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Background  Checklists have been recognized by multiple industries as a valuable tool to reduce errors of omission. In the busy environment of a pediatric intensive care unit, adverse events are common and can have severe consequences. Researchers have focused on developing evidence-based practice guidelines; however, the nature of human error means that consistent application of this evidence in practice is challenging.

Objective  To develop an evidence-based checklist as a tool to reduce preventable adverse events and enhance clinical care in pediatric intensive care units.

Methods  After a systematic review of literature and a retrospective review of local reporting of adverse events in pediatric intensive care units, nominal group technique was used to determine the structure and content for the checklist.

Results  An 8-element mnemonic checklist (KIDS SAFE) was developed: kids’ development needs, infection, deep-vein thrombosis prophylaxis, skin integrity, sedation, analgesia, family, and enteral needs.

Conclusion  Prevention of adverse events is better than cure. Use of the KIDS SAFE checklist has the potential to reduce errors of omission in pediatric intensive care units. (American Journal of Critical Care. 2013;22:61-69)
Adverse events and serious errors are common in critical care because of its complex and multidisciplinary nature. Inclusion of errors of omission—steps health care providers fail to take (eg, failure to use evidence-based therapies)—increases the prevalence of these events and errors. Estimates of preventable harm suggest that patients receive, on average, only half of the recommended care they should receive. Additionally, critically ill patients may be particularly vulnerable to iatrogenic injury because of the severity and unstable status of their illnesses and their frequent need for high-risk interventions and medications.

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Checklists are routinely used in high-performance or high-risk areas where, as in health care, errors have severe consequences for people’s safety and lives. Use of checklists can reduce error rates and increase adherence to best practices. Checklists are important tools that condense large quantities of information, reduce the frequency of errors of omission, create reliable and reproducible evaluations, and improve quality standards and use of best practices. Mnemonic checklists are easy to remember and help standardize normal, abnormal, and complex procedures by calling to mind items, tasks, or behaviors.

Checklists and goal worksheets for daily care of patients in intensive care units (ICUs) have been developed and tested by several researchers as a way to ensure that evidence-based principles are incorporated into everyday practice. A well-known checklist for adult ICU patients, known as FASTHUG, is a mnemonic to remind ICU staff to consider feeding, analgesia, sedation levels, thromboembolic prophylaxis, head-of-the-bed elevation, ulcer prophylaxis, and glucose control for each patient each day. The effectiveness of this mnemonic in improving morbidity and mortality outcomes and communication has been demonstrated in a few studies.

When attempting to apply this checklist in the pediatric ICU (PICU), we found that FASTHUG has several inadequacies. Specifically, it does not support holistic pediatric care by incorporating the physiology and development requirements of children as indicated in the literature (eg, glucose control).

The aim of our study was to develop a PICU-specific checklist to improve the use of evidence-based management and thereby prevent errors of omission.

Methods

Phase 1

To inform development of the checklist, researchers from the PICU at Royal Children’s Hospital (RCH), Brisbane, Australia, undertook a systematic review of published peer-reviewed literature on characteristics of adverse events (both preventable and nonpreventable) that occurred as a result of admission to PICUs. MEDLINE via PubMed was searched by using the MeSH terms adverse events and intensive care units-pediatric. The search was restricted to articles in English and further to studies in humans by using the limit function of PubMed. To be included, studies had to meet the following criteria: original research, patients less than 16 years old, ICU patients, and documented outcomes of adverse events. At each stage of the search, studies were independently reviewed by 2 researchers for satisfactory inclusion of these criteria.

Concurrently, 2 PICU nurses summarized and categorized reports of adverse events that occurred...
in the PICU at RCH from 2008 to 2009. Each representative independently classified reported incidents into common clinical domains, including medication, documentation, pressure injury, and health care–associated infection. Disagreements in categorization were resolved by discussion. Additional definitions for the categorization of adverse events considered in this study are provided in Table 1.

**Phase 2**

A nominal group technique (NGT)\(^{16-18}\) was used to determine the structure and content for the checklist. NGT is a highly structured, systematic approach to soliciting individual input into project design and planning by a group. It is recognized as an efficient and effective method for generating and prioritizing ideas and solutions for complex, poorly structured problems.\(^{16,15,20}\) NGT provides a means to identify important themes and issues in exploratory research that allows each member of a group to have an equal opportunity to contribute to the research.\(^{17}\) NGT has been used successfully in pediatrics,\(^{16,20}\) critical care,\(^{17,14}\) and development of guidelines.\(^{17,18}\)

For this study, the multidisciplinary group participating in the NGT consisted of volunteer, local, senior pediatric intensive care representatives from medical, nursing, research, and patient safety domains. The NGT question was as follows: For the purpose of improving the application of evidence-based management and reducing the incidence of preventable adverse events, what items do you think should be included in a PICU checklist? The group then participated in a structured generation of ideas and discussion, establishing the importance of each item that potentially would be included in the checklist.\(^{20}\) Consensus was achieved through an explicit and confidential voting process.\(^{15}\)

**Results**

**Phase 1**

From the electronic search, 53 articles were identified. Of these, 44 were rejected after review of the abstracts because they did not meet the selection criteria. A total of 8 studies met selection criteria, with consensus agreement between the 2 reviewers, who then prepared a summary of the studies (Table 2).

Information on patient safety in the RCH PICU was obtained from PRIME, a voluntary incident-reporting system that provides detailed information about the circumstances and contributory factors in an adverse event.\(^{2}\) The most common clinical areas in which preventable adverse events occurred within the PICU at RCH were comparable to those noted in the international literature, including administration and prescription of medications, pressure injuries, malfunction of intravenous and arterial catheters, and equipment problems.

**Phase 2**

Using the NGT, the multidisciplinary group determined that elements to be included in the PICU checklist should be elements that were currently prone to omission, as evident in international literature and local reporting of adverse events, and should have a notable clinical effect, as indicated by peer-reviewed research.\(^{8}\)

After several discussions, consultations, and reviews of the literature, the group developed KIDS SAFE, a checklist for 8 areas of care for PICU patients: kids’ developmental needs, infection, prophylaxis for deep-vein thrombosis, sedation, skin integrity, analgesia, family, and enteral needs.

**The KIDS SAFE Checklist**

**Kids’ Developmental Needs**

The PICU at RCH provides care for a heterogeneous group of patients who are from 1 day to 16 years old. The section of the checklist on kids’ developmental needs allows the PICU team to highlight the developmental issues specifically related to illness and health care. In addition to improving medical care, attention to these elements may improve a child’s coping mechanisms. Because of the increases in the number of children with symptoms of posttraumatic stress or a diagnosis of posttraumatic stress,\(^{28-30}\) these elements are important...
in minimizing stress. Previously, these elements may have been omitted within the complicated management of care that critically ill children require. The elements include the following:

- Infant: family bonding (eg, kangaroo care), immunizations, newborn metabolic screening, and breastfeeding support
- Child: immunizations, play therapy, and communication
- Adolescent: privacy, sensitivity of staff allocation, entertainment, and communication

### Infection

Catheter-related bloodstream infections, ventilator-associated pneumonia, and catheter-related urinary tract infections have a notable incidence and clinical impact. The timely removal of access devices, including central venous catheters, other intravenous catheters, and urinary catheters, markedly decreases the risk of health care–associated infections. Additionally, use of a care bundle to prevent ventilator-associated pneumonia can significantly reduce the incidence of the disease. The domain of infection, incorporating the daily review of access requirements and interventions to prevent ventilator-associated pneumonia, is included in the PICU checklist in an attempt to ensure that catheters are removed at the earliest clinical opportunity and that care is provided to prevent ventilator-associated pneumonia, thereby reducing the occurrence of preventable infections.

### Table 2

<table>
<thead>
<tr>
<th>Reference</th>
<th>Design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricci et al21</td>
<td>Retrospective, cross-sectional review</td>
<td>1500 patients from a single pediatric intensive care unit (PICU) in 3 years 211 adverse events involving 178 patients (11.9%) Most frequent types of adverse events involved indwelling catheters (n=51, 24.2%), equipment (n=51, 24.2%), drug errors (n=48, 22.7%), and operational problems (n=37, 17.5%)</td>
</tr>
<tr>
<td>Stambouly et al22</td>
<td>Prospective, observational</td>
<td>1035 consecutive admissions to a single PICU in 1 year 115 &quot;complications of care&quot; in 83 patients admitted, an incidence of 2.7 complications per 100 PICU-days Most common adverse events were related to the ventilator (n=60, 52.2%), infections (n=24, 20.8%), and invasive devices (n=22, 19.1%)</td>
</tr>
<tr>
<td>Larsen et al9</td>
<td>Retrospective, randomized, cross-sectional, chart review</td>
<td>259 patients’ charts from a single PICU in 1 year 183 preventable adverse events, an incidence of 33.4 adverse events per 100 PICU-days Most commonly related to sedation (n=40, 22%), skin care (n=29, 16%), and medical devices (n=26, 14%)</td>
</tr>
<tr>
<td>Agarwal et al23</td>
<td>Retrospective, randomized, cross-sectional, chart review</td>
<td>734 patients’ charts reviewed from 15 PICUs in the United States in 1 year 683 preventable adverse events identified, an incidence of 28.6 adverse events per 100 PICU-days Most common adverse events were catheter complications (n=101, 14.8%), uncontrolled pain (n=120, 17.6%), malpositioning of endotracheal tube (n=69, 10.1%), nosocomial infection (n=58, 8.5%), and constipation (n=41, 6.0%)</td>
</tr>
<tr>
<td>Silas and Tibballs24</td>
<td>Prospective, observational</td>
<td>740 patients monitored from a single PICU in 1 year 524 adverse events in 193 patients (26.1%) No detail provided on clinical characteristics of the adverse events</td>
</tr>
<tr>
<td>Niesse et al25</td>
<td>Retrospective, cross-sectional, chart review</td>
<td>360 &quot;critical incidents&quot; reviewed from a single PICU in 1 year Most common adverse events involved medication prescription and administration (n=125, 34.7%), patient management (n=52, 14.4%), and respiration (n=35, 9.7%)</td>
</tr>
<tr>
<td>Shapik et al26</td>
<td>Retrospective, cross-sectional review</td>
<td>464 &quot;incidents&quot; reported from 23 PICUs in 2 years Most common incidents were related to medication (n=186, 40%), catheters (n=101, 22%), incorrect care being provided (n=79, 17%), and the airway (n=67, 14%)</td>
</tr>
<tr>
<td>Tibby et al27</td>
<td>Prospective, observational</td>
<td>816 patients monitored from a single PICU in 1 year 181 patient-related adverse events, an incidence of 6.0 per 100 PICU days Most common patient-related adverse events involved drug errors (n=55, 30.4%), intravenous/arterial catheters (n=37, 20.4%), equipment (n=32, 17.7%) and patient injury (n=26, 14.4%)</td>
</tr>
</tbody>
</table>
Deep-Vein Thrombosis Prophylaxis

The number of venous thromboembolic events in children is increasing as a result of therapeutic advances in primary illnesses that previously caused mortality; 95% of venous thromboembolic events in children are associated with serious problems such as cancer, trauma/surgery, congenital heart disease, and systemic lupus erythematosus. Thrombosis is also a common complication of central venous catheters in critically ill patients; in prospective studies, the reported incidence has been up to 40%.

Current treatment recommendations suggest short-term prophylactic anticoagulation as an option for children who are in high-risk situations (immobility, major surgery, or trauma) and have 3 or more acquired risk factors. The risk-benefit ratio should be considered for each patient. The goal of this element of the checklist is to highlight the need to consider each patient’s individual risk factors for venous thromboembolic events. Decisions on prophylaxis are left to clinicians, with the aim of reducing these sometimes preventable adverse events.

Skin Integrity

Pressure injuries remain a common problem in critically ill infants and children; the reported incidence is 10% to 27%. Pressure injuries cause pain and discomfort and are associated with considerable financial expense due to increased length of hospital stay and nursing time. The first step in preventing pressure injuries is to correctly identify patients who are at risk by using a validated risk assessment tool (eg, Glamorgan Paediatric Pressure Ulcer Risk Assessment Scale, Braden Q Scale) so that nurses can provide timely and appropriate preventive interventions. Best practice dictates that patients who are at risk should have a plan of care that incorporates measures such as pressure support systems, positioning, skin inspections, skin care, and nutritional support. Skin integrity is included in the checklist to encourage detection of at-risk patients and the implementation of strategies to prevent pressure injury, thereby reducing the incidence of this sometimes preventable adverse event.

Sedation

Administration and management of sedatives are necessary components in the care of critically ill children. The main indications for use of sedatives include reducing anxiety and agitation, inducing amnesia, facilitating mechanical ventilation, preventing displacement of endotracheal tubes, and reducing cellular metabolism. The consequences of prolonged use of sedative agents in the PICU involve increased risk for infection, increased requirements for mechanical ventilation, and adverse neurocognitive effects. Inclusion of sedation in the checklist provides a reminder to nurses to consider progression through sedation protocols, reflect on the appropriateness of current sedation strategies, and assess patients for symptoms of tolerance or withdrawal by using a validated tool when available (eg, Withdrawal Assessment Tool). The aim of this element is to reduce inappropriate levels of sedation and facilitate early recognition and treatment of the adverse effects associated with sedation.

Analgesia

Uncontrolled pain is considered a preventable adverse event by most patient safety leaders in critical care, however, Playfor et al reported that 44% of children who remembered details of a PICU admission remembered being in pain. Pain can have physical and psychological consequences, evoking a stress response characterized by tachycardia, hypercoagulability, immunosuppression, and a persistent catabolic state that may adversely affect a patient’s recovery. Frequently assessing pain by using a validated scale improves pain control and reduces the incidence of unrelieved pain in children. According to recommendations, a child’s pain should be assessed at least every 6 hours in the PICU by using a tool suitable to the child’s developmental stage (eg, Face Legs Activity Cry and Consolability or a numeric rating scale).

Family

In most instances, involvement of the patient’s parents and family members in the care of a critically ill child has positive therapeutic effects on the health recovery of the child. However, family-centered care is an area of clinical practice in adult and pediatric critical care that still needs improvement. In order to provide true family-centered care, multiple strategies need to be considered, including the following:

- Effective and understandable information and communication between parents and professionals. These interventions benefit the child and decrease the parents’ levels of stress and anxiety. Strategies to support communication include open bedside rounds and interdisciplinary family meetings.

The KIDS SAFE checklist comprises 8 areas of care for patients in the pediatric intensive care unit.
• Tools or checklists promoting negotiated care. Use of such materials can improve parents’ involvement and decision making in their child’s care.91
• Provision of information on the transfer or discharge process. Such information can decrease parents’ anxiety and improve their satisfaction with care.92,94
• Assistance to the family for provision of physical necessities such as accommodation and food and ensuring that transport and living expenses are manageable. These interventions can decrease parents’ stress during their child’s PICU stay.95

In the busy, stressful environment of the PICU, these important items are sometimes overlooked because the multidisciplinary team is concentrating on the immediate physical needs of the critically ill child.89 Inclusion of the items in the checklist can help the team provide family-focused holistic care and minimize errors of omission in family-centered care.

**Enteral Needs**

The element of enteral needs incorporates several goals, including nutritional support, stress-ulcer prophylaxis, and bowel management. Early implementation of nutritional support is associated with improved clinical outcomes, shorter lengths of stay, decreased infection rates, and enhanced immune function.96,97 If enteral feeding is not possible, then parenteral nutrition and trophic feeds should be considered to optimize caloric intake98 and maintain integrity of the gut mucosa. Stress-ulcer prophylaxis should be considered for PICU patients at high risk for clinically important gastrointestinal bleeding.99 Bleeding from a stress-related peptic ulcer occurs in up to 43% of patients admitted to a PICU; 1 in 10 of the incidents is clinically important.101 Finally, early identification, treatment, and prevention of constipation and diarrhea and their associated complications102 should be considered. The goal of the enteral-needs element in the checklist is to prevent errors of omission such as inadequate provision of nutritional support and underprescription of stress-ulcer prophylaxis and to avoid complications associated with constipation and diarrhea.

**Discussion**

Adverse events, both preventable and nonpreventable, are a common problem in PICUs. The international incidence is 2.7 to 33.4 complications or adverse events per 100 PICU-days.22,23,25 Prevention of adverse events in several clinical domains. When designing the PICU checklist, we concentrated on preventable adverse events that were not already the focus of checklists (eg, administration of blood products) or related to system-based errors (eg, bed blockage or medication errors). Although the consequences of the preventable adverse events addressed in the checklist vary in severity, all of the events indicate a failure in the provision of evidence-based, quality PICU care.

Use of a checklist in critical care is not new; checklists and patient goals sheets have been used in adult ICUs8,9,12 and in PICUs.103,104 The innovations of the KIDS SAFE checklist are the focus on the provision of holistic care to children and the mnemonic structure to aid in quick recall.105 The checklist incorporates priorities important to all members of the multidisciplinary team, including dietitians, pharmacists, nurses, social workers, and medical staff, but can easily be adapted to suit local needs. The KIDS SAFE checklist does not encompass all PICU preventable adverse events. Attempts to do so would mean the loss of the original concept of a short, simple checklist. Vincent106 also maintains, in relation to his FASTHUG checklist,13 that a longer mnemonic is less likely to be remembered and hence less likely to be applied. Hales and Pronovost107 warn that excessive use of checklists can lead to clinicians becoming overburdened and experiencing “checklist fatigue.” The elements contained in the KIDS SAFE checklist have been carefully selected and based on evidence to avoid checklist fatigue.

Not all elements in the KIDS SAFE checklist will apply to all patients at all times. However, the aim of keeping a standard format for use in all PICU patients is to reduce the complexity of the list. In our project, we did not address the setting for application of the checklist. Published articles suggest that checklists can be used in several situations, including bedside rounds,9,10,12,14,103 as attachments to clinical pathways,107 by individual clinicians,13 and during shift-to-shift handover.105

A limitation of our study is that the team members who used the NGT were volunteers from a single tertiary center; however, they were informed by international literature and followed an established and rigorous process to ensure systematic decision making. The goal of our study was to develop a PICU checklist to improve the application of evidence-based management by preventing errors of omission. Through a systematic review of literature and review of local reported adverse events, the local representatives prioritized this information to form a PICU checklist. The KIDS SAFE checklist is unique in its simplicity, multidisciplinary focus on care of children,
mnemonic nature, and foundation in literature. Prospective studies on the checklist are needed to ascertain its effectiveness in reducing preventable adverse events.

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REFERENCES


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The KIDS SAFE Checklist for Pediatric Intensive Care Units
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