Original articles

Paediatric Admissions to the General Intensive Care Unit at Palmerston North Hospital

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ABSTRACT

Objectives: *To report Palmerston North Hospital's (PNH) recent experiences with paediatric admissions to the general Intensive Care Unit (ICU), and to identify any aspects relevant to regionalisation of paediatric intensive care.*

Methods: *Retrospective review of the ICU database and admission register to enable clinical and demographic profiling of all paediatric (aged < 15 years) admissions to PNH ICU from 1996 to 1998. Observed and predicted mortalities were compared using the Paediatric Index of Mortality (PIM).*

Results: *Seventy-five paediatric patients had 76 admissions, comprising 7.4% of ICU admissions during the study period. Forty-eight (64%) were male, and 59 (79%) of the patients received mechanical ventilatory support. The median ICU stay was 21.5 hours (range 0.1 to 568 hours). There were 3 deaths in the ICU, and one following ICU discharge but prior to hospital discharge, compared with 6.37 predicted deaths. The median PIM score overall was 5.3% predicted probability of death (range 0.8 - 61.4%), with 6 patients (7.9%) having a PIM score of greater than 30%. Fifteen patients (20%) were transferred to tertiary services.*

Conclusions: *If the PNH experience reflects that of other similar institutions, then non-tertiary ICUs admit small numbers of critically ill paediatric patients who tend to be of low to moderate severity, but who cover the full spectrum of severity. Most cases can be well managed locally, but appropriate referral and transfer is an important component in the delivery of a rational and integrated paediatric intensive care service.* (**Critical Care and Resuscitation 1999; 1: 234-238**)

Key Words: Paediatric intensive care, outcome assessment, regional health planning

INTRODUCTION

The centralisation of paediatric intensive care has been the topic of international discussion.[1-7] Key to this debate is the assertion that a higher quality of care can be delivered in a tertiary setting.[3,6,7] Whilst intuitively this assertion seems tenable, the supporting evidence has its shortcomings.[1,8-12] It must also be acknowledged that for the potential benefits of such a centralised service to be realised, adequate resources have to be available in the peripheral hospitals. Mandatory components of these resources include resuscitative and stabilisation skills, adequate provision of at least short-term Intensive Care for the full spectrum of paediatric critical illness, efficient triage (i.e. who to retain and who to refer), and a well-organised transport system.[4,5]

New Zealand's population of 3.7 million is spread widely over the two main islands, but with the greater concentration in the northern part of the North Island. The only dedicated Paediatric Intensive Care Unit (PICU) is at Starship Hospital, Auckland, and it has a well-developed retrieval system. Other tertiary centres are able to provide intensive care and transport for

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children as integral components of their services, but not as a stand-alone function. Palmerston North Hospital (PNH), 550 kilometres south of Auckland, is a 420-bed hospital with an 8-bed level 2 general Intensive Care Unit (ICU). This unit has been staffed by seven consultant staff (one intensive care qualified, the others anaesthetists with intensive care experience) and registrars, all on a dedicated ICU roster. The junior staff maintain an exclusive 24-hour presence within the Unit. There is no paediatric intensivist. Also, in PNH there is a paediatric ward which has the capability to provide *de facto* high dependency care (i.e. 1 to 1 nursing and continuous non-invasive monitoring) for medical and surgical patients. In addition to neonates, ex-premature NICU graduates of up to 52 weeks post-conceptual age may also occasionally be admitted by the paediatricians to the Neonatal Intensive Care Unit (NICU), usually with respiratory illnesses requiring short-term CPAP and/or stabilisation prior to retrieval and transfer to tertiary care.

Against this background, we offer a summary of our recent experiences with paediatric (aged less than 15 years) ICU admissions over the 3-year period from 1996 to 1998 to promote discussion of some of the issues surrounding centralisation of paediatric intensive care.

METHODS

All patients aged less than 15 years admitted to ICU from 1996 to 1998 were identified from the ICU computerised database (Access 97, Microsoft Corporation), and a report of the database record for each patient was generated. An additional manual search of the admission register was also completed. The patients' hospital notes were reviewed by one author (GJM). The Paediatric Index of Mortality[13] (PIM) score was calculated for each patient. Additional information was also obtained from the hospital Health Statistics department.

RESULTS

Seventy-five paediatric patients (< 15 years of age) had 76 admissions to ICU, with one patient having been admitted twice during the same hospital stay. Their average age was 7 years 10 months (SD $\pm$ 5 years; range 0years 7months to 14years 10months). Forty-eight patients were male. The diagnostic categories of the patients are summarised in Table 1. Their median length of stay in ICU was 21.5 hours (range 0.1 hours to 568 hours). Fifty-nine (79%) of the patients received mechanical ventilatory support at some time during their ICU admission.

There were 3 deaths in this ICU group (crude mortality rate of 4.0%), and one other death which occurred before hospital discharge. The latter was an

Table 1. Diagnostic categories of the PNH ICU paediatric admissions from 1996 -1998

Category	Number		Subcategories and additional details
Trauma with head injury	27	11	MVA; 3 farm-bike; 5 fall; 5 bicycle; 1 NAI; 1 pedestrian vs. train;
		1	Other
Sepsis/infection	9	4	Meningococcal; 1 Haemophilus meningitis; 3 viral encephalitis;
		1	Staphylococcal septic arthritis and thigh abscess
Trauma without head injury	8	2	MVA; 2 farm-bike; 1 fall; 1 bicycle; 1 gunshot wound; 1 other
Seizures	7		
Poisoning	6	4	Accidental; 2 deliberate ingestion
Postoperative	4		
Upper respiratory	3	2	Croup; 1 ex-prem. with subglottic stenosis and acute bronchopneumonia
Diabetic ketoacidosis	3		
Burns	3		All hot water burns
Lower respiratory	2	1	Bronchiolitis; 1 ex-prem with BPD, spinal muscular atrophy and bronchopneumonia
Near drowning	1		Trapped under overturned farm-bike
ALL/tumour lysis syndrome	1		
Cardiac	1		Acute rheumatic fever with valvular insufficiency
Other endocrine	1		Addisonian crisis, as a first presentation of hypopituitarism

MVA = Motor vehicle accident, NAI = Non-accidental injury, BPD = Bronchopulmonary dysplasia, ALL = Acute lymphoblastic leukaemia

Table 2. Number of paediatric deaths, observed and predicted mortality and summary of cases

	Number	Case details
Observed deaths in ICU	3	i) 16 month old male; Haemophilus meningitis; late presentation to hospital, delayed ICU referral after respiratory arrest. CT showed massive cerebral oedema. LOS 9 hours ii) 7 year old male; farm-bike accident; isolated head injury; large right temporoparietal intracerebral haematoma, pneumocephaly, bifrontal petechiae, widespread cerebral oedema, skull fractures; became brain dead and an organ donor. LOS 139 hours iii) 10 year old male; MVA passenger; Jehovah's Witness - blood products declined by family; severe head injury with multiple complex skull fractures, bifrontal contusions, widespread and extensive intraparenchymal haemorrhages and haematomata, pneumocephaly; splenectomy for rupture; fractured left and right first ribs; autopsy revealed full-thickness myocardial contusion with perforation, no aortic injury. LOS 0.1 hours
Observed deaths after ICU, before hospital discharge	1	i) 13 year old male; previous head injury with residual hemiparesis, dysarthria, and impaired intellect; prolonged seizure activity at home; presented comatose with rhabdomyolysis, ARF, sepsis syndrome; stabilised initially, deteriorated acutely during dialysis; CT revealed left hemispheric cerebral haemorrhagic infarction with marked mass effect; remained comatose throughout. LOS 393 hours.
Predicted ICU deaths	6.37	Paediatric Index of Mortality[13] (median percentage 5.3; range 0.8 to 61.4). [PIM 0-15% n = 67 (88.2%); 15.1-30% n = 3 (3.9%); >30% n = 6 (7.9%)]

LOS = length of stay, MVA = motor vehicle accident, ARF = acute renal failure

Table 3. Transfers of paediatric ICU patients to tertiary services (median LOS 9 hours, range 2 to 31 hours)

Destination	Number		Reason for transfer	Transport
Wellington	6	3	Neurosurgical (2 post-trauma)	2 PT,4 TR
		1	Gun shot wound to neck with complex vascular injury	
		1	Bronchiolitis,	
		1	Paediatric surgical (duodenal haematoma from motor vehicle accident)	
Starship	4	1	Meningococcal disease	4 TR
		1	Burns with sepsis	
		1	Bronchopneumonia and seizures,	
		1	Ex-prem with BPD, spinal muscular atrophy and bronchopneumonia.	
Waikato	3	3	Plastic surgery (2 burns, 1 traumatic full-thickness soft tissue loss)	3 TR
Christchurch	1		T_{7-8} spinal cord injury (*en route* to Burwood Spinal Unit)	1 OS
Greenlane	1		Acute rheumatic fever requiring urgent aortic and mitral valve replacement	1 OS

LOS = Length of stay, BPD = Bronchopulmonary dysplasia, PT = PNH transport team, TR = Tertiary retrieval,
OS = Other transport/retrieval service.

unexpected death. Observed and predicted deaths are summarised in Table 2. Fifteen patients (20%) were transferred for tertiary services, with only 4 being transported to the dedicated PICU (Table 3). All transferred patients survived to hospital discharge.

During the same period, there were 10 729 patients aged less than 15 years admitted to PNH, with 10 of them dying as inpatients, while in all there were 1023 admissions to ICU, with 104 dying in the Unit (crude mortality rate of 10.2%).

DISCUSSION

It is accepted that Intensive Care has a positive outcome for the vast majority of critically ill children.[14,15] It is less certain where these children would best receive such care. Those who are more severely critically ill are likely to be cared for best in tertiary centres.[3,6,7] However, our findings support the premise that those who are less severely unwell, yet still critically ill, can be well cared for in appropriately resourced non-tertiary centres. Indeed such children may have worse outcomes in tertiary centres.[6]

Severely critically ill children often present initially to centres remote from any tertiary level paediatric intensive care. Intensivists, anaesthetists and paediatricians practising in ICUs such as that at PNH have to assume responsibility for the initial care of these children, which includes recognising those who require transfer and arranging their secondary transport. In our experience, advice by telephone from tertiary centres has on occasion been very useful in this process. All of our transferred patients had only brief stays in the PNH (median LOS 9 hours), and all survived to hospital discharge. This can be interpreted as a plaudit for both the early recognition of the need to transfer, and the quality of care delivered before, during and after transport.

The transports were conducted by a number of different teams, but only those to Starship Hospital and Greenlane Hospital (33%) were performed by a dedicated paediatric transport team. All transport outcomes were satisfactory.

This does not imply that tertiary paediatric critical care can be replaced by regional non-paediatric ICUs, rather it emphasises the role of lesser levels of care in the delivery of a rational and integrated paediatric intensive care service. It is inappropriate for children with severe, complex or prolonged critical illnesses to be denied tertiary care and such children need to be transferred promptly. The geographic and demographic realities of New Zealand however dictate that it is impractical to expect that all children with critical illness will be cared for in a PICU. Given the attendant risks and inconveniences, transfer to a distant tertiary centre is not justified for any but the most ill and/or those who will require extended intensive care stay.

The organisational framework proposed for the UK[1,2] might well be useful in the NZ situation. It suggests that larger district general hospitals, which are remote from leading paediatric centres, should become designated providers of level 2 paediatric intensive care services.

If our experience reflects that of other like institutions, specialists practising in Intensive Care in peripheral centres in New Zealand are exposed to very small numbers of critically ill children. Paediatric admissions comprised only 7.4% of admissions to the PNH ICU over the 3-year period under review. Two concerns arise from this fact. One being that the number of paediatric patients is not enough to maintain competence within the smaller institutions, although the coarse outcome of observed mortality in our study would suggest that this has not been the case. The other being that to reduce the exposure of the smaller institutions even further, by wholesale centralisation of paediatric ICU services, may well reduce the exposure to critically ill children below a certain critical point,[4] and care could reach an unacceptably low standard.

The best solution remains difficult to elucidate. To further add to this difficulty, the patients involved have largely been at the lower end of the spectrum of critical illness. This is reflected in a median PIM of 5.3%, and a median length of stay of only 21.5 hours. However, very sick children have also been admitted to PNH ICU, with one in five being transferred for tertiary care (Table 3), and 7.9% having a greater than 30% predicted probability of death.

While others have used the Pediatric risk of mortality score[16] (PRISM) to examine outcomes of paediatric critical illness,[3,6,7,17] the Paediatric Index of Mortality[13] was selected for this review because of its applicability and validity in this geographical region, its ease of use, and because it evaluates the severity of the illness at presentation. Moreover, others have questioned the applicability of PRISM outside of North America.[17] It is helpful to see that we have done better than predicted, especially given the assumed high standard upon which the PIM score is based.[13] However the numbers involved are very small precluding any meaningful statistical analysis, and the implications of our findings may lend themselves to subjective interpretation. Details of the three patients who died in our ICU are provided in table 2. The child with Haemophilus meningitis presented late to our hospital, and even later to our ICU, after what was likely to have been an episode of coning. It is difficult to envisage this child having survived in any Unit unless he had presented earlier. Although one of the trauma victims

was a Jehovah's Witness, the severity of his injuries meant that he was unlikely to have survived even if the administration of blood and blood products had been allowed. The third child became brain dead after a severe traumatic brain injury, and was an organ donor.

Non-tertiary ICUs admit small numbers of critically ill paediatric patients who tend to be of low to moderate severity, but who cover the full spectrum of severity. Timely referral and transfer of appropriately selected patients is an important component in the delivery of a rational and integrated paediatric intensive care service. However maintenance of paediatric intensive care skills and resources in hospitals without a PICU form an equally important component of this same service.

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