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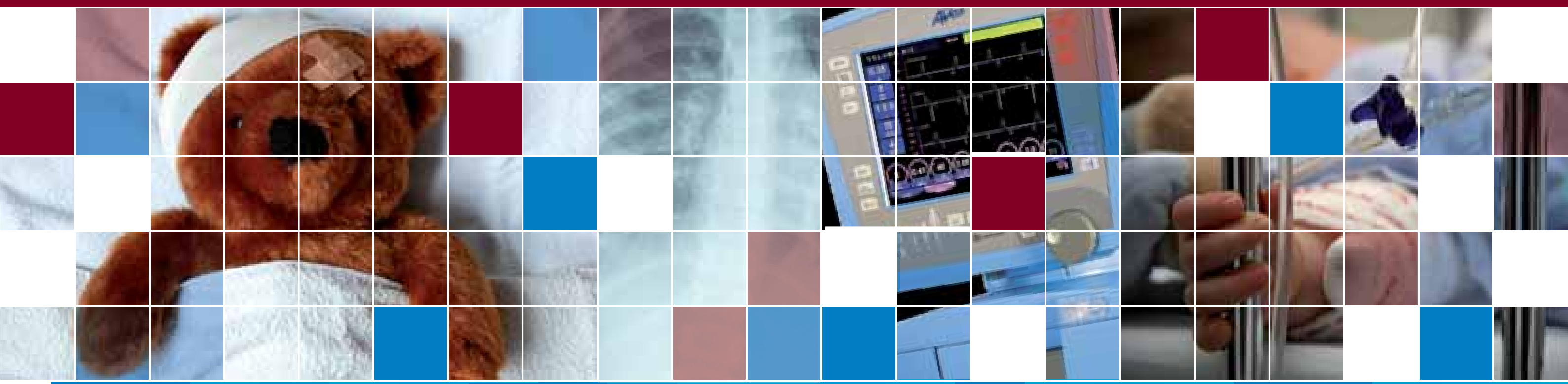

Centre for Outcome and Resource Evaluation

Report of the Australian and New Zealand Paediatric Intensive Care Registry

2015

Acknowledgements

The Australian and New Zealand Paediatric Intensive Care (ANZPIC) Registry is an international collaborative effort that is possible thanks to the dedicated individuals in participating hospitals throughout Australia and New Zealand. This report would not be possible without the hard work and commitment of many people in the intensive care community.

Many of the participating hospitals and people listed below have been associated with the Registry for many years and we thank them for their continued support. As the Registry continues to grow we also thank the new sites for their contributions which help to present a more comprehensive picture of paediatric admissions to intensive care in Australia and New Zealand.

In addition to those listed, we also wish to thank the many other individuals who are involved in the data collection, collation, cleaning, and submission of data to the Registry. For this 2015 report, thanks are also extended to staff from the ANZICS Centre of Outcome and Resource Evaluation (CORE) for their invaluable assistance in its preparation, especially Tamara Bucci. The ANZPIC Registry is funded by grants from the Ministry of Health (New Zealand), and State and Territory Departments of Health. This financial support is gratefully acknowledged.

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OUR AIMS

To collect and analyse accurate and comprehensive data reflecting paediatric intensive care activity.

To enable monitoring and benchmarking of paediatric intensive care performance.

To promote and facilitate research into critical illness in children, its management and outcomes.

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Forward

The ultimate purpose of the Registry is to turn data into information, and information into knowledge that can be applied at the bedside. In 2015, 11,471 admissions were added, bringing our dataset to more than 155,000 records.

The Registry uses collected data to monitor activity and performance, including the outcomes of children admitted to intensive care. Through this benchmarking role, we are able to assure our government funders that children in Australia and New Zealand receive the best possible care - no outliers were identified in either the specialist paediatric intensive care units or the 20 adult/paediatric units submitting data. During 2015, the Registry also assisted the Australian Council on Healthcare Services (ACHS) develop a set of paediatric intensive care clinical indicators that are more relevant than those previously promulgated by ACHS. We can all be proud of our achievements.

Furthermore, the huge amounts of data maintained by the Registry are available for researchers to explore and dissect. In 2015, the Registry Committee examined and approved data release for several important studies and a number of quality activities. All applications are reviewed by the ANZPIC Registry Clinical Advisory Committee members and I would like to thank them for their efforts during the past year. I am fully expectant that there will be an explosion of requests for data over the coming years now that the power of large databases to answer important clinical questions is being realised.

This Annual Report has been collated by Jan, Johnny, and Julieta. They have sweated over this Report whilst some of us have enjoyed a Christmas break. Finally, I would like to thank the data collectors across the two countries for their tireless efforts over the past year. Without you, there would be no data, no research and no report.

To conclude, I would like to quote from Atul Butte, a renowned bioinformatics researcher from the Stanford School of Medicine:

"Hiding within those mounds of data is knowledge that could change the life of a patient, or change the world."

Dr David Schell

Chair

ANZPIC Registry Clinical Advisory Committee, ANZICS

Executive Summary of ANZ Paediatric Intensive Care Activity in 2015

Who is contributing to ANZPICR?

- **100%** of PICUs and **20** mixed adult/paediatric ICUs contributed data
- These numbers represent approximately **92%** of all paediatric ICU admissions in Australia & New Zealand
- Data are presented on **11,471** admissions to paediatric intensive care (PICU)
- The Registry dataset now holds more than **155,000** records from 1997 to 2015

Clinical outcomes for paediatric patients

- The paediatric observed hospital mortality was **3.3%**
- The paediatric observed ICU mortality was **2.3%**, compared with a predicted mortality (PIM3-anz13 mortality prediction model) of **2.4%**

ICU activity and resources

- **11.5%** of admissions were discharged from the ICU after 1800 hours and before 0600 hours
- **835 (7.3%)** admissions were readmissions to ICU during a single hospital stay; these included both planned and unplanned readmissions.
- Approximately **41,600** bed days were delivered in the treatment of paediatric patients in 2015. Only **3.5%** of admissions were longer than 14 days, yet they accounted for **34.1%** of total occupied bed days.
- Of the paediatric ICU admissions, **39.7%** had an intubation episode, while **48.9%** of admissions required mechanical ventilation.

Monitoring and Data Review

- Performed by the ANZPIC Registry Clinical Advisory Committee (ARCAC), established in 2012
- The risk-adjusted performance of all contributing units in 2015 was within acceptable limits (using the PIM3-anz13 mortality prediction algorithm) and no outliers were identified for this time period.

1. Profile

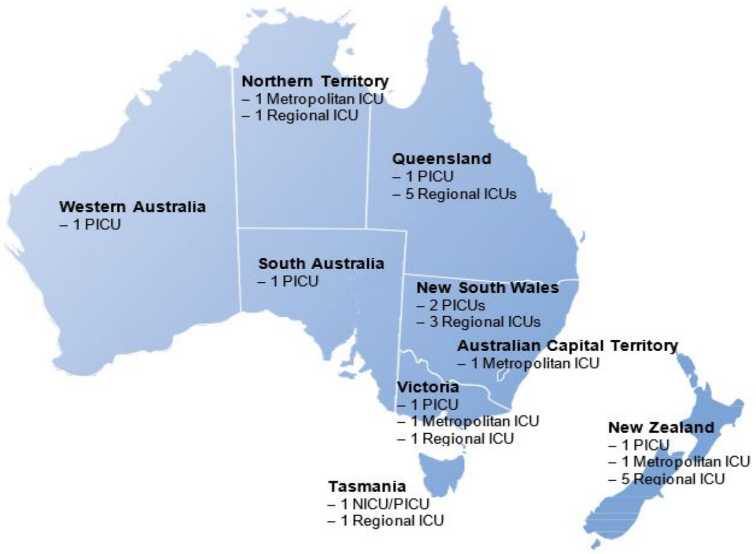
1.1 The Australian and New Zealand Paediatric Intensive Care Registry

The Paediatric Study Group (PSG) of the Australian and New Zealand Intensive Care Society (ANZICS) established the Australian and New Zealand Paediatric Intensive Care (ANZPIC) Registry in 1997. The ANZPIC Registry provides an overview of paediatric intensive care through the collection of patient episode information via three- and six-monthly data submissions for the purposes of audit, benchmarking performance, and providing data to support research. It is one of four registries currently managed by ANZICS CORE.

The aims of the Registry are:

- To collect and analyse accurate and comprehensive data reflecting paediatric intensive care activity.
- To enable monitoring and benchmarking of paediatric intensive care performance.
- To promote and facilitate research into critical illness in children, its management and outcomes.

1.2 Profile of Paediatric Intensive Care Services



This report is the 13th Annual Report describing paediatric intensive care practices and outcomes across Australia and New Zealand. Data collected from 28 ICUs (all 7 specialist Paediatric Intensive Care Units (PICUs), 1 combined NICU/PICU, as well as 20 general ICUs), during the 2015 calendar year were used to generate this report. Following the finalisation of 2015 data, the total number of admissions held within the Registry is now more than 155,000.

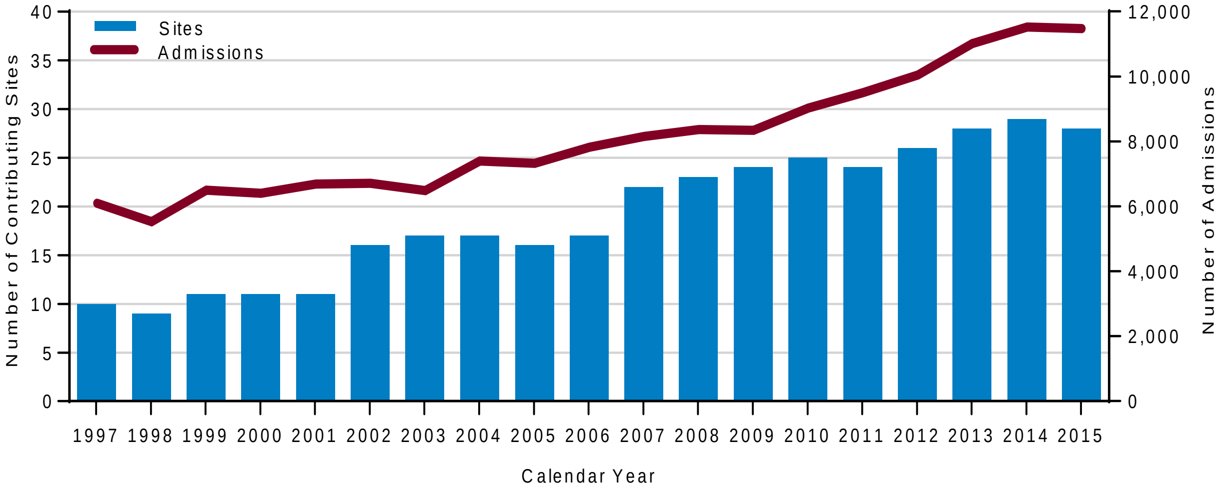
The seven PICUs are tertiary referral centres for children requiring intensive care and are based in university-affiliated children's hospitals. Data on all patients admitted to these seven units have been included, regardless of age. Therefore the report includes a small number of adult patients who were admitted to PICU for specialist care. The one NICU/PICU is also a tertiary referral centre, but data are submitted on only a subset of their total admissions: admissions of newborns with a corrected gestational age <35 weeks are not reported to the Registry (unless they have cardiac disease).

Twenty general ICUs (admitting predominantly adults) also contributed data on their paediatric admissions (patients < 16 years of age). These ICUs are based in metropolitan or regional hospitals in Australia and New Zealand. Appendix 1 lists all the contributing hospitals in 2015.

1.3 Profile of Paediatric Intensive Care Services

Figure 1.3.1 shows the continued increase in annual paediatric admissions to intensive care and in the number of units submitting data to the ANZPIC Registry.

Figure 1.3.1: Contributions to the ANZPIC Registry between 1997 and 2015



2. Data Set

2.1 Data set

The minimum data set analysed for this report includes 62 data elements; their definitions are described in the ANZPIC Registry's Data Dictionary and Data Collection forms available on the ANZICS website (http://www.anzics.com.au/Pages/CORE/data-tools.aspx). Information collected for the minimum data set includes demographic data, the diagnosis directly responsible for ICU admission, and any underlying and additional diagnoses. Additionally, physiological variables measured at the time of first contact with a doctor from the ICU (or a specialist retrieval team), ICU outcome, hospital outcome, and the length of stay are recorded. A linked table of episodes of respiratory therapy related to each ICU admission is also collected. This table includes both the start and stop times of any episode of intubation, invasive mechanical ventilation, non-invasive mechanical ventilation, high-flow nasal cannulae therapy and extra corporeal life support (ECLS). All participating units collect the minimum data set. All variables are routinely measured or recorded in the patient's medical record, and one record for each paediatric ICU admission, plus any linked records of respiratory therapy, is submitted to the Registry.

No new fields of information were added in 2015.

2.2 Data collection

Data are collected in the hospitals by either completion of the data collection forms, or by incorporating the ANZPIC Registry data items in the local clinical information system. Participating hospitals submit electronic copies of the de-identified data in a predefined format to the ANZPIC Registry every six months. Some of the specialist paediatric units use an ACCESS database supplied by the Registry for data entry, while the remaining units use unit-specific databases.

A paediatric component is included in the Australasian Outcome Research Tool for Intensive Care (AORTIC) software developed by the ANZICS Adult Patient Database (APD). This has allowed the general units already using AORTIC to collect and submit data on paediatric admissions in addition to their adult admissions. In the AORTIC software, a paediatric admission is defined as a patient less than sixteen years of age at hospital admission.

2.3 Data validation

Missing, inconsistent, or unusual data are identified and flagged at the time of submission to the Registry. Initial electronic filtering consists of both logic and range checks. Error reports are sent to each site, the data are cleaned, resubmitted to the Registry and revalidated before being approved and uploaded into the main database. All data queries are resolved before the uploading is performed.

As part of ensuring the integrity and uniformity of Registry data, site audits are routinely performed every 2-3 years. An independent data collector from another PICU re-extracts information from hospital medical records and the two datasets are compared centrally. The next scheduled audit is in 2017.

2.4 Registry Data Limitations

Limitations to the Registry data are related to the data collection process and the outcome measures used to assess unit performance.

Not all participating units have designated data managers. In ICUs that do not have designated data managers, data are collected by a range of staff, including administrative staff, clinical nurses and senior medical staff. It has been noted previously that data collection errors are more common in units without dedicated data collectors. Study days are organised by the Registry and held regularly for ICU data collectors to ensure consistency and accuracy of data submissions.

2.5 Data Completeness

A summary of the completeness of recording for fields within the registry for the 11471 admission records in 2015 is provided in Table 2.5.1. While most fields are mandatory, some fields, such as those related to ICU deaths, hours of intubation and hours of respiratory support, are not relevant to every patient.

Table 2.5.1: Summary of the completeness of data fields collected in 2015

Field Description	Maximum Possible Responses	Number of Valid Responses	% Complete
Date of Birth	11471	11471	100
Weight	11471	11460	99.9
Postcode	11471	11263	98.2
Hospital Admission Source	11471	11471	100
Retrieval	11471	11471	100
ICU Admission Source	11471	11471	100
ICU Admission Date and Time	11471	11471	100
ICU Discharge Date and Time	11471	11471	100
ICU Outcome	11471	11471	100
Principal Diagnosis	11471	11471	100
Principal Underlying Diagnosis	11471	10920	95.2
ICU Admission Type	11471	11471	100
Mechanical Ventilation within the First Hour	11471	11471	100
Systolic Blood Pressure	11471	10265 [1]	89.5
FiO2/PaO2 ratio (arterial only)	11471	3172 [1]	27.7
Base Excess	11471	5776	50.4
Source of base excess measurement	11471	5776	50.4
Pupillary Responses	11471	11471	100
Recovery from Surgery or a Procedure	11471	11471	100
Cardiac Bypass	11471	11471	100
PIM3 Low Risk Condition	11471	11471	100
PIM3 Very High Risk Condition	11471	11471	100
PIM3 High Risk Condition	11471	11471	100
Lactate in mmol/l	11471	5787 [1]	50.4
FiO2/SpO2 ratio (pulse oximetry)	11471	9385 [1]	81.8
Place of First Contact/Taking Over Patient Management	11471	11370	99.1
Hospital Admission Date and Time	11471	11471	100
Hospital Discharge Date and Time	11471	11435	99.7
Hospital Outcome	11471	11471	100
Mode of Death	250 [2]	250	100
External Cardiac Massage Performed	250 [2]	250	100
Limitation of Therapy Order	250 [2]	250	100
Date of Limitation of Therapy Order	106 [2]	106	100
Organ Donation	250 [2]	250	100
Renal Support: Haemofiltration	11471	11471	100
Renal Support: Haemodialysis	11471	11471	100
Renal Support: Peritoneal Dialysis	11471	11471	100
Renal Support: Plasmafiltration	11471	11471	100
High Frequency Oscillation	11471	11466	100
Inhaled Nitric Oxide	11471	11466	100
Intracranial Pressure Monitoring	11471	11471	100
Extra-Corporeal Membrane Oxygenation	11471	11471	100
Ventricular Assist Device	11471	11471	100
Indication for Extra Corporeal Life Support	123 [3]	117	95.1
Indigenous Status	11471	11332	98.8
Gestational Age	11471	9559 [4]	83.3
Major Non-Cardiac Structural Anomaly	11471	11454	99.9
Combination of Cardiac Surgery Procedures	11471	11470	100
Antenatal Diagnosis of Major Structural Anomaly	11471	11455	99.9
Cardiac Surgery	11471	11471	100
Inotropes	11471	11471	100

[1] Value was either not measured as part of standard patient care, or not obtained within the first hour of ICU admission
[2] Field only applicable to ICU deaths
[3] Field only applicable to occurrences of ECMO & VAD
[4] Mandatory for RACHS-eligible admissions only

3. Demographics

3.1 Population

The ANZPIC Registry reports are based on patients discharged from ICU during each calendar year. The term "admissions" has been used in this report in the context of ICU admission episodes, and refers to patients discharged from ICU during the 2015 calendar year. The Registry received data from 11,471 paediatric admissions to 28 ICUs in Australia and New Zealand in 2015. As a comparison, 11,524 admission records were submitted from 29 ICUs in 2014.

Each year, a number of children are admitted to general ICUs in Australia and New Zealand which do not contribute to the ANZPIC Registry. Many of these ICUs admit very small numbers of paediatric patients, and the children admitted are often transferred to larger units which do report to the Registry. In 2015 the number of children admitted to these units was estimated to be 1100 (8.7% of all paediatric admissions to ICU in ANZ)[1].

Admissions and ICU days by region of residence of the patient are displayed in Table 3.1.1. The child population (<16 yrs) for each state or territory was obtained from the Australian Bureau of Statistics (ABS), Australian Demographic Statistics[2], and Statistics New Zealand[3]. Admissions of patients aged 16 years or more (n= 324), patients with an overseas home address (n= 137) or where the postcode was missing (n=208) were excluded.

In 2015, the admission rate for paediatric ICU episodes was 1.92 per 1,000 children. The ANZPIC Registry admission rate is higher than the rate recorded by the Paediatric Intensive Care Audit Network (PICANet) in the UK (1.48 per 1,000)[4]. The admission rate varied across jurisdictions, from 1.2 per 1,000 for the ACT to 2.94 per 1000 for NT. The overall admission rate for males (2.15 per 1,000) was higher than that for females (1.67 per 1,000).

[1] ANZICS Adult Patient Database (2016) Unpublished Data. Personal Correspondence.

[2] Australian Bureau of Statistics (2015) Australian Demographic Statistics—Estimated Resident Population by Single Year of Age, December 2015. 3101.0 ABS, Canberra. www.ausstats.abs.gov.au/ausstats (23/6/2016).

[3] Statistics New Zealand (2015) Estimated Resident Population by Age and Sex, Annual - Dec. http://www.stats.govt.nz/infoshare/Default.aspx (23/06/2016).

[4] PICANet 2016 Annual Report – Tables & Figures. Universities of Leeds and Leicester 2016. http://www.picanet.org.uk/Audit/Annual-Reporting/ (31/11/2016)

Table 3.1.1: ICU admission rate and bed occupancy per 1,000 children <16years of age by region, 2015

Region	Population	Admission Rate	ICU Days (per 1,000 population) All Admissions	Intubated Admissions	Ventilated Admissions
ACT	78067	1.20	5.22	4.37	4.63
NSW	1518876	1.80	7.54	5.07	6.25
NT	57173	2.94	11.49	8.88	9.80
QLD	1005137	2.68	8.47	5.24	5.74
SA	319130	1.72	6.89	5.09	5.49
TAS	100760	2.11	8.07	4.80	6.15
VIC	1154335	1.76	7.02	4.57	5.21
WA	528971	1.57	4.63	3.61	3.85
NZ	979480	1.72	5.08	3.43	3.93
Total	**5,741,929**	**1.92**	**6.89**	**4.61**	**5.30**

3.2 Age

The majority of admissions to ICU in 2015 were children less than 5 years of age (66.4%), with infants <12 months of age making up more than half of this group (56.1%) and 37.2% of all ICU admissions. A greater number of males were admitted (57.5%) than females (42.5%) in most age groups, as illustrated in figure 3.2.1. Figure 3.2.2 displays the admission numbers for patients less than one year of age. Almost a quarter (24.6%) of infants admitted aged less than one year were neonates (≤28 days old). These figures are consistent with previous years' data.

Figure 3.2.1: ICU admission numbers by age (years) and sex 2015

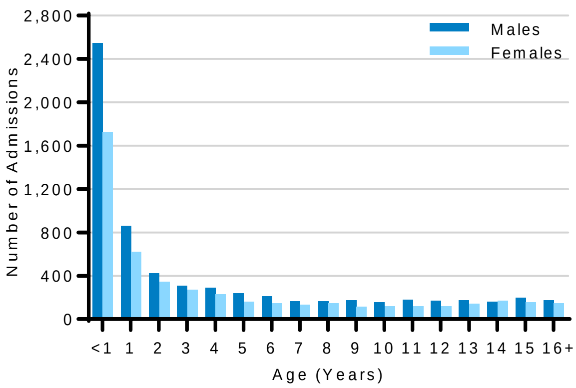
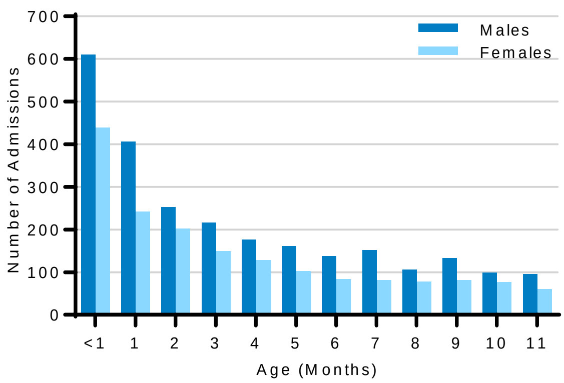


Figure 3.2.2: ICU admission numbers by age (months) and sex, for infants <12 months of age 2015



4. Admission Characteristics

4.1 ICU Admission Source

In 2015, patients admitted from the operating theatre accounted for 34.9% of ICU admissions. Direct admissions to ICU from outside the hospital (mostly retrievals) comprised 22.1% of ICU admissions, while patients admitted from the emergency department comprised 24.9%. Admissions from a ward within the same hospital made up 17.8% of all ICU admissions.

The main source of ICU admission differed between specialist PICUs and general ICUs. The operating theatre was the most frequent source of PICU admissions (41.5), while the emergency department was the most frequent source of general ICU paediatric admissions (46.7%). A comparison of admission source is presented in Table 4.1.1.

Table 4.1.1: Intensive care admission source by ICU type, 2015

	ICU Type	
Admission Source	**PICU or NICU/PICU (%)**	**General ICU (%)**
Direct ICU Admission	23.6	17.2
Emergency Department	18.1	46.7
Operating Theatre or Recovery	41.5	13.5
Other ICU or NICU	0.4	0.3
Ward	16.3	22.3

Retrievals

A total of 2641 patients were retrieved by specialist transport teams during 2015. While PICUs and general ICUs reported similar proportions of children admitted to hospital via specialist retrieval teams (22.1% and 25.9% respectively), the pattern of ICU admission source differed for the two groups. Table 4.1.2 illustrates that the proportion of retrievals that went directly to ICU in designated PICUs (85.8%) was greater than in general ICUs (56.7%), where patients were often retrieved to the hospital's emergency department (25.5%) before being admitted to the ICU. The most common reason for direct admission to ICU of retrieved patients was respiratory illness (51.5%).

Table 4.1.2: Intensive care admission source for retrieved patients, by ICU type, 2015

	ICU Type	
Admission Source	**PICU or NICU/PICU (%)**	**General ICU (%)**
Direct ICU Admission	85.8	56.7
Emergency Department	3.7	25.5
Operating Theatre or Recovery	6.0	4.0
Other ICU or NICU	0.7	0.1
Ward	3.8	13.6

The ICU outcome for retrieved patients also differed between PICUs and general ICUs. Table 4.1.3 shows that a higher percentage of retrievals to general ICUs were later transferred to another ICU.

Table 4.1.3: Outcome of ICU stay for retrieved patients, by ICU type, 2015

	ICU Type	
ICU Outcome	**PICU or NICU/PICU (%)**	**General ICU (%)**
Discharged to ward/home	91.7	79.3
Died in ICU	4.0	1.0
Transferred to another ICU	4.1	19.7
Died after discharge for palliative care	0.2	0.0

4.2 Admission Type

Admissions are classified as elective or non-elective. The admission is classified as elective if the admission: (1) follows an elective procedure, (2) is for an elective procedure in ICU (e.g. insertion of a central line), or (3) is for elective monitoring or review of home ventilation. An admission or an operation is considered elective if it could have been postponed for more than six hours without adverse effect. Unexpected admissions after elective surgery (i.e. not planned and could not have been foreseen) are not considered elective. This field is a classification of a patient characteristic rather than the administrative booking procedure for ICU beds.

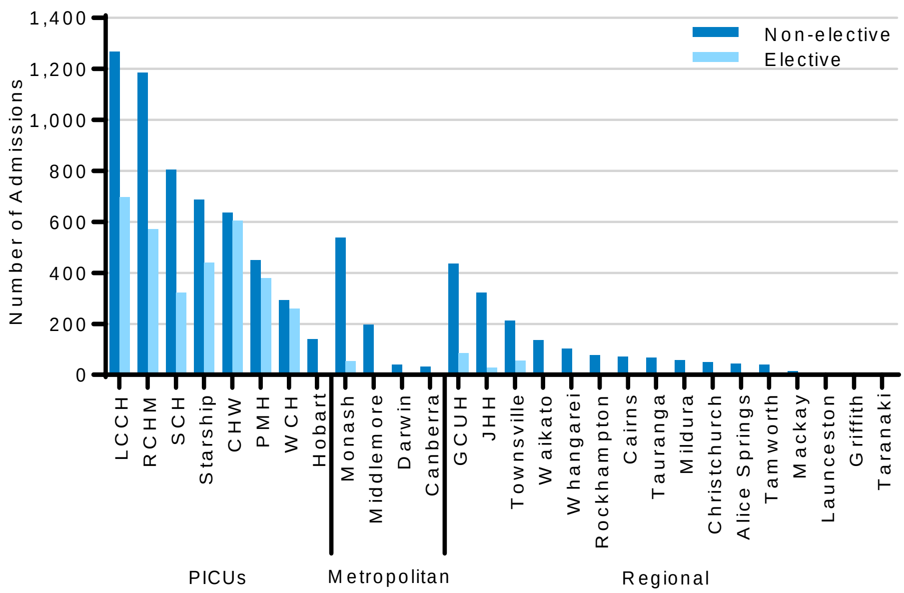
More than two-thirds of all ICU admissions in 2015 were non-elective. Admissions from the emergency department and direct ICU admissions together accounted for 65.8% of non-elective admissions, with only 10.2% of non-elective admissions coming from the operating theatre. By contrast, admissions from the operating theatre accounted for approximately 90.1% of elective admissions.

Table 4.2.1: Intensive care admission source by admission type, 2015

	Admission Type	
Admission Source	**Non-elective (%)**	**Elective (%)**
Direct ICU Admission	20.8	1.4
Emergency Department	24.5	0.3
Operating Theatre or Recovery	7.1	27.8
Other ICU or NICU	0.2	0.2
Ward	16.4	1.3
Total	69.0	31.0

Figure 4.2.1 displays elective and non-elective admissions for each hospital during 2015. While unplanned admissions were more frequent than planned admissions for all 28 ICUs in 2015, the proportion varied considerably between individual ICUs.

Figure 4.2.1: Elective and non-elective admissions for each hospital, 2015



4.3 Admission Diagnosis

Diagnosis codes developed by the ANZICS PSG[5,6] are used to code the principal reason for ICU admission. The underlying diagnosis and up to seven additional diagnoses can be assigned for each admission. The principal reason for ICU admission has been grouped into seven diagnostic groups (Appendix 2). Table 4.3.1 shows the comparative distribution of diagnostic groups for PICUs and general ICUs.

As in previous years, respiratory cases comprised the greatest proportion of all ICU admissions in 2015 (33.2% of all admissions). This represented an increase from 2014 in both the absolute number of respiratory cases (3810 in 2015 versus 3730 in 2014), and the overall percentage (33.2% versus 32.4%). For specialist PICUs, just over a quarter of all admissions were in the respiratory group (27.5%), in comparison to a just over a half (51.7%) of general ICU admissions.

[5] Slater AJ, Shann FA, McEniery J, & the ANZICS Paediatric Study Group (2003) The ANZPIC Registry diagnostic codes: A system for coding reasons for admitting children to intensive care. Intensive Care Medicine, 29: 271 - 277.

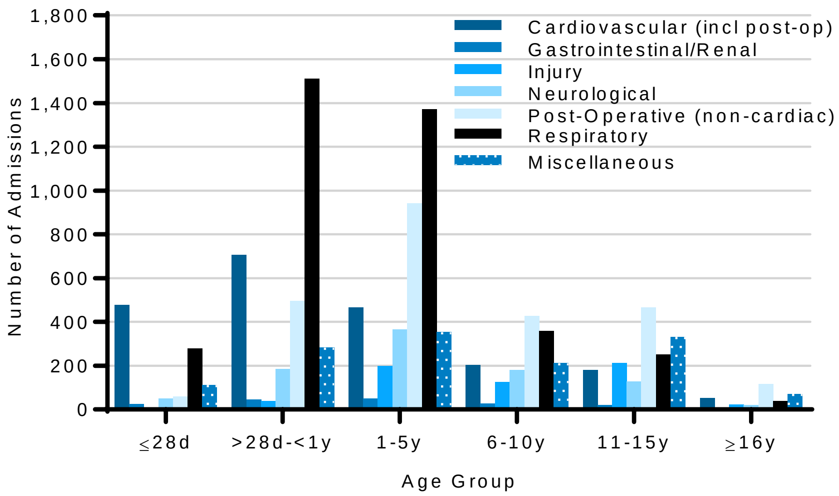
[6] ANZPICR Diagnoses Codes (pdf). http:// http://www.anzics.com.au/Pages/CORE/data-tools.aspx

Table 4.3.1: Admissions by diagnostic group and ICU type, 2015

	ICU Type	
Diagnostic Group	**PICU or NICU/PICU (%)**	**General ICU (%)**
Cardiovascular (incl post-op)	23.0	2.7
Gastrointestinal/Renal	1.6	1.4
Injury	4.1	9.1
Neurological	7.3	10.7
Post-operative (non-cardiac)	24.6	13.0
Respiratory	27.5	51.7
Miscellaneous	12.0	11.5

The mix of diagnostic groups varies with age (Figure 4.3.1). Respiratory (41.9%) and cardiovascular (27.7%) diagnoses were the most common reason for admission for children less than one year of age, while in children 11 years of age and over, the most common diagnostic group was non-cardiac post-operative (30.4%). This is consistent with previous years.

Figure 4.3.1: Diagnostic categories by age group, 2015



The five most common individual diagnoses for non-elective and elective admissions to ICU are listed in Tables 4.3.2 and 4.3.3 respectively. Also displayed is the median and mean length of stay (LoS) for each diagnosis. Bronchiolitis (18.9%) remains the most common reason for non- elective admissions to ICU in 2015, and when considering all admissions in 2015 (both non-elective and elective admissions), bronchiolitis was the main reason for admission in 10.4% of cases.

Table 4.3.2: The five most common reasons for non-elective admission to ICU, the percentage of all non-elective admissions, and median length of stay (LoS) in 2015

Principal Admission Diagnosis	Number	Percent	Median LoS (days)	Mean LoS (days)
Bronchiolitis	1498	18.9	2.07	2.95
Pneumonia or Pneumonitis	654	8.2	2.36	4.39
Asthma	540	6.8	0.98	1.31
Seizures	481	6.1	1.24	1.97
Diabetes Mellitus with Ketoacidosis	273	3.4	0.96	1.17

Table 4.3.3: The five most common reasons for elective admission to ICU, the percent of all elective admissions, and median length of stay (LoS) in 2015

Principal Admission Diagnosis	Number	Percent	Median LoS (days)	Mean LoS (days)
Adenoidectomy and/or Tonsillectomy	206	5.8	0.93	1.06
Spinal Instrumentation	194	5.5	1.02	1.75
ICU Procedure (e.g. CVC Insertion)	125	3.5	0.16	0.88
Laryngobronchoscopy	119	3.4	0.90	1.81
ASD Surgery	104	2.9	0.99	1.40

Figures 4.3.2 and 4.3.3 display a comparison over the last three years for the most common diagnoses for non-elective and elective admissions to ICU respectively. While the percentage of pneumonia admissions increased in 2015 and the admissions for seizures were reduced, most other reasons for non-elective and elective admissions were similar to previous years.

Figure 4.3.2: The five most common non-elective diagnoses 2013-2015

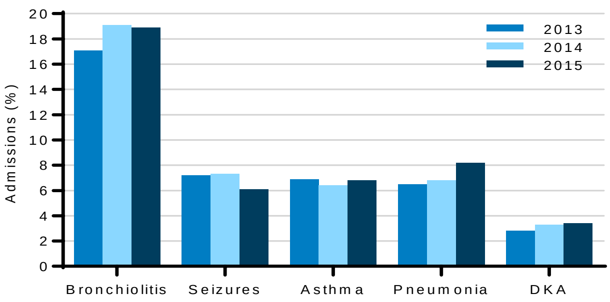
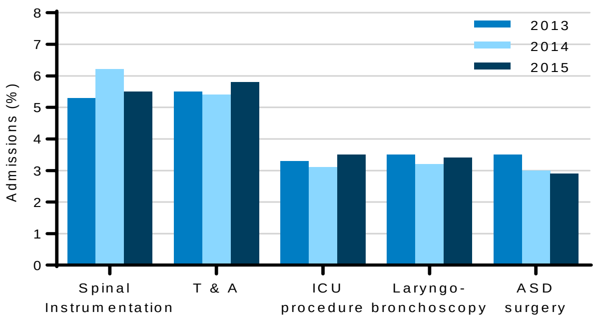


Figure 4.3.3: The five most common elective diagnoses 2013-2015



4.3 ICU Outcome

In 2015, the overall ICU crude mortality rate for paediatric patients in Australia and New Zealand was 2.309%. Table 4.4.1 gives a comparison of ICU outcomes between PICUs and general ICUs.

Table 0.1: ICU Outcome by ICU type, 2015

	ICU Type	
ICU Outcome	**PICU n (%)**	**General ICU n (%)**
Discharged to ward/home	8394 (95.9)	2477 (91.1)
Died in ICU	217 (2.5)	33 (1.2)
Transferred to another ICU	135 (1.5)	208 (7.7)
Died <24hr post discharge for palliative care	7 (0.1)	0 (0.0)

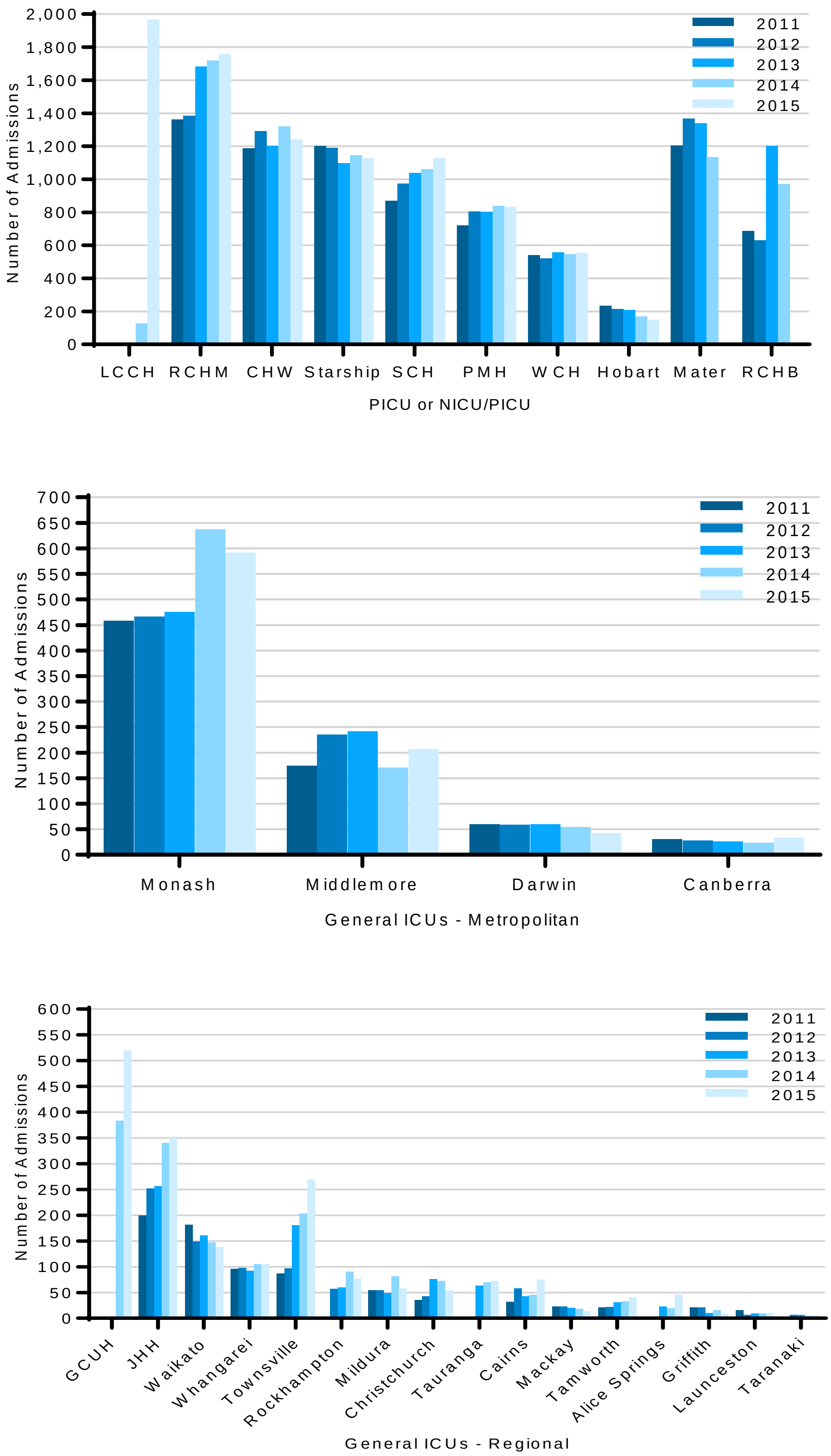
4.4 Other Admission Characteristics

Annual admission numbers per hospital each year since 2011 are displayed in Figure 4.5.1, grouped by specialist PICUs, metropolitan and regional general ICUs. In 2015, 76.3% of all admissions reported to the Registry were to PICUs, while 7.6% and 16% of admissions were to metropolitan and regional general ICUs respectively.

More than 16.6% of ICU admissions were readmissions of patients previously admitted during the year, with just under half (43.8%) of those readmissions occurring within the same hospital admission. These readmissions included both planned and unplanned readmissions.

A new field collecting the rate of unplanned readmissions (readmitted <72 hours post ICU discharge) was included from 2011 onwards. The rate of unplanned readmission within 72 hours of ICU discharge in 2015 was 2.8% of all admissions.

Figure 4.4.1: Number of patients admitted to ICUs (PICUs and general ICUs) participating in the ANZPIC Registry, by ICU classification, 2011-2015



The proportion of children ventilated (invasively and non-invasively) during ICU admission is considered a simple indicator of admission threshold. The number of admissions in each ICU and the proportion of ventilated admissions are displayed in table 4.5.1. The Children's Hospital at Westmead in Sydney, the Royal Children's Hospital in Melbourne and Starship Children's Hospital in Auckland reported the highest rates for both intubation and ventilation for PICUs.

Overall in the 2015 dataset, 48.9% of admissions had at least one episode of mechanical ventilation during their ICU stay, and 39.7% of admissions had at least one intubation episode. Over the past five years there has been a decline in the rates of both of these interventions. In comparison, in 2011, 61.1% of admissions had a ventilation episode, and 47.4% had an intubation episode.

Table 4.4.1: Number of admissions and the percent ventilated and intubated, by site in 2015

Hospital	Admissions	% Ventilated	% Intubated
Lady Cilento Children's Hospital	1965	42.1	38.0
Royal Children's Hospital - Melbourne	1758	64.8	57.1
Children's Hospital at Westmead	1242	65.2	49.2
Starship Children's Hospital	1127	58.1	57.1
Sydney Children's Hospital	1127	57.9	42.5
Princess Margaret Hospital	831	43.6	36.8
Monash Medical Centre	592	26.7	21.6
Women's & Children's Hospital	554	39.7	33.6
Gold Coast University Hospital	520	7.5	6.3
John Hunter Hospital	350	44.6	23.1
Townsville Hospital	269	30.5	29.7
Middlemore Hospital	207	48.8	16.4
Royal Hobart Hospital	149	57.0	26.8
Waikato Hospital	138	63.0	22.5
Whangarei Hospital	105	53.3	9.5
Rockhampton Base Hospital	77	23.4	16.9
Cairns Base Hospital	75	30.7	29.3
Tauranga Hospital	73	16.4	8.2
Mildura Base Hospital	58	13.8	3.4
Christchurch Hospital	54	59.3	44.4
Alice Springs Hospital	46	56.5	41.3
Royal Darwin Hospital	42	52.4	52.4
Tamworth Hospital	41	22.0	19.5
Canberra Hospital	33	54.5	51.5
Mackay Base Hospital	14	42.9	42.9
Launceston Hospital	10	50.0	50.0
Griffith Hospital	8	12.5	12.5
Taranaki Base Hospital	6	50.0	50.0

Figures 4.5.2 and 4.5.3 display the monthly admission numbers by diagnostic group, and monthly admission numbers by age group, for 2014 and 2015. Similar to previous years, admissions for respiratory related conditions in 2015 increased in the May to September period. There was greater seasonal variation in admissions for children less than one year old.

Figure 4.4.2: Number of admissions by month and diagnostic group, 2014-2015

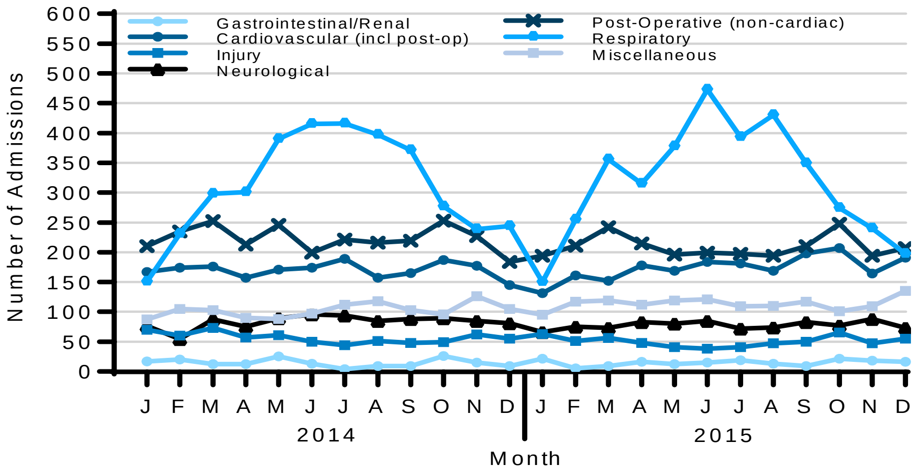
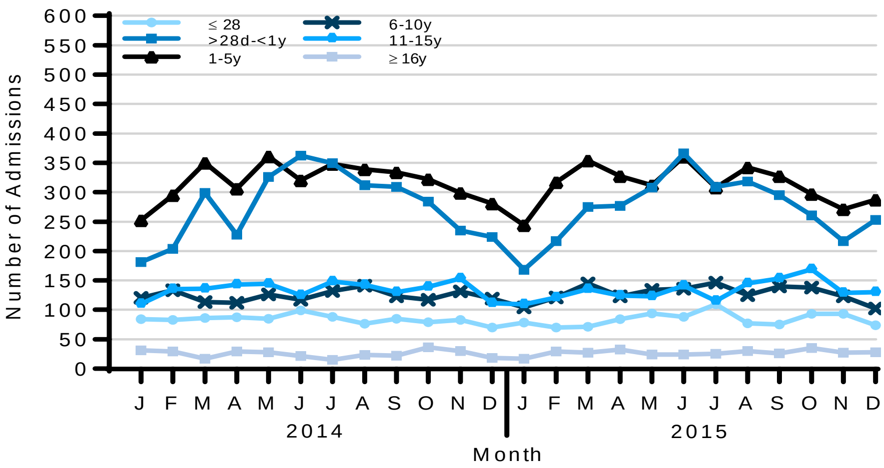


Figure 4.4.3: Number of admissions by month and age group, 2014-2015



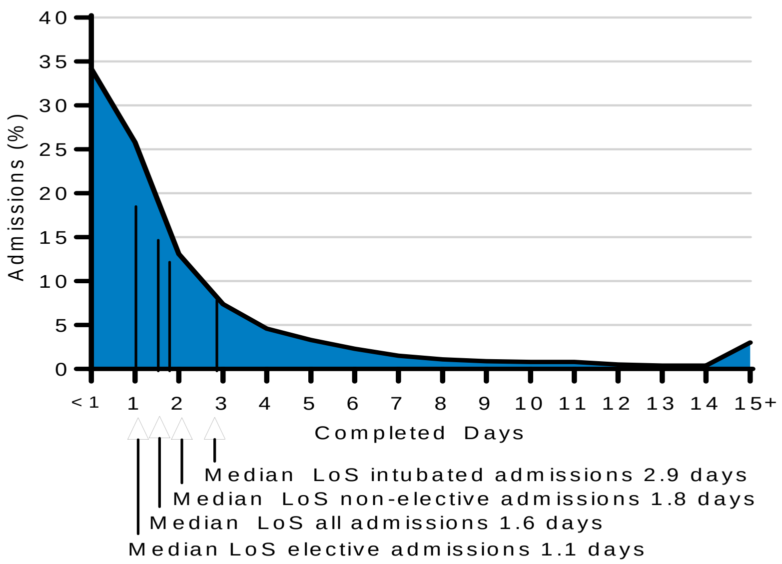
5. Length of Stay and Occupied Bed Days

5.1 Median Length of Stay (survivors only)

Length of stay (LoS) is defined as the difference between discharge date and time, and admission date and time. The LoS data analysed in this report are only for patients who survived ICU and were not transferred to another facility (n=10,871 in 2015). The ICU LoS was positively skewed with the majority (59.9%) of patients staying less than two days (Figure 5.1.1).

The median LoS was used to compare the LoS across groups. The median LoS was used as the measure of central tendency, as the mean LoS is disproportionately influenced by prolonged admissions. For example, in 2015, 3.0% of patients had a length of stay greater than 14 days. These included just over 1% of patients who stayed longer than 28 days and occupied 18.5% of total bed days for admissions in 2015.

Figure 5.1.1: Length of stay distribution in 2015



Paediatric ICU LoS in Australia and New Zealand (ANZ) contrasts with that reported by PICANet in the United Kingdom (UK), with 34.2% of admissions in ANZ staying less than 24 hours in 2015, compared with 25.4% of admissions in the UK. A higher percentage of patients in the UK stayed in ICU for longer than one week (Table 5.1.1). Inclusion criteria may have had a small effect on these differences between the two sources of data. PICANet figures included all admissions (i.e. deaths, transfers, and discharges compared with discharges only for ANZ LoS), and the ANZPIC Registry included data from general ICUs as well as PICUs.

Table 5.1.1: Comparison of ICU LoS between Australia & New Zealand, and the United Kingdom in 2015

	ANZPIC Registry		PICANet	
LOS	**Frequency**	**%**	**Frequency**	**%**
<1 hr	3	0.1	70	0.4
1 - <4 hrs	141	1.3	296	1.5
4 - <12 hrs	685	6.3	1,025	5.1
12 - <24 hrs	2,885	26.5	3,664	18.4
1 - <3 days	4,223	38.8	6,202	31.1
3 - <7 days	1,911	17.6	4,803	24.1
≥7 days	1,023	9.4	3,894	19.5

The median LoS varied with ICU type (Figure 5.1.2), with PICUs having the longest stay (1.76), versus metropolitan hospitals (1.45), and regional hospitals (1.19). As expected, LoS also varied with admission type. The median LoS for intubated patients was 2.86 days, compared to 1.11 days for non-intubated patients. Non-elective admissions had a greater median LoS (1.79) compared to elective admissions (1.06).

Figure 5.1.2: Median LoS and Interquartile Range (IQR) for all hospitals by ICU classification in 2015

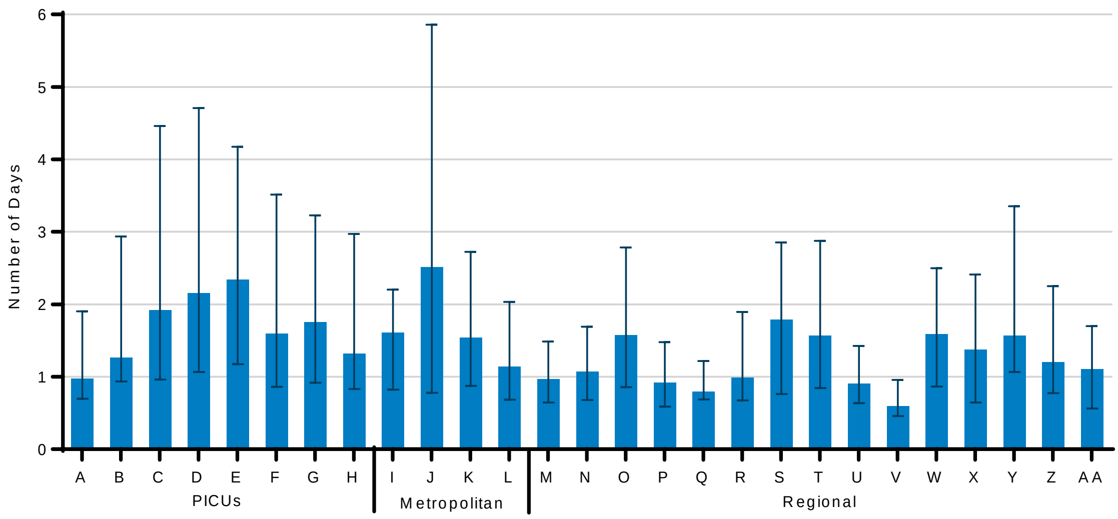
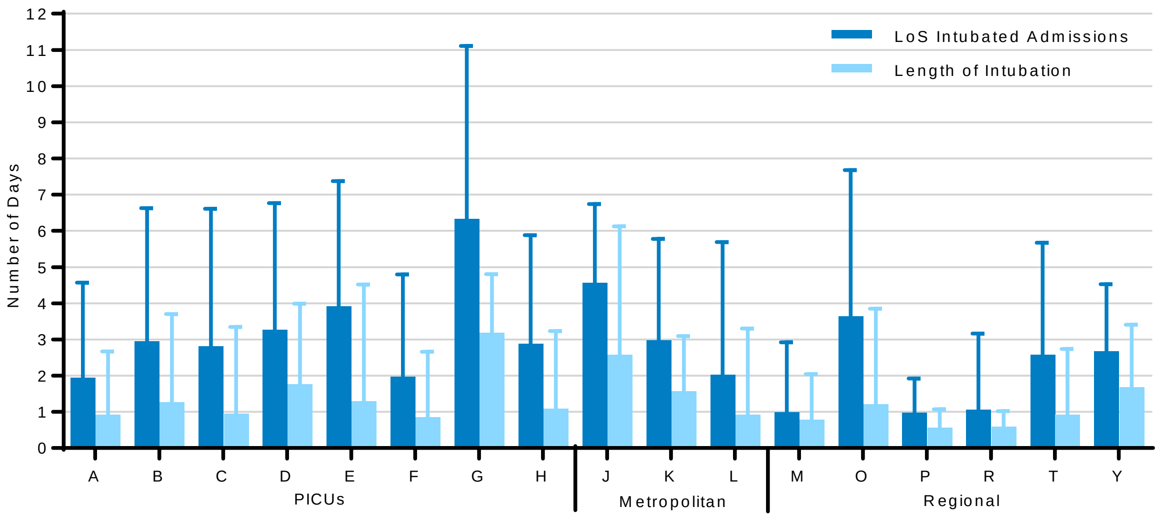


Figure 5.1.3 displays the median LoS for intubated patients, and the median duration of intubation, for hospitals with intubated patients. Hospitals with <10 intubated admissions (who were not transferred or died) have been excluded (n = 11) from this figure.

Figure 5.1.3: Median LoS and IQR for intubated admissions in each hospital by ICU classification in 2015



The LoS for each diagnostic group is summarised in Table 5.1.2. As in previous years, the gastrointestinal/renal diagnostic group recorded the longest median LoS (2.17 days).

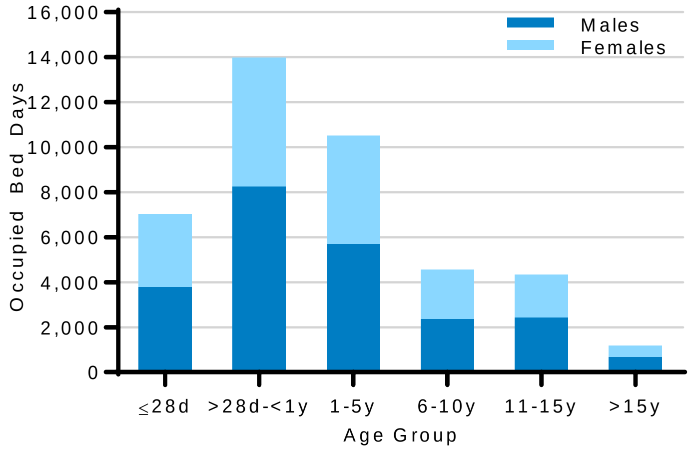
Table 5.1.2: Mean & median LoS, IQR, and percent of occupied bed days (OBD) by diagnostic group, 2015

Diagnostic Group	Mean LOS	Median LOS	IQR	OBD%
Cardiovascular (including post-op)	4.63	1.88	1.0 - 4.0	24.4
Gastrointestinal/Renal	4.98	2.17	0.9 - 5.3	2.1
Injury	3.12	1.13	0.6 - 2.3	4.7
Neurological	2.84	1.58	0.8 - 3.0	6.6
Post-Operative (non-cardiac)	2.25	0.96	0.8 - 1.9	15.0
Respiratory	3.72	2.00	1.0 - 3.8	36.7
Miscellaneous	3.25	1.50	0.8 - 3.2	10.5

5.2 Occupied Bed Days

Information presented on occupied bed days (OBD) in this report was based on all ICU admissions, including those patients who were transferred or died. There were a total of 41,600 OBDs in 2015, with children in the second age group (aged >28 days but less than one year) occupying 33.6% of ICU bed days (Figure 5.2.1).

Figure 5.2.1: Occupied bed days by age group and sex, 2015



While patients who were intubated during their admission accounted for approximately 39.7% of the total admissions in 2015, they utilised 67.3% of total bed days. Non-elective admissions (69.1% of total admissions) utilised 72.1% of bed days. Patients who stayed in ICU longer than 28 days (1.33% of all admissions) occupied a total of 9387 bed days (22.6% of total OBDs). Table 5.2.1 displays the admission diagnosis categories for patients who stayed longer than 28 days. Of the 153 admissions which were for longer than 28 days, only five patients did not require respiratory support during their admission, while 78% required respiratory support for longer than 28 days.

Table 5.2.1: Admission diagnoses and occupied bed days for long stay patients (>28 days), 2015

Diagnostic Group	Admissions	Bed days
Cardiovascular (including post-op)	53	2955
Gastrointestinal/Renal	7	296
Injury	5	328
Neurological	6	237
Post-Operative (non-cardiac)	9	563
Respiratory	47	3395
Miscellaneous	26	1612

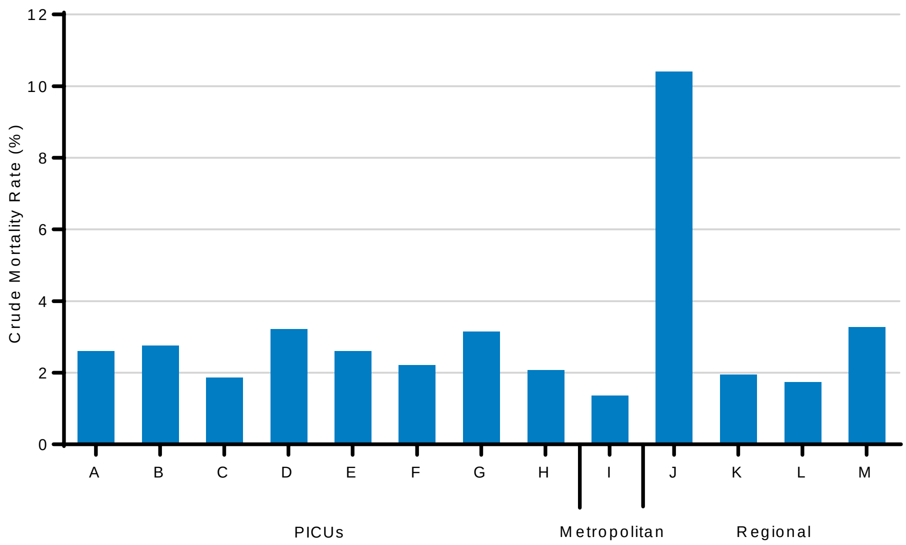
6. Mortality

6.1 Mortality Rate

The ANZPIC Registry collected data on ICU outcome and hospital outcome from all participating units. In 2015, 257 patients died in ICU (or within 24 hours of discharge from ICU for palliative care). The crude mortality rate was 2.31% (males 2.2%, females 2.46%). This rate is similar to the 2014 rate of 2.21% and since 2010 has dropped from 3.0%.

The crude mortality rate for each unit is shown in Figure 6.1.1. ICUs that recorded <2 deaths were excluded (n=15). Note the hospital codes used in this section are not the same codes used in earlier sections. Crude mortality rates vary with ICU type, with PICUs recording an average of 2.59%, metropolitan hospitals 1.1%, and regional hospitals 1.45%.

Figure 6.1.1: Mortality rate for 13 contributing hospitals by ICU type in 2015



Over 38% of deaths were in infants less than one year of age (including neonates). Consistent with previous years, the neonatal group recorded the highest rate of mortality. A breakdown of age-group specific mortality rates in 2015 is given in Table 6.1.1.

Table 6.1.1: Mortality rate by age group, 2015

Age Group	Admissions	Deaths	Age-Specific Mortality (95% CI)
≤28 days	926	36	3.9 (2.6-5.1)
>28 days - <1 year	3152	63	2.0 (1.5-2.5)
1 - 5 years	3663	78	2.1 (1.7-2.6)
6 - 10 years	1505	25	1.7 (1.0-2.3)
11 - 15 years	1562	47	3.0 (2.2-3.9)
>15 years	320	8	2.5 (0.8-4.2)

6.2 Diagnosis-Specific Mortality

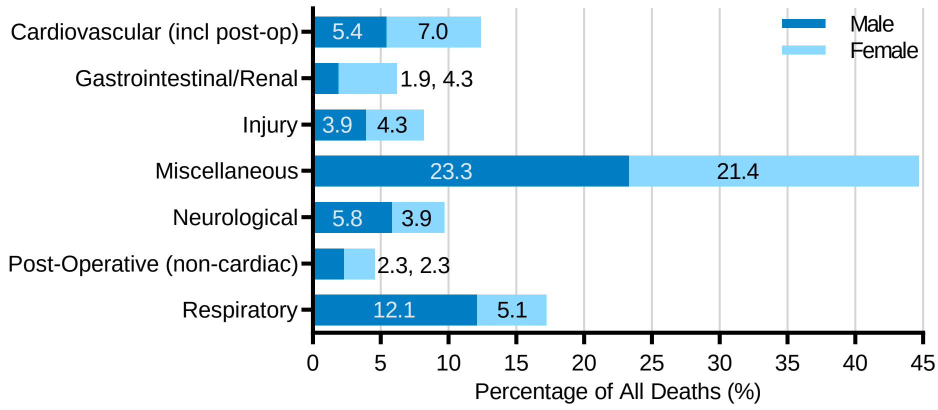
Mortality rates for diagnostic groups in 2015 are presented in Table 6.2.1.

Table 6.2.1: Mortality rate by diagnostic group, 2015

Diagnostic Group	Admissions	Deaths	Mortality Rate (95% CI)
Cardiovascular (including post-op)	1960	32	1.6 (1.1 - 2.2)
Gastrointestinal/Renal	158	8	4.8 (1.6 - 8.1)
Injury	554	21	3.7 (2.1 - 5.2)
Neurological	859	25	2.8 (1.7 - 3.9)
Post-Operative (non-cardiac)	2480	12	0.5 (0.2 - 0.8)
Respiratory	3661	44	1.2 (0.8 - 1.5)
Miscellaneous	1199	115	8.8 (7.2 - 10.3)

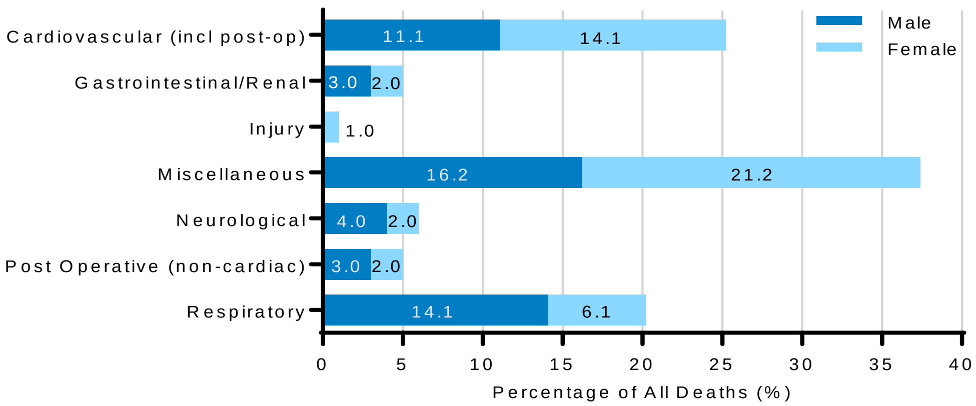
In 2015, 44.7% of all deaths had a principal diagnosis in the "miscellaneous" category. Within this category, 50.4% of deaths were for children who had been admitted due to an out-of-hospital cardiac arrest. Other diagnoses in the “miscellaneous” category leading to death included septic shock (15.7%) and in-hospital cardiac arrest (12.2%). Cardiac arrest, both in and out of hospital, was the principal diagnosis for 72 (28%) of all 257 deaths. Septic shock and sepsis were the principal diagnoses for 18 (7%) and 10 (3.9%) deaths respectively. A further 15 (5.8%) deaths had a principal diagnosis of pneumonia. The proportion of deaths in each diagnostic and gender category is presented in Figure 6.2.1. The mortality rate for males was greater than, or equal to, that for females in five of the seven diagnostic categories.

Figure 6.2.1: Diagnostic categories of patients not surviving ICU, by sex in 2015



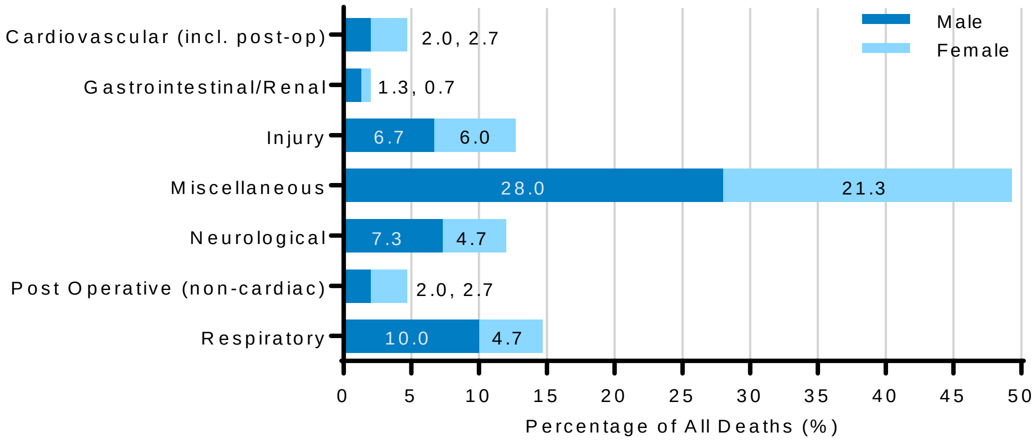
The proportion of deaths in specific diagnosis groups varied across age groups. As shown in Figure 6.2.2, the highest proportion of deaths among infants (less than 1 year old) was in both the miscellaneous category (37.4%) and the cardiovascular category (25.3%). The predominance of these two categories is consistent with previous years.

Figure 6.2.2: Diagnostic categories of patients aged <1 year not surviving ICU, by sex, 2015



In the 1–15 years age group, 49.3% of deaths were in the miscellaneous category (Figure 6.2.3), with both in-hospital and out-of-hospital cardiac arrest accounting for 63.5% of deaths in this category, as well as 31.3% of all deaths in this age group.

Figure 6.2.3: Diagnostic categories of patients aged 1-15 years not surviving ICU, by sex, 2015



6.3 Paediatric Cardiac Surgery

Since 2007, the ANZPIC Registry has collected data to enable risk assessment using RACHS (risk adjustment for congenital heart surgery)[7] for patients in ICU who have undergone cardiac surgery. In Australia, the majority of paediatric cardiac surgery (PCS) is performed at the Royal Children's Hospital in Melbourne, the Children's Hospital at Westmead, the Sydney Children's Hospital, the Princess Margaret Hospital in Perth, and the Lady Cilento Children's Hospital in Brisbane. In New Zealand, cardiac surgery is performed at the Starship Hospital in Auckland.

RACHS allocates cardiac procedures into six risk categories. Table 6.3.1 gives a breakdown of the number of cardiac procedures recorded in 2015. An additional non-RACHS category has been included for other cardiac procedures not classified in the RACHS categories. As up to six procedures can be recorded for each admission, the numbers in the table represent total procedures, not admissions.

[7] Jenkins KJ, Gauvreau K, Newburger JW, Spray TL, Moller JH, Iezzoni LI (2002) Consensus-based method for risk adjustment for surgery for congenital heart disease. Journal of Thoracic Cardiovascular Surgery, 123: 110-118.

Table 6.3.1: Cardiac procedures in 2015

RACHS Category	Procedure	No.	Percentage
1	ASD surgery (including ASD secundum, sinus venosus ASD, patent foramen ovale closure)	182	50.0
	PDA surgery >30d of age	97	26.6
	Coarction repair >30d of age	53	14.6
	Partially anomalous pulmonary venous connection surgery	28	7.7
	Aortopexy	4	1.1
	Total	364	100
2	VSD repair	134	17.7
	Total repair of tetralogy of Fallot	105	13.9
	Glenn shunt	90	11.9
	ASD and VSD repair	80	10.6
	Aortic valvotomy - valvuloplasty >30d of age	57	7.5
	Subaortic stenosis resection	53	7.0
	Coarction repair <=30d of age	42	5.5
	Repair of pulmonary artery stenosis	33	4.4
	Pulmonary valve replacement	24	3.2
	Vascular ring surgery	23	3.0
	ASD primum repair	22	2.9
	Pulmonary outflow tract augmentation	18	2.4
	Repair of total anamalous pulmonary veins >30d of age	18	2.4
	Pulmonary valvotomy - valvuloplasty	16	2.1
	Right ventricular infundibulectomy	11	1.5
	VSD closure and pulmonary valvotomy or infundibular resection	11	1.5
	Repair of AP window	10	1.3
	VSD closure and pulmonary artery band removal	7	0.9
	Repair of coronary AV fistula	3	0.4
	Common atrium closure	1	0.1
	Total	758	100
3	Mitral valvotomy - valvuloplasty	97	12.6
	Right ventricular to pulmonary artery conduit	90	11.7
	Systemic to pulmonary artery shunt	83	10.8
	Arterial switch operation	79	10.3
	Fontan procedure	64	8.3
	Repair of transitional or complete atrioventricular canal with or without valve replacement	60	7.8
	Pulmonary artery banding	54	7.0
	Aortic valve replacement	43	5.6
	Tricuspid valvotomy - valvuloplasty	39	5.1
	Annuloplasty	25	3.2
	Aortoplasty (not arch repair or graft)	22	2.9
	Mitral valve replacement	18	2.3
	Ross procedure	15	1.9
	Repair of anomalous coronary artery without intrapulmonary tunnel	12	1.6
	Left ventricular outflow tract patch	10	1.3
	Repair of double-outlet right ventricle with or without repair of right ventricular obstruction	10	1.3
	Repair of tetralogy of Fallot with pulmonary atresia	9	1.2
	Reimplantation of anomalous pulmonary artery	6	0.8
	Repair of coarction and VSD closure	6	0.8
	Tricuspid valve replacement	6	0.8
	Atrial switch operation	5	0.6
	Repair of cor triatriatum	5	0.6
	Ventriculomyotomy	4	0.5
	Tricuspid valve repositioning for Ebstein anomaly >30d of age	3	0.4
	Valvectomy of tricuspid valve	3	0.4
	Excision of intracardiac tumour	1	0.1
	Repair anomalous coronary art. with intrapulmonary tunnel	1	0.1
	Total	770	100

RACHS Category	Procedure	No.	Percentage
4	Repair of hypoplastic or interrupted arch without VSD closure	59	23.5
	Atrial septectomy	56	22.3
	Arterial switch operation with VSD closure	38	15.1
	Repair of hypoplastic or interrupted arch with VSD closure	34	13.5
	Total repair of anamalous pulmonary veins <=30d of age	15	6.0
	Konno procedure	14	5.6
	Repair of truncus arteriosus	9	3.6
	Repair of transposition-VSD sub PS (Rastelli)	7	2.8
	Unifocalization for tetralogy of Fallot - pulmonary atresia	5	2.0
	Aortic valvotomy - valvuloplasty <=30d of age	4	1.6
	Double switch	4	1.6
	Transverse arch graft	3	1.2
	Arterial switch operation with repair of sub PS	1	0.4
	Atrial switch operation with repair of sub PS	1	0.4
	Repair of complex anomaly (single ventricle) by VSD enlargement	1	0.4
	Total	251	100
5	*Nil procedures in this category in 2015*		
	Total	0	
6	Stage 1 repair of hypoplatsic left heart syndrome	28	59.6
	Damus-Kaye-Stansel procedure	10	21.3
	Stage 1 repair of nonhypoplastic left heart syndrome conditions	9	19.1
	Total	47	100
Un-classified	Chest Closure	185	28.9
	Cardiac Surgery Open – Other	90	14.0
	PA Plasty or Repair	86	13.4
	ECMO cannulation/exploration	85	13.3
	Cardiac Surgery Closed – Other	56	8.7
	Pacemaker insertion/replacement	50	7.8
	PDA surgery <=30 days	49	7.6
	Emergency Chest Opening	20	3.1
	Transplant – Heart	12	1.9
	Pulmonary Venous Stenosis Repair	4	0.6
	Fontan conversion	3	0.5
	Total	641	100

In 2015 a total of 2,831 paediatric cardiac surgical procedures were performed, of which 2,190 had a RACHS category. RACHS lower-risk categories 1, 2 and 3 accounted for 12.9%, 26.8% and 27.2% of all paediatric cardiac surgery respectively. These proportions are similar to previous years. The most commonly performed procedure was ASD surgery (including ASD secundum, sinus venosus ASD, patent foramen ovale closure) at 6.4% of all paediatric cardiac surgery, followed by VSD repair at 4.7%.

A summary of cardiac surgery mortality is given in Table 6.3.2. In this table, if more than one procedure was performed at a single operation or during the ICU episode, the case was classified once only and based on the procedure with the highest RACHS category.

In 2015 there were 1609 PICU admissions of children following cardiac surgery and/or of children who received cardiac surgery during their ICU admission. There were 28 deaths during hospitalisation in this cohort (including 12 after ICU discharge), giving a crude mortality of 1.7%. This is consistent with cardiac surgery mortality since the data collection commenced. As expected, the mortality varied with surgical complexity (Table 6.3.2).

Table 6.3.2: Hospital mortality in cardiac surgery cases, 2015

	Number of cases	% of Total	Number of Deaths	Hospital mortality rate (%)
Total	**1609**	**100**	**28**	**1.7**
Highest RACHS category for patient				
1	203	12.6	0	0.0
2	536	33.3	4	0.7
3	601	37.4	8	1.3
4	223	13.9	8	3.6
5&6	46	2.9	8	17.4

6.4 Risk-Adjusted Mortality (PIM3-anz13)

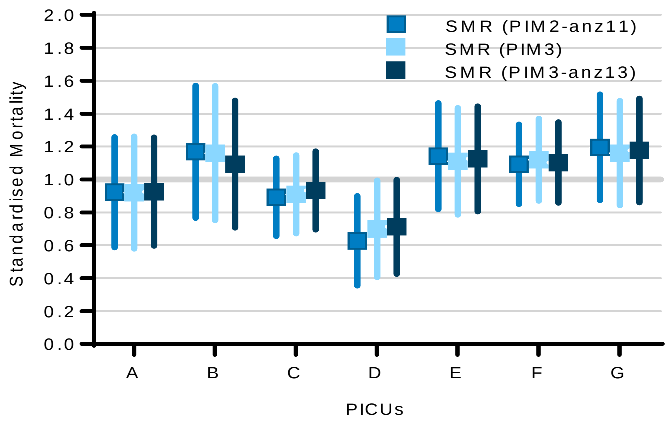
Risk-adjusted standardised mortality ratios (SMR) were calculated for each unit contributing to the ANZPIC Registry. The SMR is the ratio of the number of deaths observed in a given population to the number of deaths expected for that population. A logistic regression model is used to calculate the expected number of deaths for the population. The Paediatric Index of Mortality, PIM3[8], is the model used by the ANZPIC Registry for this purpose.

While the published PIM3 model has been developed using data from multiple countries and provides an international comparison, a regional calibration of the model should be used for the most accurate comparison of units within a region. An Australian and New Zealand calibration of the PIM3 model was generated using ANZPIC Registry data from 2012 and 2013, with the model called PIM3-anz13. The risk-adjusted mortality data presented in the 2015 report has used the PIM3-anz13 model coefficients applied to 2015 data.

[8] Straney L, Clements A, Parslow R, Pearson G, Shann F, Alexander J, Slater A, for the ANZICS Paediatric Study Group and the Paediatric Intensive Care Network (2013) Paediatric Index of Mortality 3 : an updated model for predicting mortality in Pediatric Intensive Care. Pediatric Critical Care Medicine, 14(7): 673-81.

The SMRs and their 95% confidence intervals for the seven specialist PICUs are presented in Figure 6.4.1. In this figure, comparative SMRs have been generated using three PIM models – the ANZ calibrated PIM2 model (PIM2-anz11), the published PIM3 model (PIM3), and the ANZ calibrated PIM3 model (PIM3-anz13). The 95% confidence interval of the SMRs using PIM3-anz13 for all of the seven sites included the number 1.0, indicating that the observed outcome was not significantly different from the expected outcome using the most recent and relevant model.

Figure 6.4.1: Standardised mortality ratio and 95% confidence interval using PIM2-anz11, PIM3 and PIM3-anz13 for PICUs in 2015



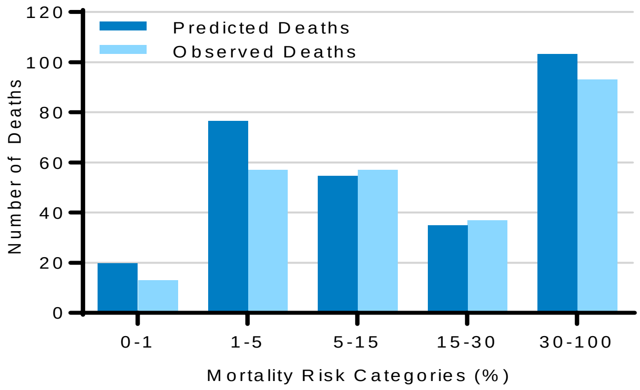
In 2015, approximately 92% of the eligible admissions had a risk of death (ROD) predicted by PIM3-anz13 of less than 5%. The ICU survival status is presented for five ROD categories in Table 6.4.1. (Admissions transferred to other ICUs excluded).

Table 6.4.1: ICU survival status by PIM3-anz13 mortality risk category, 2015

PIM3 Risk of Death	Survivors	Deaths	Total
0 - 1%	6692	13	6705
1 - 5%	3455	57	3512
5 - 15%	558	57	615
15 - 30%	112	37	149
30 - 100%	54	93	147
Total	**10871**	**257**	**11128**

A comparison of the observed number of deaths and the number of deaths predicted by PIM3-anz13 for five categories of risk of death is displayed in Figure 6.4.2.

Figure 6.4.2: Observed vs predicted number of deaths by PIM3-anz13 mortality risk category in 2015

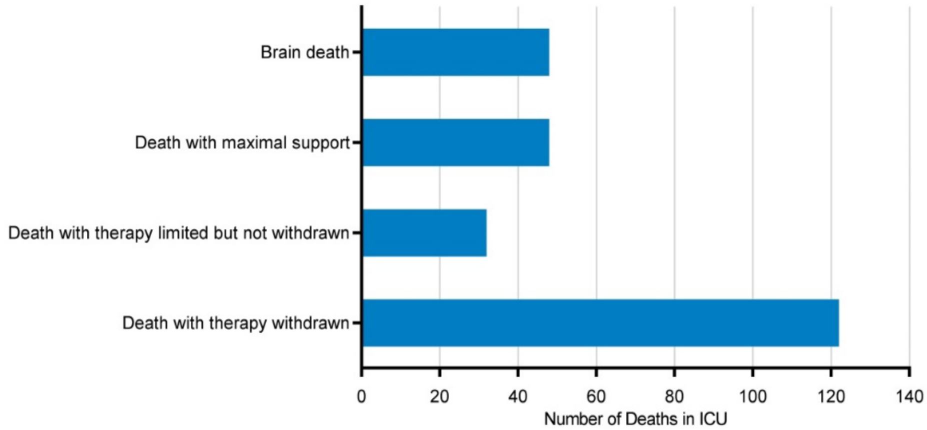


6.5 Mode of Death and Organ Donation

The Registry collects information on organ donation and the level of intervention in place at the time of death for patients who die in ICU. While there were 250 ICU deaths recorded in 2015, there were 7 additional cases where death occurred within 24 hours of discharge from ICU for palliative care.

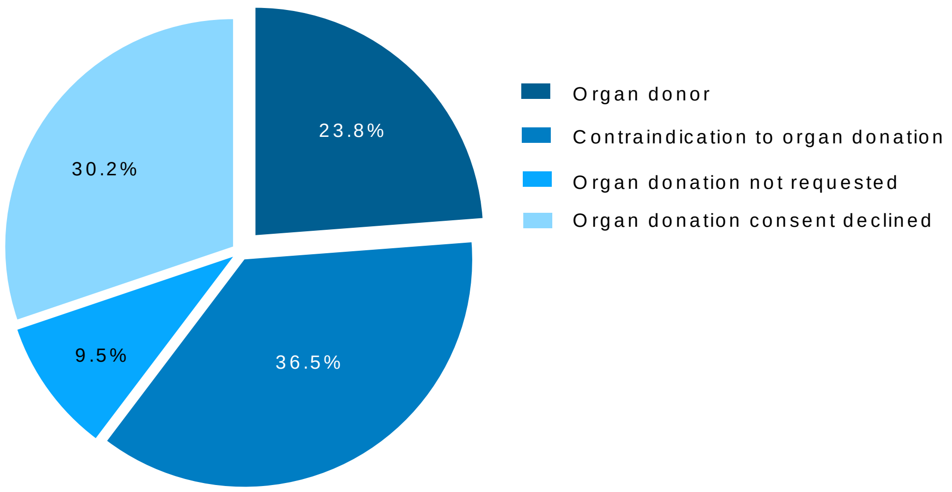
Figure 6.5.1 summarises the mode of death and level of intervention in place for the 250 patients who died in ICU in 2015. Over 61% (154) of the deaths occurred after therapy was limited or withdrawn.

Figure 6.5.1: Mode of death for all patients who died in ICU in 2015



Brain death was diagnosed in 63 cases. Where brain death was diagnosed, organ donation was contraindicated for 23 patients, and not requested in 6 cases. Of the remaining patients, consent for organ donation was requested in 34 cases and consent obtained in 15 cases. The response to organ donation for the 63 patients with brain death where organ donation was considered is summarised in Figure 6.5.2.

Figure 6.5.2: Organ donation responses for the 63 deaths in ICU with brain death in 2015



Additionally, consent for donation after cardiac death (DCD) was requested in 18 patients, and consent obtained in 8 cases.

7. Monitoring Performance of Paediatric Intensive Care

In order to assess PICU performance and benchmark performance between units, it is necessary to have methods to adjust outcome based on patient risk factors. Methods for risk-adjusting mortality have been available for many years. The funnel plot (Figure 7.3.1) and the sequential control charts (Figures 7.4.1 to 7.4.8) represent the results of analysis of risk-adjusted mortality. These figures were constructed using the PIM3-anz13 model.

As well as considering risk-adjusted mortality, the ANZPIC Registry has analysed variation in patient outcomes amongst PICUs using risk adjusted length of stay (LoS) and length of respiratory support (LoRS). These models of risk-adjustment and their application in assessing PICU efficiency, discussed in sections 7.1 and 7.2, were first applied to Registry data in the 2008 annual report, and have been reported annually since then.

7.1 Risk-Adjusted Length of Stay and Length of Respiratory Support

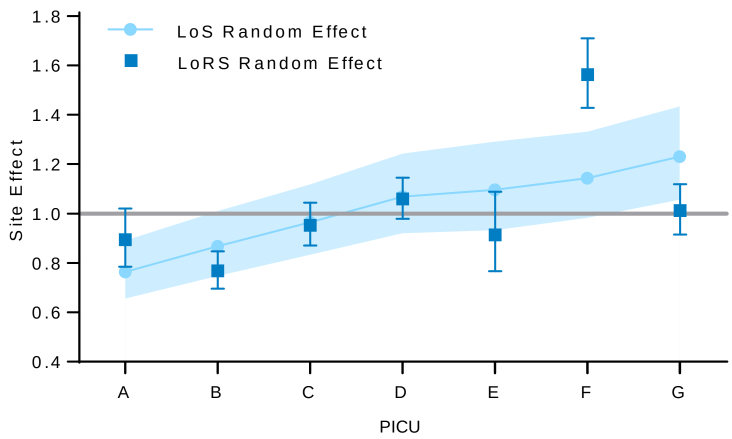
A gamma regression model of LoS and a lognormal regression model of LoRS were constructed using all patient records in the Registry for 2015[9,10]. Both models included the unit the patient was managed in as a random effect. Therefore, for each unit, a '*site effect*' was generated and this represents the risk-adjusted mean LoS and mean LoRS relative to the population overall. For example, a site effect of 1.2 for LoS indicates that the risk-adjusted mean LoS for that ICU was 1.2 times the risk-adjusted mean LoS for the Registry overall. Units where the 95% confidence interval for the site effect did not include one were considered significantly different from the overall population.

Figure 7.1.1 illustrates the results of the analysis for the seven PICUs in 2015. The figure illustrates that unit G had significantly longer risk-adjusted LoS than the overall population, while unit A had a significantly shorter risk-adjusted LoS. Unit F also had significantly longer LoRS, indicating that administrative factors such as ICU exit block were not necessarily influencing LoS at this site.

[9] Straney L, Clements A, Alexander J, Slater A, for the ANZICS Paediatric Study Group (2010) Quantifying variation of paediatric length of stay among intensive care units in Australia and New Zealand. Quality & Safety in Health Care, 19(6): e5.

[10] Straney L, Clements A, Alexander J, Slater A, for the ANZICS Paediatric Study Group (2011) Variation in duration of respiratory support among Australian and New Zealand Pediatric Intensive Care Units. Pediatric Critical Care Medicine, 12(1): 9-13.

Figure 7.1.1: Risk-adjusted mean length of stay and length of respiratory support for PICUs in 2015



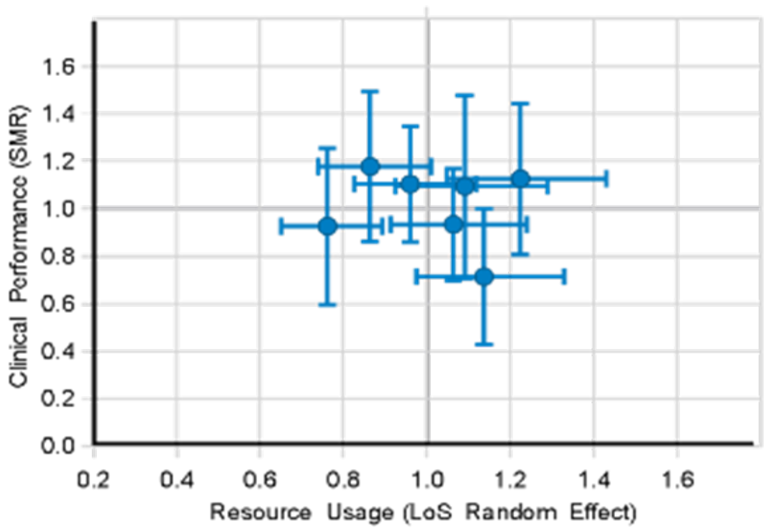
7.2 PICU Efficiency

Efficiency in healthcare is a measure of both the effectiveness and cost of care. An ICU can be considered efficient if optimum clinical outcomes are achieved with low resource use.

The modified Rapoport-Teres plot[11] (Figure 7.2.1) uses the SMR as an indicator of clinical performance, while a risk-adjusted length of stay (LoS) model provides a marker of resource use[12]. When considered together the plot illustrates efficiency.

The quadrants of the plot can be designated as most efficient (bottom left), least efficient (top right), effective but at the expense of high resource use (bottom right), and poor performance with lower resource use (top left).

Figure 7.2.1: Rapoport-Teres plot of efficiency for PICUs in 2015



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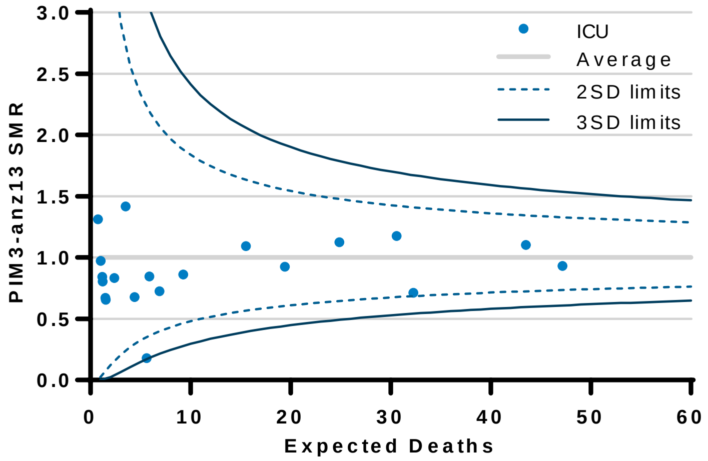
[11] Rapoport J, Teres D, Zhao Y, Lemeshow S. (2003) Length of stay data as a guide to hospital economic performance for ICU patients. Medical Care, 41:386-397.13

[12] Straney L, Clements A, Alexander J, Slater A, for the ANZICS Paediatric Study Group (2010) Measuring Efficiency in Australian and New Zealand Paediatric Intensive Care Units. Intensive Care Medicine, 36(8): 1410-1416.

7.3 Risk-Adjusted Mortality

A funnel plot (Figures 7.3.1) has been used as an alternative graphical representation of the SMR for each site contributing to the Registry. As a comparative report, the funnel plot compares a unit's SMR against the SMR of all units. This plot can identify potential outliers, as they will fall outside the control limits (set at ± 2 & 3 SDs around an SMR of 1). Figure 7.3.1 represents values from each site in 2015 and using PIM3-anz13 for the SMR. Both PICUs and general ICUs are represented on the funnel plots if there were deaths recorded during 2015. No outliers were identified for the time periods using this method.

Figure 7.3.1: Funnel plot representation of PIM3-anz13 SMRs for contributing units in 2015



7.4 Sequential Control Charts

Cumulative sum (CUSUM) charts[13] have been constructed for the seven PICUs for the years 2014 and 2015 combined (Figures 7.4.1 - 7.4.8). The x axis represents each admission to ICU in sequence for the two year period. To construct the risk adjusted CUSUM charts, the PIM3-anz13 model was used. These charts test for '*out-of-control*' signals where the loss of control is defined as doubling or halving of the odds of death in the PICU of interest relative to the population used to derive PIM3-anz13.

The first chart for each unit represents the cumulative excess deaths. The lighter line represents the cumulative number of excess deaths relative to the number of deaths predicted by PIM3-anz13. The darker line represents the cumulative number of excess deaths without adjustment for mortality risk, using an expected crude mortality of 2.5%. The second chart, the CUSUM chart, represents sequential probability ratio testing for an increase or decrease in the odds of death.

For both charts, the x axis represents each admission to ICU in sequence for the two year period 2014 - 2015. The y axis in the upper chart represents the cumulative excess deaths that have occurred relative to the number of deaths predicted. The y axis in the lower chart represents 'process control' where the process is the cumulative observed outcome relative to that predicted by PIM3-anz13.

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[13] Baghurst PA, Norton L, Slater A; for the ANZICS Paediatric Study Group (2008) The application of risk-adjusted control charts using the Paediatric Index of Mortality 2 for monitoring paediatric intensive care performance in Australia and New Zealand. Intensive Care Medicine, 34(7):1281-1288.

The CUSUM chart is designed to test two hypotheses; Hypothesis A (HA) that the odds of deaths in the unit have doubled relative to the population used to derive PIM3-anz13, and Hypothesis B (HB) that the odds of death in the unit have halved relative to the PIM3-anz13 population.

If the upper line in the CUSUM chart crosses the control limits, HA is accepted, whereas if the lower line crosses the control limits HB is accepted. The control limits of ± 2.9 and ± 4.6 are set arbitrarily. Conceptually the control limits correspond to the hypotheses being accepted at alpha = beta = 0.05 (± 2.9) or at alpha = beta = 0.01 (± 4.6). It should be noted, however, that the resetting of the chart and repeated testing mean that the thresholds no longer represent true probabilities, but become more pragmatic thresholds for deciding if the process is in or out of control. For a more detailed explanation of the methods of constructing these charts and their interpretation see reference[14].

For the two year period there was one alarm signalled at the higher threshold (4.6) for PICU B (Figure 7.4.2). The site undertook an examination of all deaths and also their data accuracy to determine possible explanations for the signal. While it is important that any signal is investigated, it should be remembered that the expected frequency of false alarms from this method of sequential probability ratio testing has been estimated to be once in every 800 to 1800 cases[15].

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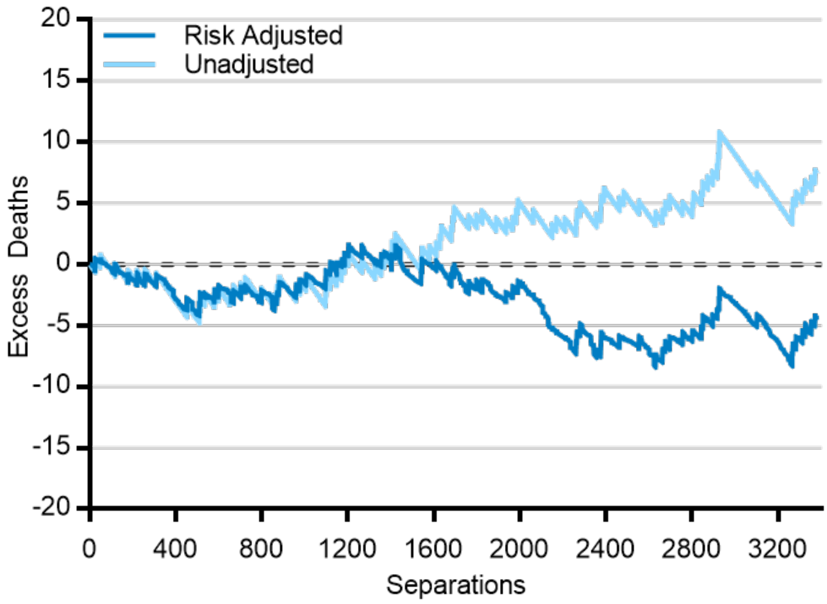
[14] Straney L, Clements A, Parslow R, Pearson G, Shann F, Alexander J, Slater A, for the ANZICS Paediatric Study Group and the Paediatric Intensive Care Network (2013) Paediatric Index of Mortality 3 : an updated model for predicting mortality in Pediatric Intensive Care. Pediatric Critical Care Medicine, 14(7): 673-81.

Figure 7.4.1: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU A, 2014 – 2015

Observed - Expected Mortality, PICU A, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU A, 2014 and 2015

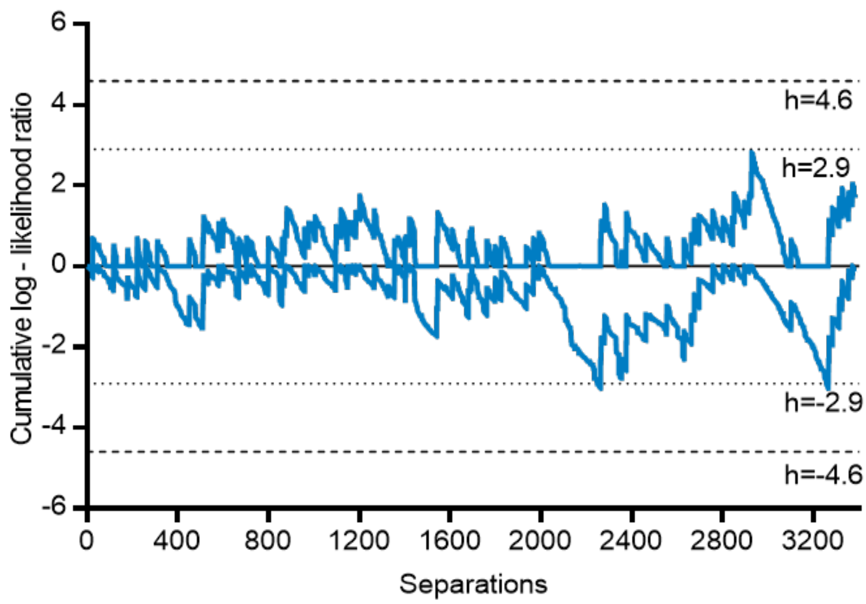
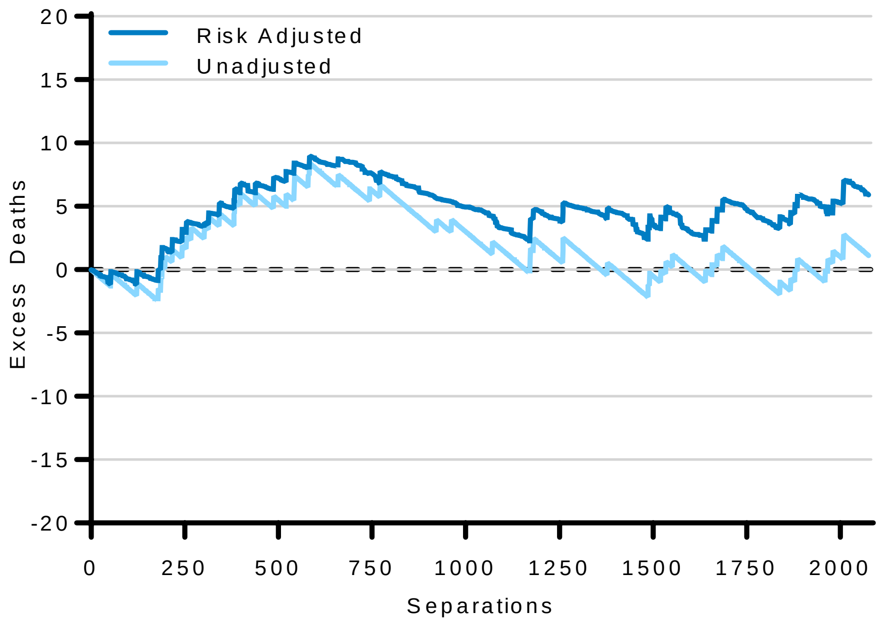


Figure 7.4.2: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU B, 2014 – 2015

Observed - Expected Mortality, PICU B, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU B, 2014 and 2015

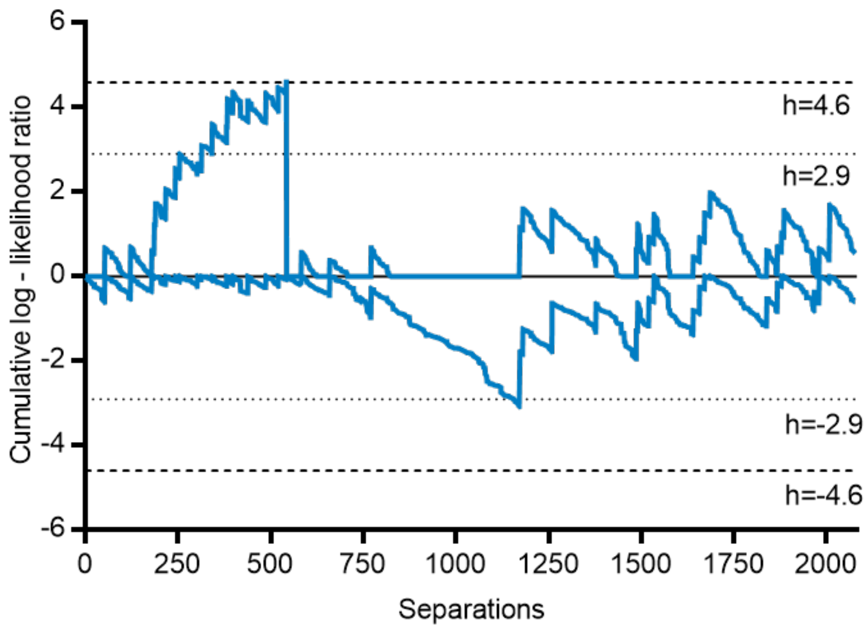
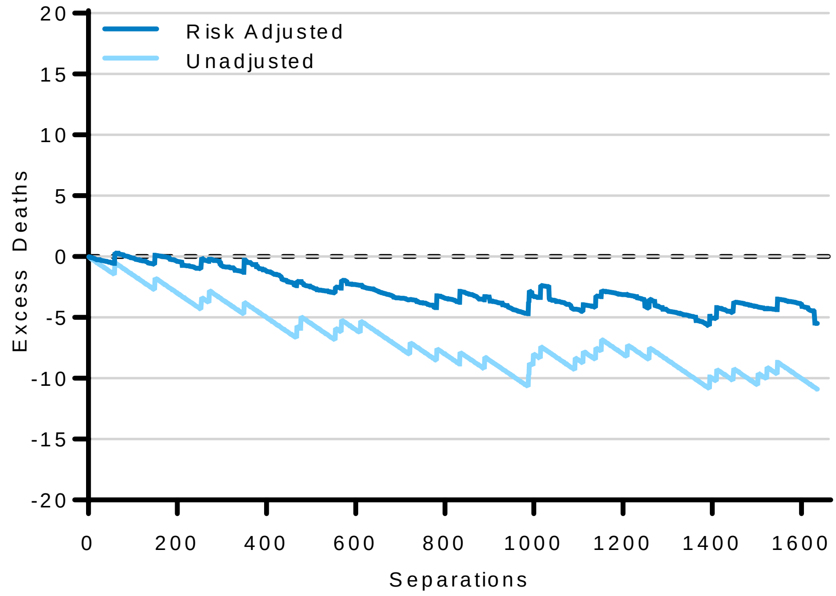


Figure 7.4.3: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU C, 2014 – 2015

Observed - Expected Mortality, PICU C, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU C, 2014 and 2015

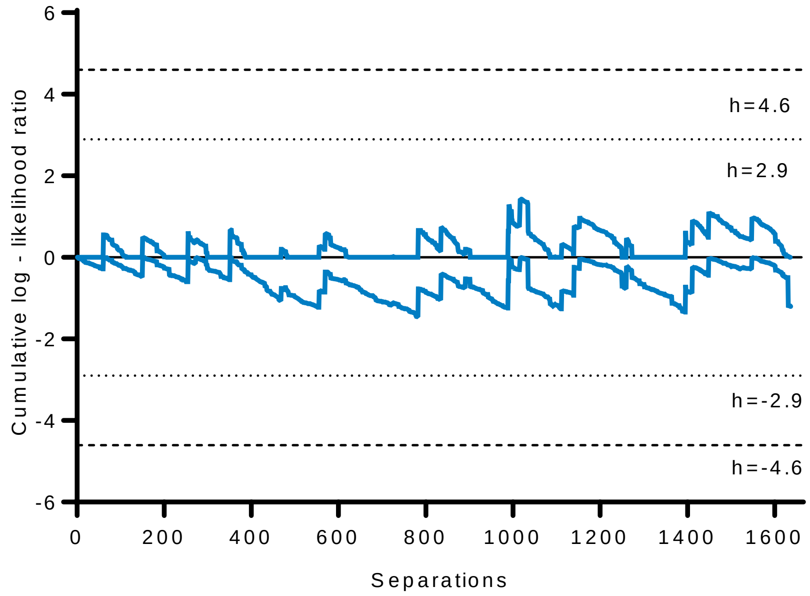
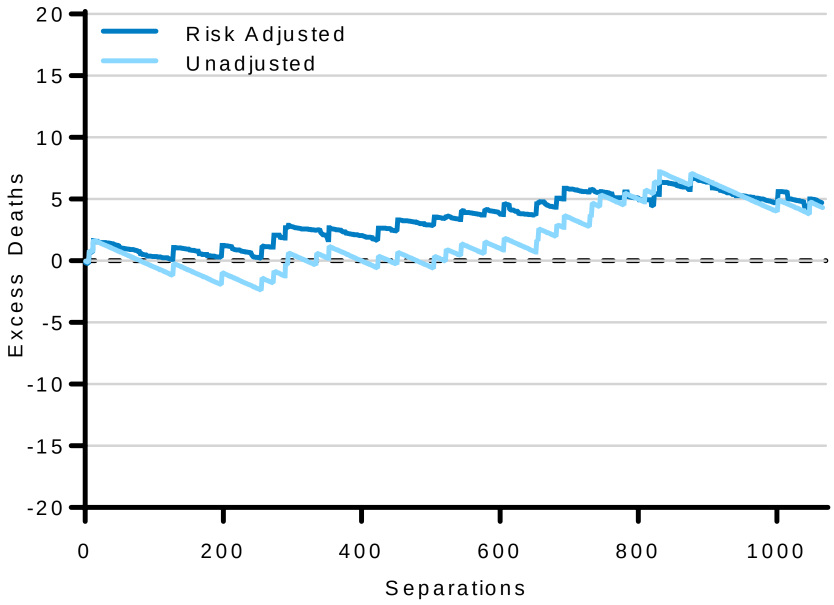


Figure 7.4.4: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU D, 2014 – 2015

Observed - Expected Mortality, PICU D, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU D, 2014 and 2015

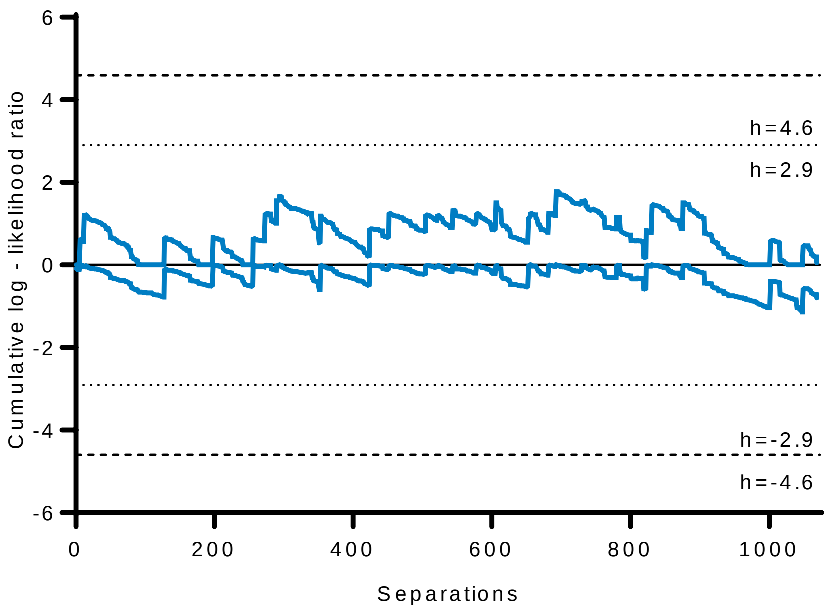
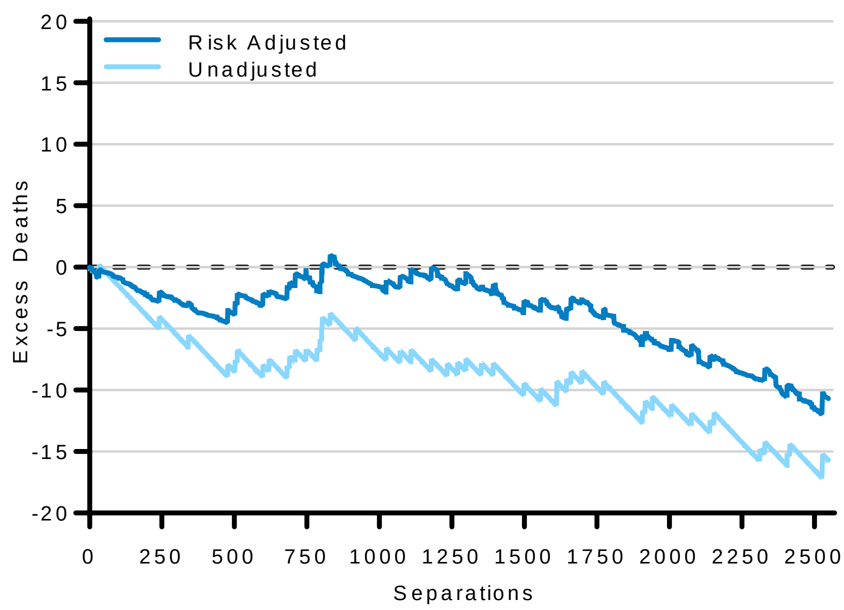


Figure 7.4.5: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU E, 2014 – 2015

Observed - Expected Mortality, PICU E, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU E, 2014 and 2015

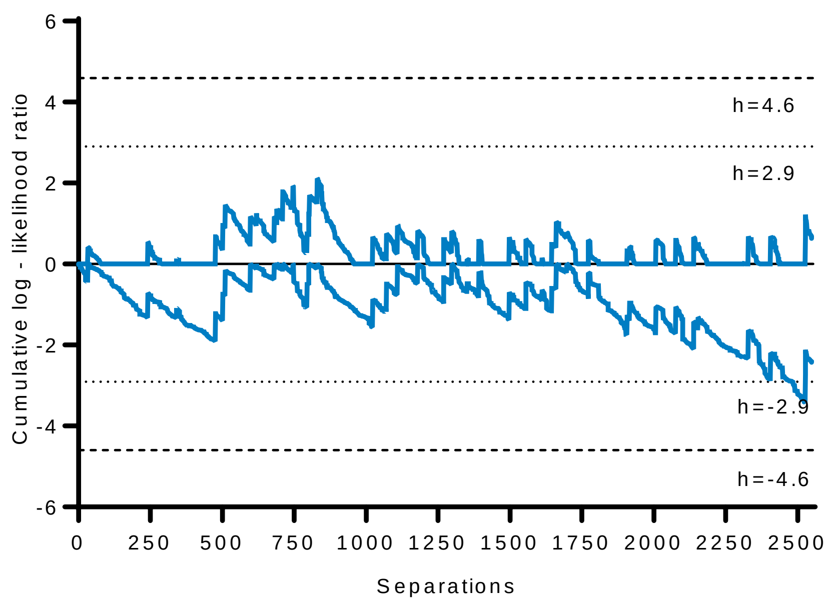
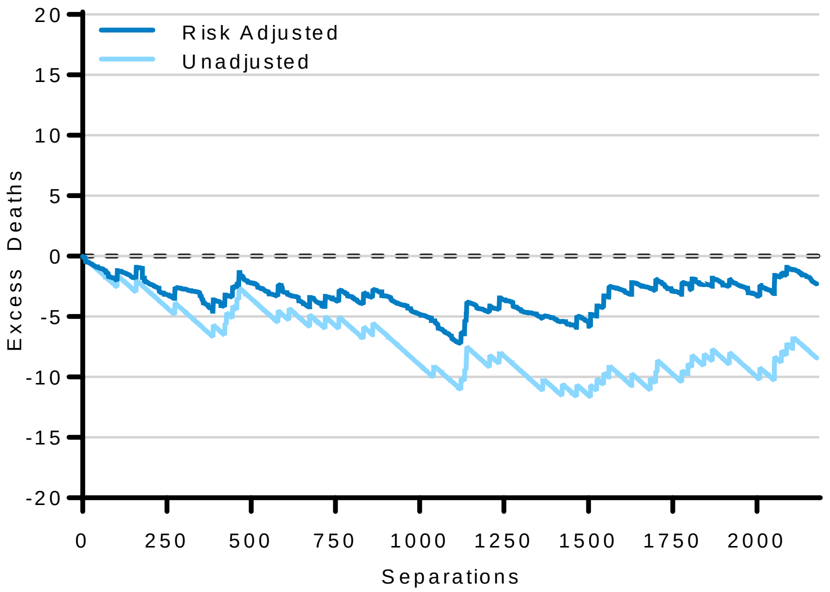


Figure 7.4.6: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU F, 2014 – 2015

Observed - Expected Mortality, PICU F, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU F, 2014 and 2015

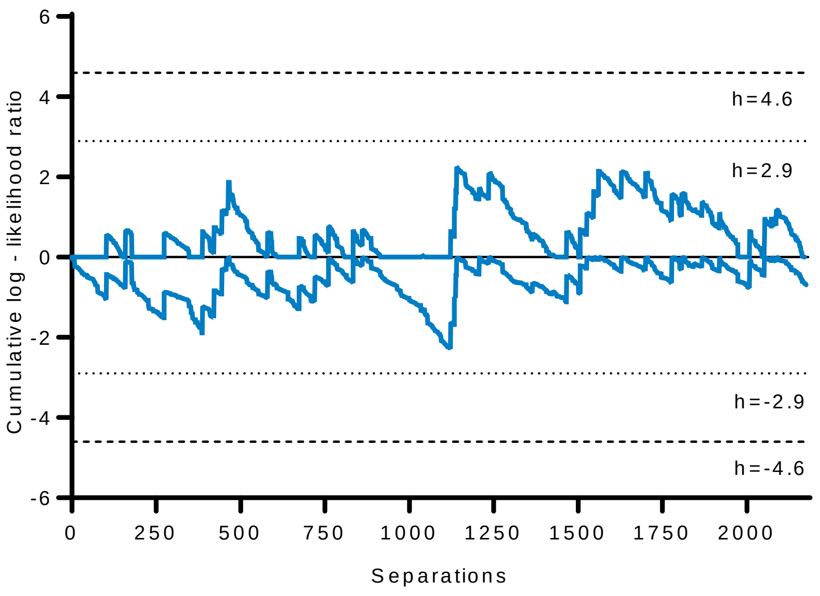
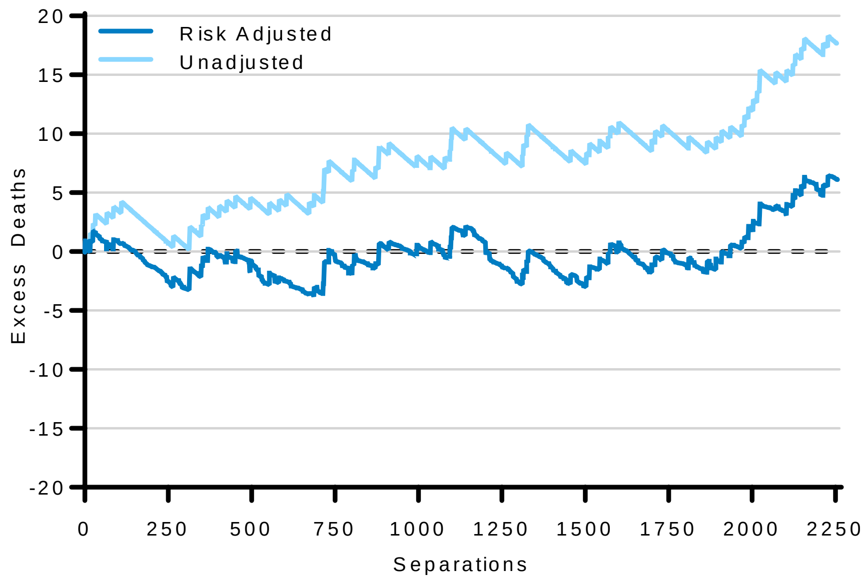
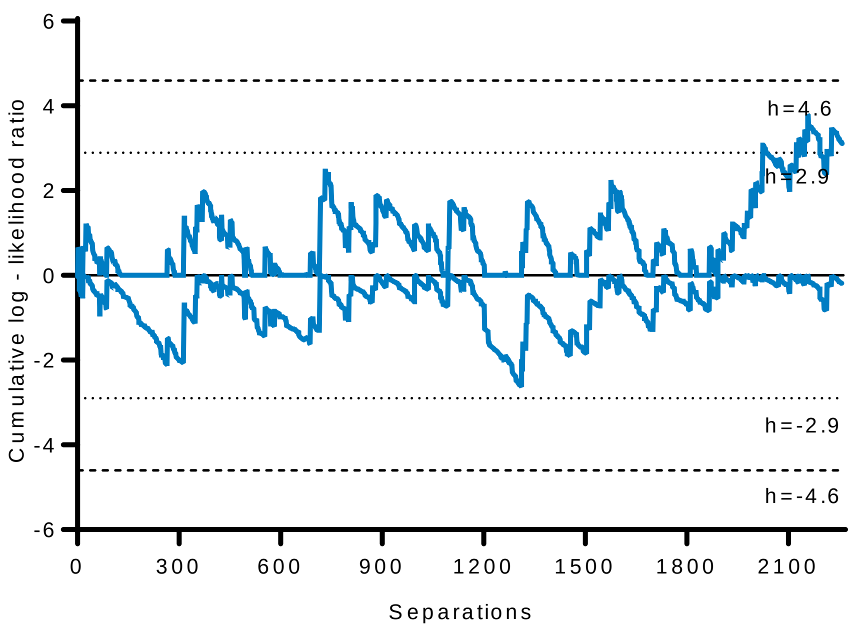


Figure 7.4.7: Sequential cumulative sum control chart for doubling and halving the odds of death for PICU G, 2014 – 2015

Observed - Expected Mortality, PICU G, 2014 and 2015



Risk adjusted CUSUM (PIM3-anz13), PICU G, 2014 and 2015



8. ANZPIC Registry Supporting Research

The data collected and analysed by the ANZPIC registry have provided an invaluable resource to the ANZICS Paediatric Study Group (PSG). In providing such a detailed picture of the case-mix, management and outcomes of children in intensive care, we have been able to identify areas where research is essential and the epidemiology has allowed thoughtful planning for research projects. This has been essential in assisting the PSG achieve the output it has over the last few years. There has also been excellent collaboration between the PSG and ANZPIC in producing several high quality, registry-based studies, including the recent Paediatric Sepsis paper published in the Lancet.

None of this work would occur without the diligence of data collectors, the excellent work at ANZPIC by Jan Alexander and Johnny Millar, the input of ARCAC and the efforts of individual researchers.

Simon Erickson
ANZICS Paediatric Study Group Chair

8.1 PSG and other Registry Publications

Last 12 months

Mortality related to invasive infections, sepsis, and septic shock in critically ill children in Australia and New Zealand, 2002–13: a multicentre retrospective cohort study. (2015) Luregn Schlapbach, Lahn Straney, Janet Alexander, Graeme MacLaren, Marino Festa, Andreas Schibler, Anthony Slater for the ANZICS Paediatric Study Group. The Lancet Infectious Diseases, 15 1: 46-54.

Trends in PICU Admission and Survival Rates in Children in Australia and New Zealand Following Cardiac Arrest (2015) Lahn Straney, Luregn Schlapbach, Glenn Yong, Janet Bray, Johnny Millar, Anthony Slater, Janet Alexander, Judith Finn, for the Australian and New Zealand Intensive Care Society Paediatric Study Group. Pediatric Critical Care Medicine. 16(7):613-620, September 2015.

In Progress

Incidence and outcome of invasive infections in critically ill Indigenous children in Australia.

Burden and outcomes of severe pertussis infection in critically ill infants

Epidemiology of Australian Influenza-related paediatric intensive care unit admissions

Epidemiology of pertussis-related paediatric intensive care unit (ICU) admissions in Australia, 1997-2013: an observational study.

Appendix 1: Contributing Sites in 2015

Hospital and ICU classification contributing to the ANZPIC Registry in 2015

Hospital	State	ICU Type
Alice Springs Hospital	NT	Regional
Cairns Base Hospital	QLD	Regional
The Canberra Hospital	ACT	Metropolitan
Children's Hospital at Westmead	NSW	PICU
Christchurch Hospital	NZ	Regional
Gold Coast University Hospital	QLD	Regional
Griffith Base Hospital	NSW	Regional
John Hunter Hospital	NSW	Regional
Lady Cilento Children's Hospital	QLD	PICU
Launceston Hospital	TAS	Regional
Mackay Base Hospital	QLD	Regional
Middlemore Hospital	NZ	Metropolitan
Mildura Base Hospital	VIC	Regional
Monash Medical Centre	VIC	Metropolitan
Princess Margaret Hospital	WA	PICU
Royal Children's Hospital - Melbourne	VIC	PICU
Royal Darwin Hospital	NT	Metropolitan
Royal Hobart Hospital	TAS	NICU/PICU
Starship Children's Hospital	NZ	PICU
Sydney Children's Hospital	NSW	PICU
Rockhampton Base Hospital	QLD	Regional
Tamworth Hospital	NSW	Regional
Taranaki Hospital	NZ	Regional
Tauranga Hospital	NZ	Regional
Townsville Hospital	QLD	Regional
Waikato Hospital	NZ	Regional
Whangarei Hospital	NZ	Regional
Women's & Children's Hospital	SA	PICU

Classification	Description
PICU or NICU/PICU	Paediatric, tertiary referral intensive care units based in a capital city
Metropolitan	All other general intensive care units in capital cities
Regional	General intensive care units outside a capital city

Appendix 2: Diagnostic Groups used in Annual Report

Diagnostic Group	ANZPIC Registry Diagnostic Codes *
Cardiovascular (including post-op)	1900-1999, 200-299, 1102, 1106, 1107
Gastrointestinal/Renal	500-699
Injury	100-199
Neurological	300-399
Post-operative (non-cardiac)	1300-1899, 1100, 1101, 1104, 1105, 1103, 1108, 1109
Respiratory	400-499
Miscellaneous	700-899

** Please access the ANZICS website for the complete list of individual diagnostic codes used in 2015 (http:// http://www.anzics.com.au/Pages/CORE/data-tools.aspx)*

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Further copies of this report can be downloaded from the ANZICS Web site: http://www.anzics.com.au (navigate to Registries & Research - CORE ICU Registries – Tools and Resources – Annual Reports)

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