



# Pediatric Intensive Care Nursing

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## **Editorial**

### **Reflecting on the early days of pediatric critical care**

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*Note: This editorial is adapted with permission from an article published in: Montreal Children's Hospital PICU Nursing Education Newsletter, 2010, 3(5), 3-6.*

The Pediatric Intensive Care Unit (PICU) that I have worked in and been affiliated with in various ways since 1978, recently celebrated a special anniversary. On this occasion, I was invited to prepare an article for the unit's Newsletter, reflecting back on how the PICU has changed over the years. This historical retrospective also corresponds with the PICU Spotlight article in this issue.

It's sometimes useful to stand back and reflect on where we have come from!

\*\*\*\*\*

When I started working as a staff nurse in the PICU in 1978, it had the following features, among others:

- There were no intensivist-physicians and no PICU fellows. Staff physicians were rotating pediatric medicine staff, with the chief medical residents providing significant leadership in critical-care specific service.
- All surgical patients, including post-operative cardiac patients, were managed medically by surgeons and their residents. As intensivists were hired, several years later, the intensivists were consultants in the care of surgical patients.
- There was only one monitor in the PICU that could display intra-vascular pressure waveforms – it was about the size of a mid-sized refrigerator. This monitor was nicknamed *Herman*. All other pressure transducers were connected to pressure gauges; nurses would read the pressures from a fluctuating needle on a gauge. Central venous pressures were measured with fluid columns. All cardiac monitors, other than Herman, were 'bouncing ball' oscilloscopes – no ECG waveform display was visible across the screen.
- There were no Respiratory Therapists (RT) in the PICU. Only one RT worked in the hospital – who worked in the basement repairing and maintaining ventilators. We used Bennet MA1 ventilators, with occasional use of Bird ventilators. All ventilators were installed and maintained by the PICU nurses.
- There was no on-site pharmacy/pharmacist, and no on-site nutritionist.
- There were no bedside pulse oximeters (i.e., no oxygen saturation monitors), no intra-cranial pressure monitors, no non-invasive blood pressure monitors, no electronic thermometers (only glass thermometers with mercury).
- Dopamine was the only continuous infusion inotrope: dobutamine was not yet available; epinephrine was administered exclusively in boluses. There was no fentanyl or midazolam.
- When TPN tubing changes were made, nurses were required to wear gowns, masks, gloves, hoods, and shoe covers.

Many, many years later, and countless extraordinary innovations later, this unit has cared for hundreds of critically ill children every year with continually improved outcome successes - like so many other PICUs. These tremendous achievements are a demonstration of the extraordinary commitment and talent of the inter-professional staff in PICUs throughout the world.



## **Is cranial molding preventable in preterm infants? A systematic literature review of the effectiveness of interventions**

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### **Abstract**

**Aims:** A systematic review of published studies was conducted to study the evidence supporting interventions to prevent or reduce cranial molding of the preterm infant in Neonatal Intensive Care Units.

**Background:** Incidence of cranial molding has increased over recent decades. Cranial molding is identified as a contributor for negative physical and psychosocial developmental effects.

**Design and Method:** A systematic literature review and critical appraisal according to the Cochrane Collaboration Center assessment criteria was performed.

**Results:** Eight intervention studies meeting the inclusion criteria were identified. Most studies used the anterior-posterior: bi-parietal ratio as measurement of cranial molding. One multi-center quasi-experimental intervention study showed that infants who received regular repositioning had a statistically significant reduction of bilateral head flattening compared to infants who did not receive this intervention. Other studies had either methodological weaknesses or showed no effect for the intervention studied.

**Conclusion:** Evidence is poor and restricted to one intervention; regular body repositioning. More well-designed randomized studies are needed to confirm the effect of regular head and body positioning.

**Keywords:** cranial molding, plagiocephaly, preterm infant, prevention, NICU.

### **Introduction**

The increasing incidence of premature infants presenting with cranial molding has been linked to recommendations regarding sleep positions (side lying and supine position) to prevent Sudden Infant Death Syndrome as well as to the increased number of very low birth weight infants admitted to the Neonatal Intensive Care Unit (NICU)<sup>1</sup>. Supine positioning of newborn infants for longer periods of time seems to increase the prevalence of cranial molding. Cranial molding is measured by the ratio between the anterior-posterior and the bi-parietal distance (AP:BP ratio) also called the cranial index (CI). (Figure 1) Larger bilateral head flattening is indicated by larger CI's. Healthy infants are born with an AP:BP ratio of 1:3. A ratio of 1:4 or more is considered to be cranial molding<sup>2</sup>.

The incidence of cranial molding in newborn infants varies from 16.0% to 22.0% at the age of 6 or 7 weeks and 19.7% at the age of 4 months and decreases to 3.3% at 2 years<sup>3,4</sup>. Research also showed that healthy newborn infants with a positional preference for one side, have higher risk to develop an a-symmetric head, compared to newborn infants without a positional preference (OR 7.1, 95%CI 3.90-12.78)<sup>5</sup>.

Another group of infants with a higher risk of cranial molding are preterm infants (born < 37 weeks gestational age [GA])<sup>2,6</sup>. In this group cranial molding is caused by a combination of

fast growing brain matter and the soft skull parts with low levels of calcium of these premature infants and being nursed for prolonged periods on hard surfaces.

Certain conditions, which are common in preterm infants, such as the relative large head of the preterm infant and the reduction of the muscle tone to be able to spontaneously change the head position, promote the effect of external compression. This results in prolonged time periods in the same positions which lead to either parietal or occipital flattening of the infant's head<sup>7</sup>.

The degree of cranial molding depends on the frequency of positional changes and gestational age. The lower the gestational age, the lower the serum calcium levels. An adequate calcium level is necessary for bone building and consequently hardening of the skull parts. Because calcium is better absorbed from the blood through the umbilical cord and placenta than from par(enteral) feeding the hardening of the skull occurs much faster in the intra-uterine environment compared to the extra-uterine environment after preterm birth<sup>2</sup>.

Cranial molding in preterm infants can have a number of negative consequences. Infants can become restricted in their possibilities of rotating the head when lying on their back. Consequently the intracranial pressure increases, resulting in psychomotor as well as cognitive developmental delays<sup>8</sup>. In addition, cranial molding is associated with auditory dysfunction and visual pursuit (coordination between eye movements and head rotation), with consequences on eye-hand grip coordination<sup>9,10</sup>. A study with magnetic resonance imaging (MRI) shows shifting of brain areas as a result of cranial molding<sup>7</sup>. Cranial molding is also identified as a contributor for the negative physical and psychosocial effects of a dissociated bonding process and lack of attachment between parents and their newborn infant<sup>2,5,6,11,12</sup>.

Treatment of serious cranial molding may include correction of the skull by helmet therapy or by surgical intervention<sup>13</sup>.

In the NICU's changing body and head positioning is used as an intervention to prevent cranial molding, but consensus on the procedure is lacking. The current guidelines are not evidence based.

### **Aim and objective**

To conduct a systematic review of published studies of interventions aimed at prevention or limiting the cranial molding (AP:BP ratio) of *Pediatric Intensive Care Nursing* 12(1-2) 2011

preterm infants. Effectiveness of interventions and feasibility and applicability will be evaluated.

### **Methods**

A systematic literature search was conducted using the method of the Evidence Based Medicine Group from Oxford<sup>14</sup>, and using the PICO system: Patient, Intervention, Control intervention and Outcome<sup>15</sup>.

The research question was: Which preventive interventions limit cranial molding in preterm infants admitted to the NICU?

The PICO was formulated as:

P: Preterm infant (24 to 36 weeks GA) admitted to the NICU

I: Preventive interventions

C: No intervention

O: Cranial molding measured by AP:BP ratio

### *Search strategy*

The systematic literature search was independently conducted by 4 of the 10 members of the National Innovation and Research Study group from the 10 Dutch NICU's in the Netherlands.

Papers published between January 1982 until July 2010 were included. Databases searched were PubMed, CINAHL, Embase, British Nursing Index and Archive, Maternity and Infant Care and the Cochrane Library. The following keywords were used: 'cranial molding', 'plagiocephaly', 'infant', 'preterm' and 'prevention' and were searched in the title and abstract. The boolean 'AND' was used to combine the used keywords and boolean 'OR' was used to combine keywords in the sense of either (cranial molding 'OR' plagiocephaly). The same strategy was performed but without 'prevention' to make the search less sensitive. In addition, the reference lists of included studies were reviewed for other potential studies that met the formulated PICO.

### *Selection criteria*

Articles with an English or Dutch abstract were included. Exclusion criteria were studies concerning 'inborn skull deformation', 'healthy term infants' and 'diagnosis or treatment'.

In a second round the distinction was made in research articles describing the results of a scientific study and descriptive articles not describing scientific study results. Research articles were included, other articles were used as background information.

### *Critical appraisal*

The included studies were independently critically appraised to establish the quality of the study and the effect of the interventions studied,

by four researchers. The checklists of the Cochrane Center were used for this purpose<sup>16</sup>. All articles were appraised for validity and reliability with the appropriate checklist for the design used. The results of the individually critical appraisal were compared and in case of an inconsistent interpretation between the researchers a meeting was planned to reach consensus.

## Results

The search strategy using the terms 'cranial molding or plagiocephaly', 'infant' and 'preterm' combined with the term 'prevention' resulted in seven articles of which only two met the inclusion criteria seemed relevant. A less sensitive search was performed; the keyword 'prevention' was deleted and this generated 72 articles. Abstracts of these 72 articles were assessed for their relevancy. Twelve articles were selected for their potential relevancy. Twelve other articles did not include an abstract or could not be judged for their relevancy based on the abstract provided. The other 48 articles were excluded because they appeared to be no research article or because the study described the effectiveness of an intervention to treat instead of to prevent cranial molding. From the initial selected 24 (12 and 12) articles we were unable to retrieve only one article<sup>17</sup>. Eventually eight articles emerged to answer our research question and were consequently critical appraised (see Figure 2).

Three studies used a randomized clinical trial (RCT) design<sup>19-21</sup>. Two studies had a quasi experimental design, one was a cohort study with a pretest - posttest design, one study had a patient-control design and one a case study design<sup>2,18,22-24</sup>. Five of the studies compared different interventions, a pressure relief mattress, an air mattress, waterbed, water pillow or gel pillow with the standard practice of a so called hard mattress<sup>18-22</sup>. Two studies compared the effectiveness of (re)positioning with standard care<sup>2,23</sup>. One study describes the use of a therapeutic mattress combined with a developmental care program<sup>24</sup>.

Six of the included studies used the anterior-posterior bi-parietal (AP:BP) ratio as primary outcome for cranial molding. This ratio was measured at time points ranging from 3 till 13 weeks (Table 1). One study used the CI index as outcome for cranial molding.

### *Pressure relief mattresses*

Four studies described the effect of pressure relieving mattresses<sup>19-21,24</sup>.

The study of Cartlidge & Rutter had several  
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limitations, such as a small sample size (17 infants in each group), and did not report a power analysis<sup>19</sup>. The preterm infants in this study were cared for on an air mattress or on a conventional mattress of 12 millimetre thickness (brand and type not mentioned). Randomization was performed by sequence of admittance; one infant in the control group followed by one infant in the experimental group. Measurement of the skull was not blinded; the assessor was acquainted with the infants' group. All measurements were performed by the same assessor. The follow-up was short until three weeks post delivery. The result of the AP:BP ratio control group vs. intervention group was 1.48 vs. 1.40 respectively. Analysis showed effect of the intervention, but considering the methodology issues, results need to be interpreted with caution. The feasibility and applicability of this intervention are also doubtful since the used air mattress (Apnoea alarm Mark 3 Vickers Medical, Hampshire, UK) is no longer available.

Hemingway & Oliver performed a well designed blinded RCT. The sample size estimation was 100 infants to be included but only 84 infants were actually included<sup>20</sup>. A block randomisation was used; the researcher had no influence in the group assignment. The effect assessor was blinded for the intervention. The brand and type of the mattress used as well as the waterbed were not mentioned. Patient characteristics between groups were comparable. During interim analysis the effect of the intervention appeared to be unsatisfactory and as a consequence the study stopped.

At follow-up, 11 weeks after birth, only five infants were assessed, the other 79 infants were already transferred to other units, discharged home, transferred to a cot or deceased. The outcome AP:BP ratio was control vs. intervention 1.51 vs. 1.49. The results showed no effect in favour of the waterbed and the evidence was not conclusive and consequently the waterbed was not implemented in daily practice.

Chan et al. did not report a power analysis for their study<sup>21</sup>. The sample size was 144 infants. Intervention infants were cared for on a pressure relief mattress (Geo-Matt, Span America, Greenville USA), control infants on a standard mattress (no mention of brand and type). Randomization procedure was clear. Follow up was performed until 7 weeks after birth. The pressure relief mattress did, compared to the standard mattress, not reduce the cranial molding (AP:BP ratio 1.49 vs. 1.51 respectively). The study results however were not supportive

for the use of this intervention and for that not applicable.

McManus & Capistran performed a case study and used a visco-elastic mattress and a twice-weekly developmental care program for an extremely low birth weight infant (24 4/7 weeks GA and 730 grams)<sup>24</sup>. Cranial molding was measured using the CI; the patient was admitted with a CI of 72 percent. By week 2, CI measurements approached normal limits (CI = 75 percent). When placed on continuous positive airway pressure, the CI became 66.7 percent. Following position changes to midline, CI measurements continued to improve and remained within normal limits until discharge. This dual-element program was feasible but this study does not reveal enough evidence due to the fact that N=1.

#### *Water and gel pillows*

Marsden studied the effect of a water pillow with a twin of 30 weeks gestational age in a patient-control study<sup>18</sup>. One of the twins received standard care (not specified) and a standard mattress (brand and type not mentioned) while the other twin was placed on a water pillow (Travenol Laboratories, Deerfield, USA). Before discharge, after 36 days in hospital, the AP:BP ratio was measured. The skull of the infant receiving standard care was more molded compared to the infant on a water pillow (AP:BP ratio 1.49 vs. 1.39 respectively).

Conditions and results of the intervention as well as the control infant were poorly described. There is very limited evidence for a positive intervention effect. Results as well as applicability are judged doubtful.

The study of Schultz et al. evaluated the effectiveness of gel pillows in preterm infants<sup>22</sup>. Power analysis was not performed. Sample size was underpowered with 81 infants of  $\leq 34$  weeks, weighing  $\leq 1500$  grams. Infants were randomly assigned at birth to usual care on a standard mattress (n = 40) or to placement on a gel pillow (n = 41). It was mentioned that nurses were not very helpful during the study. Beforehand nurses were convinced of the effect of gel pillows and supplied the control infants with liquid filled IV bags. Measurements (not blinded) were performed upon entry and weekly thereafter, until infants had been transferred, discharged or reached 2000 grams. Analysis revealed no statistically significant differences between subjects in the control group versus intervention group upon entry or at 10 weeks post intervention, AP:BP ratio 1.47 vs. 1.39 respectively. There is no evidence for a positive intervention effect and this intervention is for that

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reason not applicable.

#### *(Re)Positioning*

Hemingway & Oliver performed a multi-centre study with a quasi experimental design<sup>2</sup>. They studied the effects of (re)positioning on cranial molding. One hundred and forty six preterm infants were included in two comparing groups. The randomization procedure was described clearly. One group was cared for in supine- or side lying and the head was alternated between left and right side according to a standardized protocol. The other group was cared for according to a repositioning guideline including changing posture every 3 hours (range 2 to 4 hours) into one of the six prescribed positions; left side, right side, head in midline, supine position with head to the right, head in midline in anti-Trendelenburg and supine position with head to the left. Each position is applied equally over 24 hours. Different types of mattresses were used, the Geomatt (Span America, Greenville USA), a standard mattress, water- and gel pillows (brand and type not mentioned). Follow up of the preterm infant was until at least two weeks after birth and at most 13 weeks after birth. The AP:BP ratio was measured, the effect assessors were blinded for the intervention.

Until nine weeks after birth no differences appeared between both groups. From week nine forward a statistical significant difference between both groups occurred. The group repositioned according to the new guideline had a more round skull compared to those in the standard protocol group, AP:BP ratio 1.35 vs. 1.55 respectively ( $p=0.05$ ). No specific explanation was given for this. The effect of the positioning guideline was well-founded and the study results are valid and applicable.

Vaivre-Douret and Golse studied the effects of two different lying-position body supports for physiologic and functional positioning<sup>23</sup>. Twenty-seven preterm infants were without randomization included. A first sample experimented with a "Home-Cocoon" support made by nurses with rolled sheets, and a second sample provided a "Coconou" support, made with a specifically designed rolled pad. Assessments were administered pretest (on admission without support) and posttest (at discharge) by a blinded single assessor. Cranial shape was measured subjectively as normal if without deformation or abnormal if there was at least cranial flattening. The follow-up lasted until 20 days after admittance. The "Coconou" group performed significantly better than the "Home-Cocoon" group, with fewer cranial deformities, Home-Cocoon vs. Coconou 43% normal vs. 85% normal ( $P < .05$ ).

The study had some methodological shortcomings, the results are doubtful valid and not yet applicable.

### Discussion

This systematic literature review resulted in one intervention with statistically significant effect on prevention of cranial molding, and studied according to the methodological standards. All other studies concerned non effective interventions for prevention of cranial molding. Moreover these studies revealed unsatisfactory methodological quality. Some of the interventions described in the studies are outdated since the material used is no longer available (e.g. mattresses of Geo-Matt). The interventions studied were limited and dated while modern materials as gel mattresses are not yet studied.

The only intervention shown to be effective is the repositioning guideline of Hemingway & Oliver<sup>2</sup>. This guideline is not applicable under all circumstances. The suggested postures are difficult if not impossible in case of drainage of pneumothorax, therapeutic hypothermia, severe illness or instability of the preterm infant.

Nurses, at least in the Dutch NICU's provide repositioning without having a standardized protocol and without evidence of the effect of the care provided on preventing cranial molding. As long as other interventions are not proven to be effective it is recommended to use the Hemingway & Oliver guideline<sup>2</sup>. One should realize the fact that posture to prevent cranial molding can also affect other functions of the body, like respiration and motor development of the preterm infant. Alternate postures could as a consequence of drainage prevent atelectases. Supporting a flexed body position during all postures could positively effect motor development and reduce stress. These effects are not studied in the studies included in this review.

### Conclusion

In conclusion more well designed research is necessary to establish the possible positive effects or side effects of other interventions to prevent cranial molding, like gel mattresses or individualized developmental care. The repositioning guideline of Hemingway & Oliver has to be studied more extensively for long term outcome en side effects on respiration and motor development<sup>2</sup>.

### Acknowledgements

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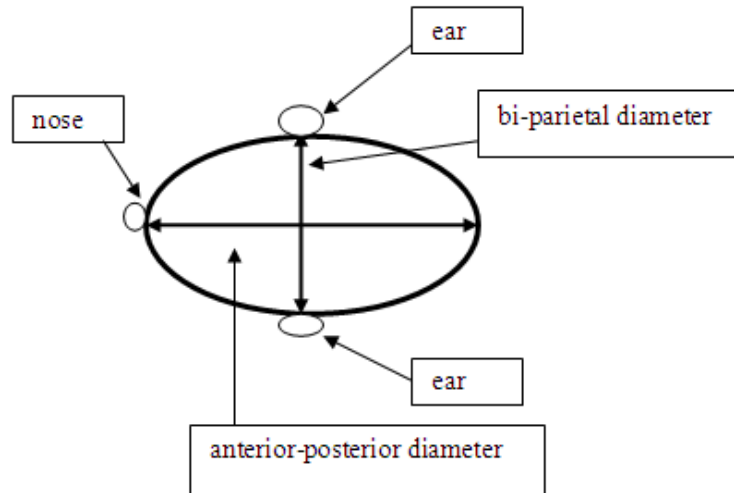
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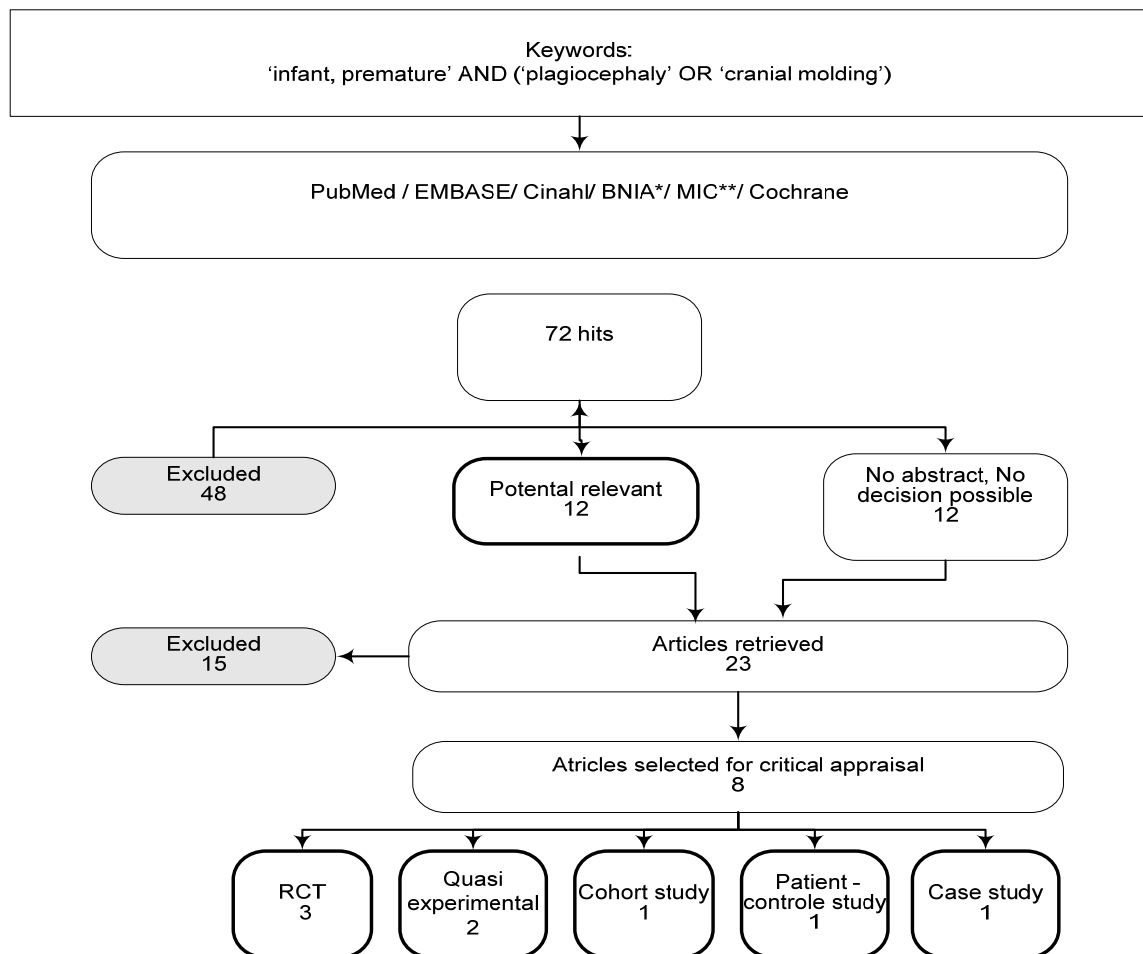
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**NB: See following pages for Figures and Table**





**Figure 1. Measurement of the anterior-posterior diameter and bi-parietal diameter**



BNI\*, British Nursing Index and archive; MIC\*\*, Maternity and Infant Care

**Figure 2. Flowchart search strategy and selection**

Table 1. Included studies on preventive interventions to decrease cranial molding

Authors	Design	Population	(Co-) Intervention	Primary outcome	Results control vs. intervention	Conclusion
Marsden, 1980 <sup>19</sup>	Patient control	N=2, twins, GA <sup>†</sup> 30 weeks without complications	Standard mattress vs. water pillow	AP:BP <sup>‡</sup> ratio follow-up at 36 days post partum	1.49 vs. 1.39	No baseline measurements and effectiveness not evaluated
Carlidge & Rutter, 1988 <sup>20</sup>	RCT*	N=34, preterm infants >26 and <31 weeks GA	Standard mattress vs. air mattress	AP:BP ratio follow-up day 21	1.48 vs. 1.40	Small group, short follow-up, no evidence for effect of air mattress, availability mattress doubtful
Hemingway & Oliver, 1991 <sup>21</sup>	RCT	N=47, preterm infants with GA <32 weeks	Customary firm mattresses vs. waterbed	AP:BP ratio follow-up till 11 weeks (or at discharge)	1.39 vs. 1.38	Adequate design, acceptable groups size, no evidence for the use of a waterbed
Chan, Kelley & Khan, 1993 <sup>22</sup>	RCT	N=144 preterm infants > 24 and < 36 weeks GA	Standard mattress vs. pressure relief mattress	AP:BP ratio follow-up till 7 weeks	1.51 vs. 1.49	Acceptable groups size, short study period, pressure relief mattress does not decrease cranial molding
Hemingway & Oliver, 2000 <sup>2</sup>	Quasi experimental	N=146, preterm infants >22 and <32 weeks GA	Standard protocol vs. repositioning regimen	AP:BP ratio follow-up till 13 weeks	1.55 vs. 1.35 <sup>§</sup>	Adequate groups size, long period of follow-up, repositioning schedules effective
Vaivre-Douret & Golse, 2007 <sup>24</sup>	Pre-test/post-test study	N= 27 preterm infants > 28 and <35 weeks GA	Positioning and Home-Cocoon support vs. positioning and Coconou support	Normal abnormal head form during admission	57% vs. 15% <sup>§</sup> abnormal cranial shape	Small groups, subjective measurement of outcome, positioning in combination with Coconou effective
Schultz et al., 2008 <sup>23</sup>	Quasi experimental	N=81 preterm infants ≤34 weeks GA and ≤1500gr	Standard mattress vs. gel pillow	AP:BP ratio Follow up at 5 and 10 weeks	1.47 : 1.39	Adequate design, underpowered, no evidence for the use of a gel pillow
McManus & Capistran, 2008 <sup>25</sup>	Case study	N=1 preterm infant 24 4/7 GA and 730 g.	Therapeutic mattress and developmental care program	AP:BP ratio Follow up till 7 weeks	NA <sup>  </sup>	Describes and not evaluates the possibilities of the two part intervention

\*RCT = randomized clinical trial, <sup>†</sup>GA = gestational age, <sup>‡</sup>AP:BP = Anterior-Posterior diameter: Bi-Parietal diameter, <sup>§</sup> P < 0.05,

<sup>||</sup>NA: Not applicable



## Spotlight on PICU

*This regular column will provide readers with an opportunity to learn about fellow PICUs in various parts of the world.*

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### **Intensive Care Without Walls – An Australian Perspective**

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Intensive care evolved in the 1950s from respiratory units, recovery rooms, coronary care units and general wards to dedicated, stand-alone intensive care units (ICU) during the 1960s and '70s. During the 1990s a range of services have been developed whereby intensive care practice has moved back outside the ICU to patients, in particular to the deteriorating or dying patient and those patients generally requiring a higher level of care than can be provided where they are currently located. In other words in many countries we now have intensive care without walls. These services include medical emergency/rapid response teams (MET/RRT), liaison services and retrieval services. Australian ICU nurses have been integral in the development of all of the services that have seen ICU teams, expertise and resources move beyond the ICU walls to wherever the patient may be.

Recent innovations that exemplify the concept of intensive care without walls include the MET/RRT and the ICU liaison service, where Australia has made a large contribution. Both are discussed briefly below. The service which will be the main focus of this paper is arguably a true intensive care without walls - the mobile intensive care provided by specialist retrieval services. Retrieval services take intensive care teams and equipment to critically ill patients,

provide intensive care interventions and therapies, stabilising the patient until they can be moved safely to definitive care in another location.

### **Medical Emergency Teams/Rapid Response Services**

Historically, one of the first services involving ICU resources moving out of the ICUs were the cardiac arrest teams, whereby an essentially dead patient in a ward area triggered an urgent team response. Members of these teams typically included an ICU nurse and doctor in addition to anaesthetics and senior medical staff.

The realisation slowly dawned on a clever few that, rather than continue to respond to essentially dead patients, it might be smarter to intervene with these individuals earlier on, potentially preventing the progression to full cardiac arrest and a dismal outcome. The ICU team at Liverpool Hospital in Sydney pioneered this concept<sup>1</sup>, which they named the Medical Emergency Team (MET), the term subsequently adopted across Australia. This is alternatively known as Rapid Response Teams (RRT) in North America and Critical Care Outreach Teams in the United Kingdom<sup>2</sup>. This approach has largely replaced the cardiac arrest team, with emphasis now based on the recognition of deteriorating patients. Evidence shows that that

mortality and adverse events such as cardiac arrest have reduced since the introduction of the MET<sup>3,4,5</sup>.

The Royal Children's Hospital in Melbourne was amongst the first paediatric hospital to adopt MET teams and to undertake research into their outcomes. While the large Australian multi-centre study in adults (the Merit trial) comparing the MET approach with the traditional arrest team appears to have been victim of the Hawthorne effect, the work of Kinney and Tibballs has demonstrated reduced mortality amongst children in their institution<sup>6,7</sup>.

### **ICU Liaison Services**

In more recent times, the ICU liaison service has evolved, so that patients moving from ICU to ward areas are followed up by the ICU team, most commonly ICU nurses who have developed the liaison role. The service allows preparation of the receiving ward to plan for the transfer of a patient who may still be a higher acuity, but no longer requiring ICU. Education of staff, supervision by ICU team members post-transfer, planned discharge and a greater awareness for all concerned has seen this approach prove successful in transition of patients, in support of ward staff, less fear and uncertainty by patients and families, and seems to result in fewer unplanned transfers back into the ICU<sup>8,9</sup>. The Australian College of Nursing has established a Special Interest Group for Liaison Nurses who are currently developing a set of core role competencies and scope of practice<sup>2</sup>.

Many paediatric centres are implementing this approach, and the relatively new role in Australia of Nurse Practitioners has allowed the liaison service to also provide an intermediate service that allows nurses to request a review of a baby or child prior to the need for a rapid response or MET call.

### **Retrieval Services**

Australia is a large island continent of over 7 million square kilometres with a population of only 22 million people who largely inhabit the coastal fringe<sup>10</sup>. There are many rural and remote communities that lie hundreds of kilometres from major city hospitals. Consequently Australia has had a long track record of moving resources to sick and injured people, then transferring to definitive care.

Perhaps the most famous service is the Royal Flying Doctor Service (RFDS), which was established in the 1920s, and was the first civilian aeromedical retrieval service in the world<sup>11</sup>. RFDS operate a fleet of fixed wing aircraft staffed by doctors and flight nurses in all

Australian states, often working in conjunction with specialist newborn and paediatric retrieval services such as NETS NSW and WA. The surf rescue services that patrol many Australian beaches began using aircraft in the 1970s, and Australia now boasts many rotary wing retrieval services as both primary responders and inter-hospital transport in addition to RFDS and Air Ambulance fixed wing assets<sup>12</sup>. These are occasionally bolstered by the use of private and military aircraft, particularly for international retrievals.

Our colleagues in the military have the distinction of being the first to move injured adults – soldiers – by aircraft during World War I<sup>13</sup>. The transport of newborns and children is described in the literature from the 1960s in the UK and North America, usually in the form of case reports of babies and children with urgent surgical conditions or trauma injuries that were transported to children's hospitals for definitive care<sup>14, 15</sup>.

Paediatric hospitals in Australia are centralised generally in the capital cities of five mainland states, with one hospital in a major city almost 200 kilometres from Sydney. Transporting babies and children has evolved over the past three decades into a sub-specialty of both aviation and critical care medicine and nursing practice. Outcomes of children retrieved from general hospitals to PICUs by specialist paediatric retrieval services are associated with improved mortality<sup>16</sup>. Paediatric and neonatal retrieval services in Australia began initially with a number of neonatal ICUs (generally in capital cities) retrieving babies from outlying hospitals. In the 1970s and 1980s it was usually a PICU or NICU registrar who went – often by taxi – without a nurse, without a mobile telephone, with only limited and quite basic equipment and utilising the services of the state-based ambulance service to return with their patient to the children's hospital<sup>17,18</sup>.

The history of Newborn and paediatric Emergency Transport Service (NETS) NSW is typical, originating in the former Camperdown Children's Hospital and the former Prince of Wales Children's Hospital, both in Sydney. Each hospital had been sending ICU staff to retrieve babies and children since the late 1970s. Prince of Wales Children's Hospital (now Sydney Children's Hospital) had a combined NICU/PICU unit and retrieved newborns and children in a donated and converted vehicle with a modified ventilator. At Camperdown, two separate retrieval services were run by the PICU and the NICU. Registrars travelled generally by taxis and occasionally police cars to the baby or child and

returned via road ambulance. Air Ambulance was utilised occasionally. Equipment was rudimentary at best, with this author recalling the store room in PICU holding the Oxylog Classic ventilator, the Lifepack 5 monitor and a backpack with some essential equipment for cannulation and intubation. It needed to be able to be carried by only one person, as a nurse could rarely be spared from PICU to accompany the doctor.

There was no retrieval-specific education and certainly no courses – experiences were shared. In 1985 nurses became retrieval team members and in the mid-1990s the three teams amalgamated to become NETS NSW<sup>17</sup>. Telstra Childflight was the first dedicated paediatric and neonatal rotary wing service in the world, commencing operations in partnership with NETS NSW in 1989. Since then, they have taken NETS NSW teams on over 6000 retrievals across NSW<sup>19</sup>.

Some 30 years later, NETS NSW is a dedicated retrieval service for babies and children, based in purpose-built facilities that include: a helipad and accommodation for the fleet of custom-fitted road ambulances; a clinical coordination centre staffed by retrieval nurses around the clock, seven days/week; facilities for clinical staff, emergency vehicle operators, pilots and associated support and administrative staff. In addition to retrieval by either road vehicle, rotary wing or fixed wing aircraft, the service offers: clinical consultation; coordination of retrieval by other services including the ambulance service, Air Ambulance, RFDS, interstate paediatric and newborn services and local adult retrieval services (for children only, not newborns); bed-finding; mobilisation of local assistance that is closer to the patient until a team can be present; and paediatric and neonatal education<sup>17</sup>.

Through the Clinical Coordination Centre, callers are placed into a virtual conference room, where they can then consult directly with the NETS consultants who can then include other specialists from all facets of paediatrics, neonatology and obstetrics. Consultants are commonly consulted from NICU, PICU, Emergency, Surgery, Neurology to name just a few. In the context of a time-critical injury, a neurosurgeon with appropriate equipment can be taken with the retrieval team to the patient to perform surgery. NETS NSW receives approximately 3000 calls annually and conducts over 2000 retrievals each year.

### Conclusion

Intensive care in the 21<sup>st</sup> century has moved well beyond the four ICU walls, providing rapid response systems for the deteriorating patient,

establishment of liaison services that support ongoing monitoring and care of higher acuity patients in addition to staff support and education. The commitment to provide the highest possible standard of care to patients and their families has also led to a new critical care specialty – stabilisation and retrieval of critically ill patients from wherever they may present to tertiary care in a specialist hospital.

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## Come & Join PICU-Nurse-International

An Internet discussion group of the  
***International Pediatric Intensive Care  
Nursing Network.***

For more information, visit our website:  
<http://groups.yahoo.com/group/PICU-Nurse-International>  
or contact Franco Carnevale (moderator) at  
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## Questions & Answers from PICU-Nurse-International

### Column Editor

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*This column features particular dialogues that unfolded on the PICU-Nurse-International egroup that were particularly pertinent, stimulating, generated significant interest, and provided particularly informative replies.*

### January-December 2011

#### Heparin Use in Arterial and Central Venous Pressure (CVP) Systems

##### Question:

We are in the process of reviewing heparin use in our hemodynamic monitoring systems (arterial and CVP). I would appreciate hearing what other sites are doing. Are you using heparin? What concentrations and problems encountered.  
Saskatoon, Canada

##### Answers:

We use pre-mixed Heparin 1u/ml in NaCl 0.9%. We got in 500ml bags which connect to our system. We use it at a rate of 1 ml per hour for all patients through a syringe driver. Children over 20kgs get 3mls per hour. There is absolutely no science to this practice at all, but we rarely get any problems, so what works continues!  
Birmingham, UK

We use Heparin 5 u/ml at 1 ml/hr for children 2.5 - 30kg, under 2.5kg -1u/ml at 1ml/hr, over 30kg - Normal Saline at 3mls/hr.

LA and PA lines, 1u/ml at 1ml/hr for children under 30kg, over 30kg, Normal Saline 3mls/hr. We also run a low dose heparin infusion (10u/kg/hr, and titrated to APPT as per protocol) through the central line of children less than 5 kg.  
Auckland, New Zealand.

We use heparin in the arterial line in a saline solution of 1u/ml, at the rate of 2ml/hr in neonates and 3ml/hr in pediatric patients. In adult/teenager patients, we start using only saline solution for arterial line in this year and so far no particular problems with arterial catheters (e.g. obstruction).

For CVP catheter that is not in use, we use a saline solution with heparin 10u/ml every 8 h to maintain open the catheter.  
Padua, Italy

We use heparin in the arterial line 1000u/500 ml saline at the rate of 3ml/hr and this would average a continuous flush of 6u/hr. We have, though a huge problem with DVT in all ages and it is unclear to us "why". We didn't change CVC types, medications are more or a less the same, we try to respect separate runways for TPN, Lipids, furosemide etc. Nevertheless, we cannot put a finger on the problem. Anyone would like to share view, thoughts on that?  
Brussels, Belgium

#### Pediatric Stroke

##### Question:

We currently have several adult stroke protocols in place. We are looking at developing a pediatric protocol/guideline for acute strokes. I would like to benchmark and see if anyone has a pediatric

protocol for acute stroke. If you have a protocol for pediatric acute stroke could you let me know if you would be willing to share your protocols/guidelines?  
Oregon, USA

**Answers:**

I looked at pediatric stroke order sets and standards of care about 2 years ago and wrote an order set based on ischemic vs. hemorrhagic stroke in children - obviously the approach is different. I would be happy to send a copy electronically or in hard copy.  
Denver, USA

**Post Op Vital Signs**

**Question:**

Please consider sharing your practice relating to the frequency of vital signs for patients brought directly to the PICU from the Operating Room. Is this a written policy? Is it based on EBP or just the way you have always done it? Please include what type of patients you might admit directly to the PICU and whether the patients are intubated or extubated on arrival.

Kansas City, USA

**Answer:**

Attached is our guideline of care for post op patients who bypass the recovery room. Vital Signs are taken q15 minutes x 4, then q30 x2, then per ICU routine. Patients admitted directly from OR are usually intubated, even if they are going to be extubated directly. The organ transplants and spinal fusions are usually admitted directly. Other patients admitted directly are patients that are unstable, having airway issues, or bleeding copiously.

Seattle, USA

**Basic medication administration competency**

**Question:**

I am wondering if anyone has done a new implementation of basic medication administration proficiency testing (pen and paper or computer based testing) and if you have, did you test all current RN employees or did you "grandfather" them all in and only test new hires? If grandfathered how you do answer the question of RN medication administration competency (if asked) by regulatory agencies? I am also looking to find out if places are using a peer reviewed test like the national league for nursing basic proficiency in medication administration or did you create their own?

Wisconsin, USA

**Answers:**

We take a medication administration test every year with our competencies. New staff must also pass medication administration competency test in order to give medications on the unit. The test is created new every year by the Nursing Education Specialist, and is ICU specific (ECMO specialists and charge nurses have more in-depth questions).

Seattle, USA

At our hospital there is a requirement for nurses to do a yearly online quiz. All nursing students and agency nurses must do the quiz, and pass, prior to administering any medication. This is an online portal available to all staff. The portal also has fire safety and other mandatory yearly tests. The quizzes are disciplinary specific, for example PICU, NICU, emergency and oncology have specific requirements. We do have competency document and we have a local quiz. If you would like it please let me know and I will email it to you.

Birmingham, UK

I am interested in administration of medication competency document and quiz. In my unit, the golden rule of 3 checks and 5 rights is very important. There is a list of common drugs used.

Hong Kong

**Nellcor N600 and Masimo SET Radical pulse oximeters**

**Question:**

We are in the process of assessing which type of pulse oximetry system to switch to. The choices are



between Nellcor N600 and Masimo SET Radical. We currently have Philips Monitors. I would love to hear some thoughts from others who have either of these systems.

Questions:

1. Which one do you currently use? And what units? (Type of ICU, patient populations, acute care units)
2. Pre-support and installation -how did this part of the process go? Did you have an education plan for the nurses?
3. What type of monitors do you use?
4. What type of pulse ox probes do you use? Do you re-process them?
5. Post installation support? How is this?
6. Why did you choose this product? If you had to choose again, would you still choose this product? If not, why?
7. Have you measured or noticed a decrease in your false alarms?

Anything else to add would be greatly appreciated!

Seattle, USA

**Answer:**

I can't answer all your questions, but we upgraded to Phillips last year and use the Masimo Set. We have no problems at all and they are very similar to the probes we had before. I'm not sure our staff even noticed they were different, and there were no education issues.

Birmingham. UK

### **CVVH citrate blood sampling**

**Question:**

When using citrate to anticoagulate our CVVH circuit we currently take post-filter blood samples to measure the circuit ionised Ca. Does anyone sample pre-filter? If so, what is the target range for the circuit?

Brisbane, Australia

**Answers:**

We use post-filter sampling

California, USA

We sample pre filter and our target range is 0.3 - 0.4 for the ionized Calcium.

Vancouver, Canada

We sample post-filter. Our target for circuit  $iCa^{++}$  is 0.35-0.40 mmol/L and our serum  $iCa^{++}$  target is 1.1-1.3 mmol/L. Generally speaking we don't have much difficulty reaching those goals fairly quickly.

We run hourly gases until stable, then q4H.

Alberta, Canada

### **Site for Central Venous Catheter Insertion**

**Question:**

Just wondering about a "ratio" between people inserting CVC via the femoral route versus people always using the jugular or subclavian route?

Incentives:

- Femoral CVC: more prone to line sepsis and secondary deep venous thrombosis (DVT)?
- Subclavian: more "hygienic", less secondary DVT?

Can anyone share his/her impressions with me please?

Brussels, Belgium

**Answers:**

Our cardiac patients will sometimes have an IJ for monitoring purposes (eg BiDi Glen), and then have this removed on Day 1 post op. day to minimise the risk thrombus in the cannula. These patients would always have a femoral central line for administration of inotropes. We have also had some issues with SVC obstruction secondary to IJ or subclavian lines in our cardiac patients. I haven't heard of any increase in incidence of infection in femoral lines, but understand why this may be the case.

Auckland, New Zealand

We do both – femoral more often in small children and infants, IJ or tunnelled more often in bigger children. We have a longer scrub time for dressing changes with femoral lines, and we change dressings immediately on any site if loose or soiled, so dressings get changed more frequently for femoral lines due to soiling. I don't have statistics, but my impression is that we have more problems with clots with the femoral lines, but not a statistically interesting difference in infection rates.  
Seattle, USA

### **Anal Dilation**

#### **Question:**

I am wondering who performs (Surgeon, ARNP or bedside RN) regular anal dilations for your patient with Hirschsprung's/ anal atresia post operatively? If the bedside RN does it, do you have a policy/procedure you are willing to share?  
Seattle, USA

#### **Answers:**

Most of our patients that get daily anal dilations are in the NICU. The surgeon or surgeon's staff (NP, PA, CNS) will do the first few, then mark the depth on the dilator and write an order for the size and frequency of dilation. the bedside nurse is then taught as well as mother/father if present.  
Oklahoma, USA

We don't see many of these kids in PICU here so the surgeon does them as far as I know.  
Canada

### **Peripheral Parental Nutrition**

#### **Question:**

We are seeking best practices regarding infusing PN in peripheral IVs.

1. Do you infuse peripheral PN and what dextrose concentration, osmolarity and pH do you infuse if you do peripheral PN?
2. What about medications and other solutions? Do you have peripheral IV selection criteria?
3. What are your checking practices? Are they all the same or different based on infusion materials or the children's characteristics?

Vancouver, Canada

#### **Answers:**

Related to Q3, we continuously monitor inline intravenous pressure. The volumetric are always combined with an inline measurement system, while their threshold is set at the lowest level. IV dressings are transparent and a clinical inspection (palpation, visual control) are associated routines to early detect extravasation.

Since the introduction/investment of/in these high precision devices we observe less extravasation, regardless of the products infused.

Brussels, Belgium

12.5% dextrose is the most that can be infused peripherally- not sure about the pH or osmol.

There are only a couple of "NEVER PIV" medications, (calcium, 3%, KCL etc). Even if we had to, we would infuse at much slower rates and have it more dilute if there was no other option.

Every 2 hour monitoring for non-vesicants and every 1 hour and PRN for any vesicant.

Memphis, USA

### **Bolus Medication from Infusion Pumps**

#### **Question:**

Is your unit using a pre-set bolus feature to give boluses from a drip on an infusion pump? And if you are, have you had any issues?

Seattle, USA

#### **Answers:**

Yes, we use preprogrammed bolus doses on our infusion pumps (Alaris). We have not had any

problems. There must be an independent verification by a second RN when programming and at each shift change/change in RN to use the feature with prn doses as long as the dose is not changing.  
Oregon, USA

We use the Medfusion Smartpumps for our continuous infusions. There is a bolus feature programmed for many of the medications according to the medication library established by our hospital pharmacy. We set up the infusion dosing and bolus doses according to the doctor's weight-based orders within the parameters on the pump.  
Victoria BC, Canada

We use set boluses on our infusions (we use Alaris Guardrails) and have found it very good. It provides accuracy and is convenient. We have set our infusion pumps so that only drugs which are suitable to bolus have the bolus mode option active. Bolus doses are preset per kg at an appropriate dose. If a larger dose it required nursing staff tend to give a second bolus rather than adjusting the dose. It is important to ensure the bolus dose is correct for the intended use. We had this problem with our ECMO heparin where the bolus was set at 75u/kg (loading bolus dose) as on the standard heparin infusion. Therefore the nursing staff needed to adjust the dose every time they gave a bolus. This has been very frustrating and adds risk. Fortunately we have been able to correct this.  
Brisbane, Australia

### **Developmental Care in the PICU**

#### **Question:**

We are working on a project here in Chicago on developmental care and have some questions:

1. Does your PICU have a unit-based developmental care program or committee?
2. Does your institution or unit have policies regarding developmentally supportive care?
3. How does your institution or unit assess development upon admission? Who does this? What tool do you use?
4. What type of education does your unit or institution provide to nurses regarding normal development?

Chicago, Illinois

#### **Answer:**

Our answers are pretty much "no" unfortunately, however we are interested and are wondering if there have been any positive responses to this query yet?

We have a part-time child life specialist, we have feedback from families indicating this is one of our challenges and we are working on a skills validation tool for this.

Vancouver, Canada

### **Narcotic checks**

#### **Question:**

We are reviewing our practice guidelines on narcotic double checks and are interested in learning about your practice/policy on narcotic checks.

1. What does your double check look like and where does it take place--pt room or at the Pyxis?
2. What is double checked--order, patient weight, MAR, syringe with narcotic to be administered, waste, or other?
3. If using an electronic record, how is the narcotic check documented?
4. Do you have good compliance with your double check practice?
5. What about checking repeated doses throughout the shift to the same patient?

Currently, a second nurse checks the narcotic in the patient room by: looking at the MAR--noting dose & last time given clarifying pt weight checking the syringe to be administered & vial medication drawn from checking the amount wasted (which should also be drawn up in a syringe to validate the remaining amount) witness the disposal of the waste document as a witness of the amount wasted in the electronic record.

Kansas City, USA

#### **Answer:**

We do independent verification for all opiates (narcotics). It can take place at the pyxis or the room. Each RN independently determines the dose, based on MAR, patient's weight with dose and then

volume based on concentration. The MAR is checked with the orders every night and the original order would only be checked if this was the same day the order was written. For doses given through the shift, the same process would need to occur unless the dose is being administered from a "smart infusion device". And if the same RN had verified the bolus dose in the infusion device and the RN is using restore, they would only need to verify the "restore" use button. We have good compliance with our process in the PICU. We will be converting to an electronic record next April. It sounds like our process is similar to your current process.  
Oregon, USA

### **Follow up for staff following a child's death**

#### **Question:**

Our group who looks at issues related to end of life care and we are seeking input about what others do regarding: Follow up for staff after a child's death.

We are considering initiating a routine phone call to staff who are present so that we can "defuse" the event – persons volunteering to do this would be trained by our psychologist with Critical Incident Stress Management training and experience. Are any of you currently involved with such practices?  
Vancouver, Canada

#### **Answers:**

I run the Bereavement Follow up Service for parents in our unit. What to do for staff support is an ongoing concern, as many staff (particularly senior) don't feel they need anything, and I don't think would appreciate a phone call when they are on time off. If we have a particularly stressful death, usually post sudden arrest, we will sometimes organize a formal debrief with the hospital psychologists. I feel there is a gap as far as supports for nurses go, particularly with nurses new to the unit who don't yet have a support network in place. We are usually pretty good at discussing things informally, but I'm sure this doesn't work for some staff!  
New Zealand

We do a similar thing with particularly traumatic situations/deaths in the PICU. We usually will have our unit chaplain and someone from the Critical Incident Stress Management Team do a debriefing in our unit in a separate room usually a few times the week after something like that happens. I think a lot of nurses find it very helpful to just come and vent their feelings. Not everyone participates, because people deal with that stuff in different ways.  
Atlanta, USA

### **Patient Diary**

#### **Question:**

I was recently reading an article about nurses writing a diary relating patient's stay in adult ICU. Is anyone writing diaries for PICU patients? If so, who is involved: nurses, social workers, parents? Do you have any rules or protocol stating what can or cannot be written? Are you using any pictures or graphic?  
Montreal, Canada

#### **Answers:**

We have had parents who have requested this, but I'm afraid we had to stop it. Staff became a little too friendly with one family and it became a little difficult with keeping professional boundaries. Any written notes must now go in the patient notes. If you do use this method of communication it does have advantages for the child in some instances, but you must have some ground rules.  
Birmingham, UK

We have diaries for several years. Parents, nurses and play specialists are writing in these. Parents are very happy with it, but also the older children. Most of the time they don't remember anything from their stay at the PICU and these diaries are very helpful for them. We never had problems with the content.  
Amsterdam, Netherlands

Our NICU keeps a journal at the baby's bedside for whomever who likes to write in and just keep updates for the parents because a lot of times the mother is still in the hospital and can't come to visit.

I think it's mostly nurses that update it and they do sometimes include pictures.  
Georgia, USA

We have a journal box with books and stickers, etc for parents to make up their own journals. We also have a file of relevant photos, e.g. equipment, ECMO, helicopter. The parents write the journal themselves. Occasionally a parent may ask staff to write in it as well, but it is basically the parents' responsibility and property. It can give them a sense of doing something important at a time when they feel helpless.

Auckland, New Zealand

### **ICU Expansion**

#### **Question:**

We are having an expansion, starting next year from 20 to 31 beds. We have the possibility of access to some travel funds to visit some other large centers.

We would very much like to visit Rotterdam, Paris, Toronto, Chicago (who we think are also expanding), Atlanta (? 30 beds). Firstly, is there anyone from any of the centers I have mentioned who might be able to host a visit of a few hours or so please? Secondly, is there anywhere any of you would recommend we visit and could you put up with us coming to see you?

We particularly want to find out how you group your children, how you organize your staffing and how you educate and retain a large group of staff. If it helps, we are a mixed unit of all specialties serving the population of the West Midlands, UK. 50% of our work is cardiac surgery. I look forward to hearing from you! Thanks in anticipation.

Birmingham, UK

#### **Answers:**

You may want to check with Children's Hospital of Wisconsin in Milwaukee Wisconsin. They aren't far from Chicago (about 120 kilometers) and you might be able to combine a visit to both.

Children's in Wisconsin just went from a 32 bed one floor PICU to a 72 bed 3 floor PICU. They opened in April of 2009 after building a new tower for the children's hospital. They went through an extensive hiring of new staff to grow to this size and Deb Soetenga, the CNS from the original 32 bed unit created a new orientation program that is very successful. They oriented over 80 new staff including new graduate nurses in less than a year. One of the units they expanded was the pediatric CVICU which went from being within the 32 bed unit to having its own unit.

I would encourage you to contact the nursing director for Pediatric Critical Care. They have done some visits with a hospital from South Africa that is being built and others from the United States as well.

Denver, USA

Here in Chicago, we expanded from 28-42 beds about 4-5 years ago. We are currently in the process of building a new freestanding children's hospital that will be completed in June 2012. We would be happy to host you and your group for a visit to learn about how we managed our expansion and our plans for separating our combined PICU into a med-surgical PICU and a cardiac care unit (admit to discharge med/surgical cardiac services).

Chicago, Illinois

### **Regular Shift**

#### **Question:**

I am looking for any units/floors that utilize 8 hour shifts other than ER or PACU as part of a regular shift, not overtime shifts.

Atlanta, USA

#### **Answer:**

We do a mix of long days and short shifts to keep everyone happy! Our shifts are:

- Early - 0730-1500hrs
- Late - 1300-2030hrs
- Long Day - 0730-2030hrs
- Night - 2000-0800hrs

Birmingham, UK



## Instructions for Authors

### *Prepared by*

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### **Format**

Manuscripts must be written in English; either American or British spelling may be used but must be consistent throughout. Manuscripts should be typed double-spaced, using Arial or Times New Roman font in at least 11-point, with margins of at least 2 cm or 1 inch. Number pages consecutively beginning with the title page. The preferred length for research, clinical and review papers is 1000-2500 words, excluding references. Submissions to Spotlight on PICU should not exceed 1500 words. The sections of the manuscript should be in the following order.

### **Title page**

- Title should be concise and informative, and typed in bold capitals.
- Names (first name, initial(s) and family names) of authors in the order in which they are to appear. Include a maximum of 4 qualifications for each author
- Institutional affiliation(s) of each author
- Address, telephone and fax numbers and email address of corresponding author

### **Abstract**

An abstract not exceeding 250 words is required for all submissions except those for Spotlight on PICU. For research studies, the abstract should be structured under the following headings: Background, Methodology, Results (or Findings), Conclusions.

### **Body of text**

Use headings to structure the paper. The type of paper will determine the headings, eg for research papers the main headings will be Introduction, Background, Methodology/Methods, Results/Findings, Discussion, Conclusion. Up to 2 levels of headings may be used. Papers reporting research conducted in humans or animals should include a statement that the study was approved by the relevant body or bodies.

### **References**

The list of references should only include works that are cited in the text and that have been published or accepted for publication. References such as "personal communications" or "unpublished data" cannot be included in the reference list, but can be mentioned in the text in parentheses.

References should start on a separate page following the text. They must be numbered in the order in which they appear in the text and listed in numerical order. In the text, designate reference numbers on the line (i.e., in normal text, not superscript) in parentheses. If using Endnote or Reference Manager, references should be formatted using the style *Intensive Care Medicine*.

### **Examples**

*Journal article:* Tan AM, Gomez JM, Mathews J, Williams M, Paratz J, Rajadurai VS (2005) Closed versus partially ventilated endotracheal suction in extremely preterm neonates: physiologic consequences. *Intensive and Critical Care Nursing* 21:234-242

*Journal article published on-line ahead of print:* Duff JP, Rosychuk RJ, Joffe AR (2007) The safety and efficacy of sustained inflations as a lung recruitment maneuver in pediatric intensive care unit patients. *Intensive Care Medicine* 10.1007/s00134-007-0764-2

*Book:* McHaffie H (2001) *Crucial decisions at the beginning of life: parents' experiences of treatment withdrawal from infants* Radcliffe Medical Press, Abingdon

*Book chapter:* Cordery C (1995) Doing more with less: nursing and the politics of economic rationalism in the 1990s. In: Gray G, Pratt, R. (ed) *Issues in Australian Nursing* 4. Churchill Livingstone, Melbourne, p 355-374

*Conference paper:* Copnell B, Tingay DG, Kiraly NJ, Sourial M, Gordon MJ, Mills JF, Morley CJ, Dargaville PA Comparison of the effectiveness of open and closed endotracheal suction. Proceedings of the Pediatric Academic Societies' Annual Meeting, San Francisco, May 2006. E-PAS2006:2059:5560.2342.

*Electronic source:* National Institutes of Health (2004) Program announcement: Improving care for dying children and their families. <http://grants1.nih.gov/grants/guide/pa-files/PA-04-057.html> Accessed: July 20, 2004

### **Figures and Tables**

All figures (graphs, photographs, diagrams) and tables should be numbered consecutively and cited in the text. Each figure and table should be on a separate page at the end of the manuscript. Tables should have a title above and, if needed, a legend at the bottom explaining any abbreviations used.

Figure legends should be typed on a separate page. They should be concise but self-sufficient explanations of the illustrations.

Illustrations should be supplied in electronic format.

Written permission must be obtained to reproduce illustrations and tables that have appeared elsewhere, even if the work of the author(s). Borrowed material should be acknowledged in the legends. Identifiable clinical photographs must be accompanied by written permission from the persons in the photograph, or parent or guardian for children.

### **Manuscript submission**

Electronic submission is required. Manuscripts should be saved as a Word document and emailed to the editor Franco Carnevale ([franco.carnevale@mcgill.ca](mailto:franco.carnevale@mcgill.ca)).

Submissions to Spotlight on PICU can be emailed directly to the column editor, Dr Bev Copnell, at [Beverley.Copnell@med.monash.edu.au](mailto:Beverley.Copnell@med.monash.edu.au)