Paediatric Intensive Care Society | | Specified Time Log (where appropriate) | Number & Proportion of units meeting standard ≤ 10 beds (14 *15) n | (%) | >10 beds (18) n | (%) |
|---|---|---|---|---|---|---|
| **Nursing** | | | | | | |
| 164 (fig S3) | Nursing establishment 7.01 WTE | | 2* | (13) | 3 | (17) |
| | 6.40 WTE | | 6* | (40) | 5 | (28) |
| Appendix 1 (fig S9) | Levels of care & patient dependency | A | 10 | (71) | 13 | (72) |
| | | B | 9 | (64) | 6 | (33) |
| | | C | 10 | (71) | 10 | (56) |
| | | D | 9 | (64) | 9 | (50) |
| 167 (fig S5) | Paediatric resuscitation training. | | 1 | (7) | 4 | (22) |
| **Medical** | | | | | | |
| 162 (fig S6) | Advanced paediatric life support training | | 12* | (80) | 12 | (67) |
| 157 (fig S10) | Consultant availability | A | 13 | (93) | 16 | (89) |
| | | B | 8 | (57) | 12 | (66) |
| | | C | 11 | (79) | 17 | (94) |
| | | D | 8 | (57) | 10 | (55) |
| 158 (fig S11) | Medical trainees: normal working hours | A | 11 | (79) | 13 | (72) |
| 159 (fig S12) | ST4 or above: outside normal working hours | B | 6 | (43) | 5 | (28) |
| | | C | 7 | (50) | 9 | (50) |
| | | D | 6 | (43) | 4 | (22) |

*Organisation G is a 10 bedded general intensive care unit with 2 designated paediatric beds, no care was provided for paediatric patients at the specified times therefore the organisation is only included where indicated by *.

Table 2. The proportion of units indicating the availability of specified support services as detailed in the PICS Standards by unit size.

| Standards of the Paediatric Intensive Care Society | | Number & Proportion of units meeting standard | | | |
|---|---|---|---|---|---|
| | | ≤ 10 beds (15) | | >10 beds (18) | |
| | | n | (%) | n | (%) |
| 144 | Interfaith & spiritual support | 15 | (100.0) | 17 | (94.0) |
| | Social workers | 13 | (87.0) | 17 | (94.0) |
| | Interpreters | 14 | (93.0) | 18 | (100.0) |
| | Bereavement support | 14 | (93.0) | 16 | (88.0) |
| | Patient advice & advocacy services | 15 | (100.0) | 16 | (88.0) |
| | Family psychological support | 11 | (73.3) | 18 | (100.0) |
| | Staff psychological support | 12 | (80.0) | 18 | (100.0) |
| 169 | Discharge coordinator | 4 | (27.0) | 2 | (11.0) |
| 170 | Pharmacy | 14 | (93.0) | 18 | (100.0) |
| | Physiotherapy | 14 | (93.0) | 18 | (100.0) |
| | Dietetic | 14 | (93.0) | 18 | (100.0) |

A wide range of support services are detailed in the PICS Standards ranging from spiritual and bereavement support to interpreters and other specialist services. Nearly three quarters of units (70%: n=23) have access to all the named support services in Standard 144. All units except one have dedicated time from pharmacy, physiotherapy and dietetic services. Although only 18% (n=6) of all units have a specified discharge coordinator, in some organisations the role may be incorporated into other staff positions.

# HUMIDIFIED HIGH FLOW OXYGEN THERAPY IN PAEDIATRICS

Children with respiratory diagnoses formed the second biggest primary diagnostic group of patients (after cardiovascular) in PICU between 2009 and 2011 and accounted for 26.4% of admissions (1). Fifty-four percent of these cardiovascular cases were planned admissions whereas 10.6% of respiratory admissions were planned (1). Previous analyses have shown that respiratory failure in infants contributed the majority of the unplanned respiratory admissions and were likely to be secondary to acute bronchiolitis (2). The seasonal nature of bronchiolitis in turn, explains the surge in admissions over the winter months. Hospital admissions of infants with bronchiolitis has increased by 50% between 2004 and 2011 (3), and PICANet data from 2002 to 2012 shows a steady increase in the proportion of patients with bronchiolitis admitted to PICU (Figure 1).

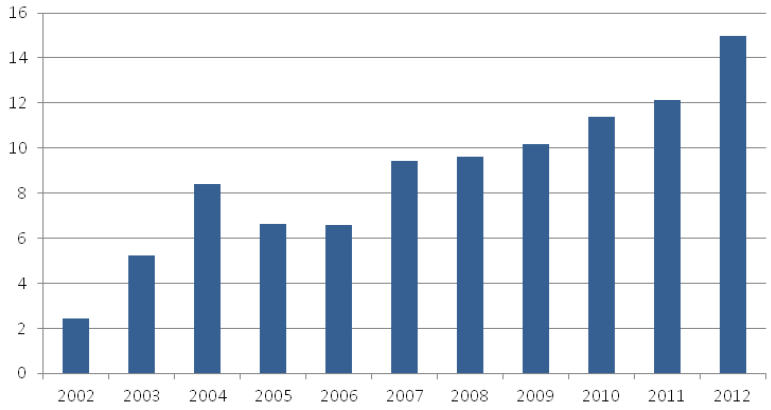


Figure 1. Bronchiolitis admissions as percent of total PICU admissions

As there is no effective preventive or curative intervention for acute bronchiolitis at present, supportive measures and measures to prevent deterioration are the goals of current hospital management. In addition to supportive measures like supplemental oxygen and nasogastric tube feeding, some practitioners argue that non-invasive ventilation early in the illness may abort the progression to respiratory failure (4). In the UK, the southwest critical care network has equipped and trained district hospitals to use Continuous Positive Airway Pressure (CPAP) in infants with respiratory failure (5) and suggest that this is a factor in the comparatively low PICU admission rate per 100,000 population in that area. However, a systematic review of controlled trials of CPAP in bronchiolitis showed that despite

Dr John Alexander

Consultant Paediatrician

University Hospital of North Staffordshire NHS Trust

modest reductions in respiratory rate and $PCO_2$, there was no difference in the need for intubation (6). Nevertheless, many paediatricians provide this treatment on the anecdotal observation that it is tolerated by most infants, could reduce the work of breathing and may prevent intubation.

A recent technique reported to be useful for managing respiratory failure in bronchiolitis is humidified high flow nasal cannula oxygen (HHFNC), first described in adult literature about 10 years ago (7). Traditional oxygen delivery using nasal prongs was first described in children in the 1920s (8) but the use of low flow nasal cannula oxygen rather than oxygen delivery via head box or by facemask only became popular in the 1990s. Nasal cannula oxygen works by increasing the oxygen concentration within the nasopharynx which becomes a gas reservoir for the respiratory system. The advantages of nasal cannula oxygen is that it is more comfortable for the patient, allows the infant to be nursed out of the cot by the mother and allows the child to breast or bottle feed if tolerated. The disadvantage is that oxygen delivered from a wall port or oxygen cylinder via a flow meter to the patient is anhydrous and cool. Respiratory mucosal surfaces rapidly dry out when exposed to anhydrous gas and prolonged nasal cannula oxygen in preterm infants is associated with increased need for suction which in turn leads to local trauma (9). In adults, dryness and discomfort has been shown to increase with increasing oxygen flow rates (10) and flow rates are usually limited to 6 L/min or less. In children flow rates are usually limited to 1-2 L/min or lower for the same reason. This relatively low flow rate may not match the inspiratory flow rate of the patient with the resultant entrainment of room air to make up this deficit. Studies have shown that the fraction of inspired oxygen falls with increasing respiratory rate (11).

HHFNC oxygen overcomes some of the problems of low flow oxygen treatment. There are a number of devices available on the market, licensed for use as oxygen delivery devices. The mechanisms vary, but all devices ultimately deliver a blend of air and oxygen that is humidified to 100% relative humidity (RH) and warmed to 37$^{o}$C. This permits the delivery of much higher gas flow rates (up to 60 L/min in adults and 6-8 L/min in infants) without drying out the nasal mucosa and without the discomfort caused by high flow of cold gases.

Early reports of the use of HHFNC oxygen found that it was well tolerated and preferred by patients over traditional oxygen delivery systems (10). Studies in adult patients showed a range of effects of HHFNC treatment from no effect on oxygenation to significant improvements in oxygen and a reduction in the number of patients needing intubation (12). There was evidence of a significant increase in the concentration of oxygen in the nasopharynx (13) and evidence of increased pressure in the nasopharyngeal space (14). Of note in the latter paper is that although HHFNC led to an increase in the measured mean pressure in the nasopharynx the pressure fell to zero during inspiration. This contrasts with pressures generated during CPAP which are always above zero.

Patient undergoing HHFNC treatment.

Evidence of the use of HHFNC in children is mainly in the neonatal period and studies have compared it to CPAP. A Cochrane study found that there was no difference in intubation rates between CPAP and HHFNC if used as primary treatment of respiratory failure but that it was inferior to CPAP when used as respiratory support following extubation (15). Despite the lack of conclusive evidence, more than 75% of respondents to a survey said that they used HHFNC in the neonatal period (16). Post neonatal studies consist of two case series of its use in bronchiolitis for patients in PICU. The papers infer benefit for this technique by demonstrating reduced intubation rates

compared to historical controls (17, 18). To date there are no randomised control trials of HHFNC in children published although the clinical trials registry do indicate that there are some studies currently underway.

There has been considerable interest in trying to understand how HHFNC improves respiratory outcome. Physiological studies suggest a number of possible mechanisms and a recent publication has attempted to provide a framework for considering how HHFNC works (19). Briefly it is suggested that there is a combination of four possible mechanisms as set out below.

- HHFNC flushes out the exhaled carbon dioxide in the nasopharynx and the large airway and reduces the physiological dead space. This improves the efficiency of breathing and reduces the work of breathing.
- Inspired gases that are warmed to body temperature and fully humidified do not need further warming in the nasopharynx which reduces the metabolic cost of respiration.
- The high flow rate generates a small but measureable positive pressure in the nasopharynx which splints pharyngeal muscles, expands the posterior pharyngeal space and reduces inspiratory resistance.
- The high flow rates generate some positive pressure that is transmitted to the airways and through the airways to the alveoli.

A very recent study in adult volunteers has provided some fresh and intriguing data. It would appear that HHFNC exerts different effects in sleep and during wakefulness. In the latter, there is an increase in tidal volume associated with a reduction in respiratory rate, the combination of which maintains the minute volume. In sleep however, there is a reduction in tidal volume with no change in respiratory rate and therefore a reduction in minute volume (20). Additionally, in this study, an in-vitro model used to study pressure variation concluded that HHFNC results in a significant increase in pressure during expiration but only a small increase during inspiration. The explanation for these observations is not clear but it could be that HHFNC improves the efficiency of breathing by altering resistance to gas flow in the nasal passage, thus allowing the subject to take slower and deeper breaths without compromising gas exchange. Some supportive evidence for this comes from a study where high flow nasal air was used in children with sleep apnoea. This showed that the high flow reduced inspiratory flow limitation, increased tidal breathing and led to a reduction in obstructive sleep apnoea that was comparable to that achieved with CPAP (21).

There have been reports of complications associated with HHFNC. An early publication reported subcutaneous, orbital and cranial air leak (22) while a more recent one reported serious intra-thoracic air leaks (23). The denominator for these adverse events is unknown so it is not possible to quantify a complication rate, but it should be noted that this technique is not without its drawbacks.

## Summary

In summary, HHFNC is a method of delivering a higher concentration of oxygen than is possible with conventional nasal cannula treatment. The exact mode of action is unclear but the main effect appears to be a reduction in inspiratory flow resistance combined with reduction in physiological dead space and a small amount of increased airway pressure. Benefits have been reported in adults, in preterm infants and in children but a lot more research is needed to define the patient populations that would benefit, the flow rates that are safe and the criteria for starting and terminating this treatment.

## References

1. Paediatric Intensive Care Audit Network National Report 2009 - 2011 (published September 2012): Universities of Leeds and Leicester.

2. O'Donnell R, Darowski M. The PICANet Team (2006) Acute respiratory failure in children under one year. Paediatric Intensive Care Audit Network National

Report 2004 - 2005 (published May 2006): Universities of Leeds, Leicester and Sheffield. ISBN 0 85316 249 2: 111-21.

3. http://www.hscic.gov.uk/hes - accessed 9th May 2013.

4. Ganu SS, Gautam A, Wilkins B, Egan J. Increase in use of non-invasive ventilation for infants with severe bronchiolitis is associated with decline in intubation rates over a decade. Intensive Care Med. 2012 Apr 18;38(7):1177–83.

5. Linnitt J, Davis P, Walker J. SWACIC 10. [cited 2013 May 9]; Available from: http://www.picanet.org.uk/research_projects.html

6. Donlan M, Fontela PS, Puligandla PS. Use of continuous positive airway pressure (CPAP) in acute viral bronchiolitis: A systematic review. Pediatr. Pulmonol. 2011 Aug;46(8):736–46.

7. Malinowski T, Lamberti J. Oxygen concentrations via nasal cannula at high flowrates. Respir Care. 2002;47(9):1039.

8. Leigh JM. The evolution of oxygen therapy apparatus. Anaesthesia. 1974;29(4):462–85.

9. Kopelman AE, Holbert D. Use of Oxygen Cannulas in Extremely Low Birthweight Infants is Associated with Mucosal Trauma and Bleeding, and Possibly with Coagulase-negative Staphylococcal Sepsis. J. Perinatol. 2003 Mar;23:94–7.

10. Cuquemelle E, Pham T, Papon J-F, Louis B, Danin P-E, Brochard L. Heated and Humidified High-Flow Oxygen Therapy Reduces Discomfort During Hypoxemic Respiratory Failure. Respir Care. 2012 Oct 1;57(10):1571–7.

11. Kuluz JW, McLaughlin GE, Gelman B, Cantwell GP, Thomas J, Mahon T, et al. The fraction of inspired oxygen in infants receiving oxygen via nasal cannula often exceeds safe levels. Respir Care. 2001;46(9):897–901.

12. Ward JJ. High-Flow Oxygen Administration by Nasal Cannula for Adult and Perinatal Patients. Respir Care. 2013;58(1):98–122.

13. Tiep B, Barnett M. High flow nasal vs. high flow mask oxygen delivery: tracheal gas concentrations through a head extension airway model. Respir Care. 2002;47(9):1079.

14. Parke R, McGuinness S, Eccleston M. Nasal high-flow therapy delivers low level positive airway pressure. Br. J. Anaesth. 2009 Oct 20;103(6):886–90.

15. Wilkinson D, Andersen C, O'Donnell C, De Paoli A. High flow nasal cannula for respiratory support in preterm infants. Cochrane Database Syst. Rev. Online. 2011;5:CD006405.

16. Ojha S, Gridley E, Dorling J. Use of heated humidified high-flow nasal cannula oxygen in neonates: a UK wide survey. Acta Paediatr. 2013 Mar;102(3):249–53.

17. Schibler A, Pham TMT, Dunster KR, Foster K, Barlow A, Gibbons K, et al. Reduced intubation rates for infants after introduction of high-flow nasal prong oxygen delivery. Intensive Care Med. 2011 Mar 3;37:847–52.

18. McKiernan C, Chua LC, Visintainer PF, Allen H. High Flow Nasal Cannulae Therapy in Infants with Bronchiolitis. J. Pediatr. 2010 Apr;156:634–8.

19. Dysart K, Miller TL, Wolfson MR, Shaffer TH. Research in high flow therapy: Mechanisms of action. Respir. Med. 2009;103(10):1400–5.

20. Mundel T, Feng S, Tatkov S, Schneider H. Mechanisms of nasal high flow on ventilation during wakefulness and sleep. J. Appl. Physiol. 2013 Feb 14;114(8):1058–65.

21. McGinley B, Halbower A, Schwartz AR, Smith PL, Patil SP, Schneider H. Effect of a High-Flow Open Nasal Cannula System on Obstructive Sleep Apnea in Children. Pediatrics. 2009 Jun 29;124(1):179–88.

22. Jasin LR, Kern S, Thompson S, Walter C, Rone JM, Yohannan MD. Subcutaneous scalp emphysema, pneumo-orbitis and pneumocephalus in a neonate on high humidity high flow nasal cannula. J. Perinatol. 2008;28(11):779–81.

23. Hegde S, Prodhan P. Serious Air Leak Syndrome Complicating High-Flow Nasal Cannula Therapy: A Report of 3 Cases. Pediatrics. 2013;131(3):e939–e944.

# PICANet goes to Bastion

## Introduction

The conflicts of recent years have required UK military forces to treat a significant number of civilian children, some of whom require critical care support. The treatment of injured children in coalition medical facilities is consistent with the Geneva Conventions and is required by the Law of Armed Conflict. Until 2012, there was no ongoing structured audit of this activity. Previously published data demonstrates that up to 10-15% of admissions to NATO medical facilities deployed to conflict areas are paediatric. These admissions pose a significant challenge to medical, nursing and paramedical staff, who may have limited paediatric experience.

In 2011 the Medical Director of Joint Medical Command requested that the deployed adult intensive therapy unit (ITU) at Camp Bastion commence PICANet data collection to monitor paediatric activity.

## Justification of Need

Continuous audit of paediatric intensive care medicine (PICM) practice in the deployed ITU was proposed for a number of reasons. One aim of audit was to provide overall benchmarking of the current service, comparing outcomes to those achieved in UK centres. It was recognized from the inception of the project that any such comparison would be fraught with difficulties because the structure of the intensive care service at Bastion is completely different to that seen in the UK, the severity of injuries seen at Bastion are not seen in the UK and the PIM2 score is not specifically developed for blast injury and gunshot wounds. Despite this, the exercise was still thought to be useful because in addition to benchmarking, there were other aims. These included the capacity to monitor supply and demand to facilitate planning for future needs, to quantify resource requirements in relation to training of personnel, allocation of equipment and to aid research. Following discussion, PICANet kindly agreed to support data collection.

David Inwald
Steve Bree
Gail Whittle
Roger Parslow

## Setting up data collection

Resource requirements were identified to include administrative support for data entry in the UK (one-two hours per week), training of nurses and medical staff to collect data on paper forms, identification of a "PICANet champion" for each deployment and continuity support to ensure that processes developed in the initial set up are not lost when staff change over. Two members of Defence Medical Services staff, David Inwald (medical) and Gail Whittle (nursing) began regularly attending the pre-deployment training package in late 2011 to train the ITU team to collect the PICANet dataset, initially with the support of Roger Parslow. In each deployment period (3 months for nursing staff and 2 months for senior medical staff), a PICANet champion is identified to supervise data collection and to submit the paper forms to the Royal Centre for Defence Medicine for processing and entering onto PICANet Web. The process has now been running for over a year and appears to be yielding good quality data.

A child admitted to the Field Hospital.

## Problems

The main difficulty in ensuring PICANet data collection runs smoothly is the transient nature of the staff on the ITU. This is mitigated by a rolling training programme occurring every three months during the pre-deployment training package. Further difficulties have been encountered with demographic data, as many patients have an unknown name, home address or date of birth on arrival at the hospital. Even when the name becomes known, date of birth often poses difficulties as many Afghans do not know their birthday and sometimes even year of birth is not known. In these cases, age has been estimated and date of birth logged as 1st January in the estimated year of birth. Address often remains unknown but patients are given an Afghan psuedopostcode on the PICANet database for the purposes of analysis. Entering diagnostic data

onto PICANet web is also sometimes challenging as the list of diagnoses available does not include the multitude of blast and penetrating trauma injuries encountered at Bastion. 30 day mortality is impossible to collect as there is no long term follow up of children who have been discharged home or to other medical facilities.

## Results

From the beginning of data collection to 1st November 2012, 52 patients were admitted, with a median age of 10 years (IQR 5-12.3). 16 were female and 36 male.

Primary diagnosis was trauma related in 44 cases, including 20 blast injuries (usually from an improvised explosive device), 14 gunshot wounds, 8 burns, 2 road traffic collisions and 1 near drowning. The remaining 6 cases included 1 premature birth, 1 snake bite, 2 infants with opiate ingestion and 1 elective surgical case. There were 2 readmissions following complications of the initial traumatic injury (Figure 1).

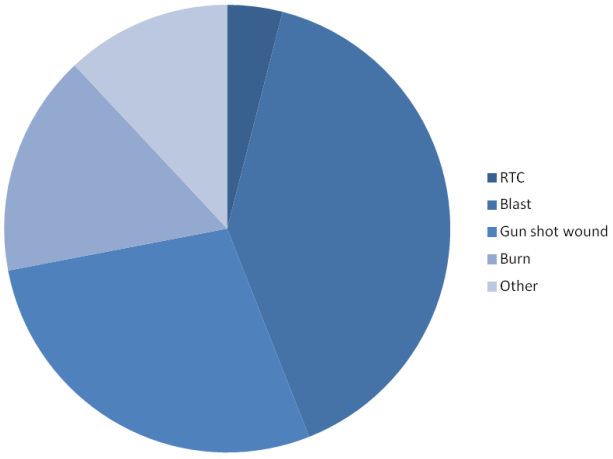


**Figure 1.**

Interventions on the ITU included invasive ventilation in 38/52 (73%), non-invasive ventilation in 4/52 (7.7%) and vasoactive drugs in 4/52 (7.7%). Other more complex ITU interventions, including ICP monitoring and renal support are not available in the deployed ITU. Length of stay was 0-3 days in 40/52 (77%) and more than 3 days in the remaining 12/52 (23%) of patients (Figure 2).

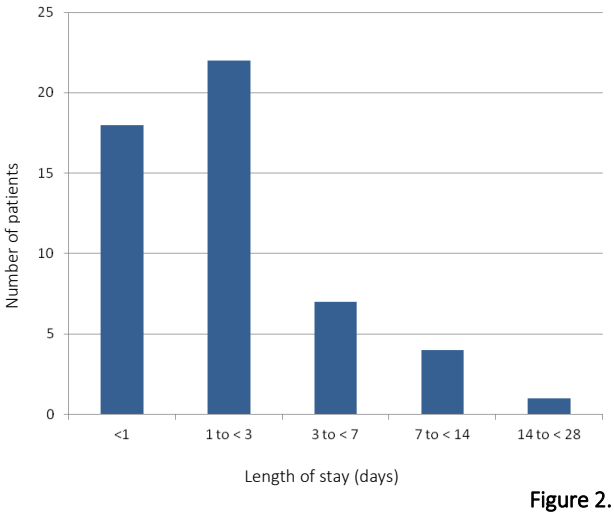


**Figure 2.**

Expected mortality using PIM2 scoring was 2.08/52 (4%) and observed mortality was 5/52 (9.6%). This gives a unit standardised mortality ratio (SMR) of 2.4 (95% CI 0.8-5.25). However, the confidence intervals for the SMR are wide and include 1, indicating that that the finding is not statistically significant. Furthermore, PIM2 is not an appropriate risk adjustment tool for blast injury and gunshot wounds. Injury severity scoring systems are likely to be more appropriate and work is ongoing to look at these scores in this group of patients. In comparison to the UK, the case mix at Bastion is also highly unusual. In the entire UK dataset from 2002, there were only 11 PICU admissions for gunshot wounds.

The hospital mitigates the risk of treating children in an essentially adult unit by a number of different strategies, including extensive pre-deployment training in clinical, ethical and child protection issues, ensuring adequate equipment and clinical guidelines, clinical governance and rapid access to specialist advice in the UK through KIDS (Kids Intensive Care Decision Support), the West Midlands paediatric ICU retrieval service.

## Conclusion

Despite the practical difficulties, it is possible to collect the PICANet dataset in a deployed military ITU in a combat environment several thousand

miles from the UK. Further work is ongoing to examine the data generated in detail. PICANet data collection will allow the Defence Medical Services to monitor supply and demand, to facilitate planning for future operations, to quantify resource requirements in relation to paediatric training and equipment and will aid research.

Camp Bastion Operating Theatre.

## AFFILIATIONS

Steve Bree, Consultant Anaesthetist, Ministry of Defence Hospital Unit Derriford, Derriford Hospital, Derriford Road, Plymouth, PL6 8DH

David Inwald, Consultant Paediatric Intensivist, St Mary's Hospital, Imperial College Healthcare NHS Trust, Praed Street, London, W2 1NY

Gail Whittle, Regular Nursing Officer, 201 Field Hospital, Fenham Barracks, Barrack Road, Newcastle NE2 4NP

Roger Parslow, Senior Lecturer in Epidemiology, Paediatric Epidemiology Group, Division of Epidemiology, Leeds Institute of Genetics, Health and Therapeutics, University of Leeds, LS2 9JT

University of Leeds

Roger Parslow
Phil McShane
Thomas Fleming
Lee Norman
Jodie Batchelor

PICANet
Paediatric Epidemiology Group
Centre for Epidemiology & Biostatistics
The Leeds Institute of Genetics
Health and Therapeutics
University of Leeds
Worsley Building
Leeds
LS2 9LN

r.c.parslow@leeds.ac.uk
0113 343 4856

University of Leicester

Elizabeth Draper
Caroline Lamming
Caroline Lovett
Martin Perkins

PICANet
Department of Health Sciences
University of Leicester
22-28 Princess Road West
Leicester
LE1 6TP

msn@leicester.ac.uk
0116 252 5414

www.PICANet.org.uk
PICANet@leeds.ac.uk

HQIP
Healthcare Quality Improvement Partnership

Paediatric Intensive Care Society