Using the Delphi method to develop nursing-sensitive quality indicators for the NICU

Lin Chen, Li-Hua Huang, Mei-Yuan Xing, Zhi-Xian Feng, Le-Wen Shao, Mei-Yun Zhang and Rong-Ya Shao

Aims and objectives. To develop nursing-sensitive quality indicators consistent with current medical practices in Chinese neonatal intensive care units.

Background. The development of nursing-sensitive quality indicators has become a top priority in nursing management. To the best of our knowledge, there has been no objective, scientific and sensitive evaluation of the quality of neonatal intensive care unit nursing in China.

Design. A modified Delphi technique was used to seek opinions from experts about what should be used and prioritised as indicators of quality care in neonatal intensive care unit nursing.

Methods. Based on a literature review, we identified 21 indicators of nursing-sensitive quality in the neonatal intensive care unit. Our group of 11 consultants chose 13 indicators to be discussed using the Delphi method. In October and November 2014, 39 neonatal intensive care unit experts in 18 tertiary hospitals spread across six provinces participated in two rounds of Delphi panels.

Results. Of the 13 indicators discussed, 11 were identified as indicators of nursing-sensitive quality in the neonatal intensive care unit: rate of nosocomial infections, rate of accidental endotracheal extubation, rate of errors in medication administration, rate of treatment for pain, rate of peripheral venous extravasation, rate of compliance with handwashing techniques, incidence of pressure ulcers, incidence of noise, the bed-to-care ratio, the proportion of nurses with greater than five years neonatal intensive care unit experience and incidence of retinopathy.

Conclusions. The 11 neonatal intensive care unit nursing-sensitive indicators identified by the Delphi method integrated with basic Chinese practices provide a basis for nursing management and the monitoring of nursing quality.

Authors: Lin Chen, Candidate of Master, Associate Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province and Department of Nursing, Shaoxing Central Hospital, Shaoxing, Zhejiang Province; Li-Hua Huang, MD, Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province; Mei-Yuan Xing, MD, Associate Research Fellow, Library, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province; Zhi-Xian Feng, MD, Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province; Le-Wen Shao, Candidate of Master, Associate Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province; Mei-Yun Zhang, MS, Associate Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province; Rong-Ya Shao, MD, Associate Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, Hangzhou, Zhejiang Province, China

Correspondence: Li-Hua Huang, Professor of Nursing, Department of Nursing, The First Affiliated Hospital of Zhejiang University, No. 79, Qingchun Road, Hangzhou 310006, Zhejiang Province, China. Telephone: +86 13867129329. E-mail: 982985630@qq.com

What does this paper contribute to the wider global clinical community?

- There has been no objective, scientific and sensitive system to evaluate the quality of NICU nursing in China.
- The 11 NICU nursing-sensitive indicators identified by the Delphi method integrated with basic Chinese practices provide a basis for nursing management and the monitoring of nursing quality.
Relevance to clinical practice. This study identified nursing-sensitive quality indicators for neonatal intensive care unit care that are suitable for current clinical practice in China.

Key words: Delphi method, neonatal intensive care unit, nursing quality, nursing-sensitive indicator, quality measures

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Introduction
Evaluating the quality of nursing care is at the heart of nursing management, and the choice of sensitive indicators that are nursing-specific is critical (American Nurses Association 1996; Mueller & Karon 2004). Objective, scientific and sensitive indicators can not only effectively evaluate the quality of care, but can also help guide clinical care and aid in the mentoring of nurses for continuous quality improvement. The development of nursing-sensitive quality indicators may contribute to the standardisation of care, improve the quality of clinical nursing at all levels and increase patient safety.

Nursing-sensitive quality indicators refer to the tools used to perform a quantitative assessment of the quality of nursing care and provide quality control. Nursing-sensitive quality indicators are those specific to nursing inputs and staffing (Nakrem et al. 2009, Lindberg & Ludvigsen 2012, Burston et al. 2014 Krau 2014). The levels of these indicators in terms of patient outcomes can be used to objectively measure the standard of nursing care (International Council of Nurses 2012).

Background
Although measures of nursing quality for adult and paediatric inpatient care have been implemented for some time (Lacey et al. 2006), standards for care in the neonatal intensive care unit (NICU) have been a more recent innovation (Elverson & Samra 2012). The ability to evaluate the quality of nursing care is essential in order to maintain the highest standards of care, increase patient safety and demonstrate effective clinical management (Mueller & Karon 2004, Franklin & Carol 2009). A linear model, which includes the structure, process, and outcome of a particular healthcare service, provides a clear guide for the inclusion of quality indicators at each stage to improve overall results (Donabedian 2004). In China at present, the Guidance for Implementation of the Standards for Evaluation of Class 3 Grade A Hospitals (2011 edition) from the Medical Affairs Division of the Ministry of Health is used as a reference for the establishment of quality indicators for nursing care. The ‘Quality Management in Nursing’ section of the Guidebook includes nursing quality indicators for specialists; however, these indicators lack specificity and sensitivity, particularly as they relate to the NICU (Zhao et al. 2010).

The NICU provides centralised monitoring, treatment and care of critically ill newborns. In the unique, complex environment of the NICU, newborns are especially vulnerable because of the physiological immaturity of their organ function and immune system. They cannot express themselves with language, so nursing behaviour during hospitalisation will largely affect disease outcome as well as the growth and development of the newborns (Coughlin et al. 2009). In severe cases, patients may experience learning disabilities in adulthood (Mokhnach et al. 2010). Similarly, a safe noise level is essential for the healthy development of newborns at risk in the NICU. Alarm equipment and excessive noise caused by medical activities disturb the sleep cycle of normal newborns. With continuous noise levels >60 dB, there is a risk of ear damage similar to that of drug toxicity (Krueger et al. 2005). Iatrogenic events, such as nosocomial infections, respiratory events, skin injuries, medication errors and misidentification, are also potential risks (Ligi et al. 2008, Samra et al. 2011). Thus, qualified, safe care is critically important for newborns.

To the best of our knowledge, there is presently no objective, scientific and sensitive way to monitor and evaluate the quality of NICU nursing in China. The aims of this study were to develop nursing-sensitive quality indicators consistent with current practices and the cultural background in China and to provide a database for nursing administrators.

Methods

Design
The Delphi method is a structured process for collecting opinions from a group of experts in writing using a
questionnaire prepared by the investigator. These experts exchange their opinions anonymously through letters of inquiry and then provide recommendations. After repeated inquiries and the collation of feedback, the group finally reaches a reliable consensus. This method not only reflects each expert’s individual knowledge and experience, but also maximises their collected wisdom (Linstone & Turoff 2002). We utilised a modified Delphi technique (McKenna 1994, Schmidt 1997, Wilson et al. 2010) to seek opinions from experts about what should be used and prioritised as indicators of quality care in NICU nursing.

Initial construction of potential indicators

We searched the Cochrane library for relevant systematic reviews and meta-analyses and various databases, including cnki.net, Cqvip and Wanfang, for related key words and original papers related to neonatal care and safety from 2004–2014. The articles were then reviewed individually (Lacey et al. 2006, Mokhnach et al. 2010, Sekar 2010, Profit et al. 2011, Samra et al. 2011, Boss et al. 2012, Elverson & Samra 2012, Kowalkowski et al. 2012, Profit et al. 2013). We identified 21 NICU nursing-sensitive quality indicators: the rates of failed rescue, nosocomial infection, accidental extubation, errors in medication administration, pain management, peripheral venous extravasation, parental satisfaction, handwashing, surfactant use, pneumothorax, complications of parenteral nutrition, retinopathy of prematurity (ROP), readmission, pressure ulcers, noise, low temperature, hypoglycaemia, growth rate, the nurse-to-patient ratio, the proportion of nurses working greater than five years in a NICU and family-centred care (FCC). These quality indicators were classified according to Donabedian’s systems approach (Donabedian 2005, Elverson et al. 2012) and grouped into structure (e.g. nurse-to-patient ratio and proportion of nurses with greater than five years of nursing experience), process (e.g. rate of treatment for pain and incidence of noise) and outcome (e.g. rate of nosocomial infections and rate of accidental extubation).

Consultation Group

We then convened a group of consultants composed of 11 nurse managers and nurse specialists with extensive experience in clinical care in the NICU. The group decided to exclude nine indicators, including the rates of failed rescue, parental satisfaction, surfactant use, pneumothorax, complications of concurrent parenteral nutrition, FCC, hypothermia, hypoglycaemia and growth rate, because of their low incidence in clinical practice or inconsistency with China’s cultural practices. In addition, the rate of accidental extubation was changed to the rate of accidental endotracheal extubation, and the readmission rate was changed to 24-hour and 48-hour readmission rates. The remaining 13 nursing-sensitive quality indicators in the NICU were considered by the expert panel in the first round.

Delphi panel

The original expert panel consisted of 41 NICU doctors and nurses from 18 tertiary hospitals in six provinces (Zhejiang, Jiangsu, Henan, Gansu, Guangxi and Guizhou).

Data collection and analysis

Two rounds of questionnaires were delivered via email in October and November 2014. Each round was open for three weeks, and reminders were emailed at the beginning and end of week 3. There was a one-week interval between the two rounds. Each survey took approximately 25 minutes to complete and was returned by mail to assure anonymity. The questionnaire included three sections: (1) demographic information about the panellists; (2) an explanation of the research goal and instructions for completion and return; and (3) rating each indicator in terms of importance, reasonableness of the formula and practicality of the method of collecting information on a five-point Likert scale where 5 points indicted that it was extremely important, reasonable or practical, and 1 point was not at all; this section also included a suggestion field where panellists could express their views about revisions, additions or deletions and their reasons for these suggestions.

Suggestions from the first round were considered by the consultants, and some were incorporated into the second round if all the consultants agreed. Achievement of a consensus is the standard for completion of the Delphi process, and a consensus was reached in this study after two rounds. ‘Consensus’ was reached when an indicator was ranked as important or not important with little change from the previous round, and indicators were then retained or deleted as appropriate.

Statistical analysis

The mean, standard deviation (SD) and coefficient of variation were determined for each domain and round. A coefficient of variation ≤0.3 indicated less variability of the panel members’ opinions. The Kendall coefficient of concordance was used to evaluate the agreement among raters. All statistical analyses were carried out with IBM SPSS statistical
results and responses anonymous.

Results

All 41 panel members responded in the first round. The responses of two panellists were excluded because the members stated that they were not familiar with the nursing profession. Most of the panellists were nurses (n = 30, 76.9%), females (n = 37, 94.9%), nurse or doctor in charge (n = 23, 59.0%) and recipients of a Bachelor’s degree (n = 30, 76.9%). Their mean age was 37.0 years (SD = 5.0 years), and their mean work experience in a NICU was 10.8 years (SD = 5.3 years; Table 1).

In the first round, a total of 13 indicators were assessed, and descriptive statistics are shown in Table 2. The 24-hour and 48-hour readmission rates were considered less important because they may have been affected by various factors relative to the patients’ family members; therefore, these two items were eliminated after the panel discussion. Two indicators, rate of errors in medication administration and incidence of noise, were retained because the panellists recognised their importance for nursing quality in the NICU despite the fact that the coefficients of variation for both indicators were >0.3 for two domains (the reasonableness of the formula and practicality of the method of collecting information; Table 2). As a result, 11 nursing-sensitive quality indicators were retained for the second round.

In the second round, 38 of 39 questionnaires were returned, yielding a response rate of 97.44%. Because the coefficients for variation for pain management and incidence of noise were >0.3 for the practicality of collecting information, we revised the methods and process of data collection for the two indicators according to suggestions provided by the panellists (Table 2).

The agreement between the expert opinions was determined using the Kendall coefficient of concordance (or Kendall’s W) for each domain. The W-value for concordance of the two rounds ranged from 0.212–0.446 (all p < 0.001), indicating excellent agreement between the expert panellists (Table 3).

At the end of two Delphi rounds, we summarised the opinions and suggestions of the expert panel and identified 11 nursing-sensitive quality indicators in the NICU (Table 4).

Discussion

Using the Delphi method, we identified 11 nursing-sensitive quality indicators for Chinese NICUs: rate of nosocomial infections, rate of accidental endotracheal extubation, rate of errors in medication administration, pain management, peripheral venous extravasation, handwashing, incidence of pressure ulcers, noise, the bed-to-care ratio (this figure is used rather than a nurse-to-patient ratio because NICU beds are always fully occupied, and the Chinese government uses the number of beds rather than the number of patients for statistical analysis), the proportion of nurses with greater than five years of NICU experience and the incidence of ROP.

The consultation group had begun with 21 indicators identified from the literature; several that were proposed in other countries but were not suitable for use in China were eliminated. For example, the rate of failure to rescue is an important and sensitive indicator for the evaluation nursing quality in the NICU in other countries (Gephart et al. 2011). Because differentiating between failure to rescue and giving up on treatment is difficult, this indicator was eliminated.

Family-centred care represents a partnership between families of the children and healthcare professionals to promote emotional, social and developmental support. FCC
Table 2 Descriptive statistics regarding nursing-sensitive quality indicators in the NICU

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Round 1</th>
<th>Round 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Index importance</td>
<td>Rationality of the calculation formula</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Nosocomial infection rate</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Accidental endotracheal extubation rate</td>
<td>4.70</td>
<td>0.66</td>
</tr>
<tr>
<td>Errors in medication administration</td>
<td>4.87</td>
<td>0.42</td>
</tr>
<tr>
<td>Pain management</td>
<td>4.49</td>
<td>0.69</td>
</tr>
<tr>
<td>Peripheral venous extravasation</td>
<td>4.89</td>
<td>0.31</td>
</tr>
<tr>
<td>Handwashing*</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Incidence of pressure ulcers</td>
<td>4.43</td>
<td>0.69</td>
</tr>
<tr>
<td>Noise</td>
<td>4.35</td>
<td>0.63</td>
</tr>
<tr>
<td>Nurse-to-patient ratio</td>
<td>4.84</td>
<td>0.37</td>
</tr>
<tr>
<td>Proportion of nurses working greater than five years</td>
<td>4.65</td>
<td>0.48</td>
</tr>
<tr>
<td>Incidence of ROP</td>
<td>4.43</td>
<td>0.93</td>
</tr>
<tr>
<td>24-hour readmission rate</td>
<td>3.84</td>
<td>1.24</td>
</tr>
<tr>
<td>48-hour readmission rate</td>
<td>3.70</td>
<td>1.31</td>
</tr>
</tbody>
</table>

SD, standard deviation; CV, coefficient of variation; ROP, retinopathy of the preterm child.

*Handwashing was assessed by two formulas: (1) number of actual implementations divided by the number of required implementations and (2) number of hand sanitisers requisitioned within the statistical period divided by the number of bed days within the statistical period. Both formulas for handwashing were considered as two data collection formulas under the same indicator.
has become the gold standard in NICU care in the USA (Gooding et al. 2011). Implementing FCC can reduce parental stress and increase their efficacy and confidence, facilitate parental awareness of their children’s condition and care needs, promote healthy recovery and shorten the hospital stay. Currently, the majority of the NICUs in China have adopted a no-accompaniment and closed-end management policy to control hospital infection and facilitate observation, treatment and newborn care services. Family members can visit the patients only during designated periods. Some of our consultants believed that FCC indicators were forward-looking and played a guiding role in nursing care and, thus, recommended their inclusion. Others suggested that although these indicators were significant, they were rather difficult to implement as most NICUs in China have not yet adopted this model. The team recommended exclusion of this indicator at present, but indicated that they may consider re-adoptation of such indicators at a more appropriate time, along with the gradual transformation of the NICU model. Indicators, such as growth rate, the rate of breastfeeding after discharge and the incidence of pneumothorax, were also not recommended for inclusion because the effects of nursing care on these particular indicators were less apparent.

In the first and second rounds of discussion, four panel members recommended incorporation of the rate of appearance of red buttocks (Yu et al. 2006) as an indicator of the quality of obstetric care. Red buttocks occur because of the thin and tender skin of the newborn, nonstop usage of diapers during hospitalisation and inadequate nursing care; however, our panellists believed that, with continuous improvement in the quality of care and continuous improvement in skin care, neonatal red buttocks rarely occurred. Thus, they recommended that this indicator be excluded from the NICU Quality Care metrics. In contrast, because the prevention of pressure ulcers (i.e. local damage of the skin and/or subcutaneous tissue usually located at a bony prominence and caused by stress or stress combined with shear) does fall within the scope of nursing practice, this indicator was retained. Specifically, stages I–IV of the International Npuap/Epuap Pressure Ulcer Classification System are included.

In the first and second rounds of discussion, noise data had a coefficient of variation of 0.3. Some panellists believed that noise was not an applicable indicator because even in the quietest state, the noise level remains around 55 dB due to the NICU instruments and may be even higher at different times (e.g. visiting hours) and places (e.g. at the nurses’ station or near the sink; Matook et al. 2010). The majority of Chinese hospitals accommodate multiple patients in the same room to facilitate medical staff visits at any time. However, other countries have transformed hospital rooms into independent or semi-independent accommodations to reduce noise and improve lighting conditions. Although noise is recognised as harmful to newborns, this has not been addressed in China. Given the significance of noise in the NICU environment, the panel recommended monitoring the noise level in different time frames depending on the department to complete a more objective and accurate NICU noise assessment. The panel also recommended further discussion about a standard that would limit the noise level to not above 45 dB during the day and 35 dB at night.

With regard to the occurrence of ROP, some panellists mentioned that not all hospitals carry out this screening programme, so data collection would be difficult. However, NICU nurses had little impact on its occurrence because the duration and quantity of the oxygen supply are controlled primarily by a doctor rather than a nurse. Sabzehei et al. (2013) mentioned that ROP occurrence was related not only to the oxygen supply, but also to the intensity and time of illumination by room light in the NICU. As ROP is the leading cause of blindness in children, and its occurrence is closely related to nursing practices, the study group proposed retention of this indicator. At present, provincial hospitals screen every NICU infant while municipal hospitals are still establishing criteria for who is screened.

Pain management is measured as a nursing-sensitive indicator internationally (Lawrence et al. 1993, Krechel & Bildner 1995). There are noticeable discrepancies in how to calculate the numerator and denominator for the rate of pain management in China because there is currently no consensus as to how to define neonatal pain or manage it. Mokhnach et al. (2010) did detail empirical measurements

### Table 3

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Importance</th>
<th>Rationality</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W-value</td>
<td>$\chi^2$</td>
<td>p-Value</td>
</tr>
<tr>
<td>First round</td>
<td>0.31</td>
<td>137.47</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Second round</td>
<td>0.26</td>
<td>94.44</td>
<td>&lt;0.001</td>
</tr>
</tbody>
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Table 4 Nursing-sensitive quality indicators in the NICU

<table>
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<th>Index</th>
<th>Significance</th>
<th>Formula</th>
<th>Interpretation</th>
<th>Methods of collecting information</th>
</tr>
</thead>
</table>
| Rate of nosocomial infections (%)          | Newborns in the NICU are always critical, unstable, immune-compromised and accept more invasive procedures, so the rate of nosocomial infections increases significantly compared to other wards, resulting in prolonged hospitalisation and a delay in physical development | Number of sites of nosocomial infection within the statistical period \(\times\) 100 \[
\frac{\text{Number of hospitalised patients within the statistical period}}{\text{Number of hospitalised patients within the statistical period}}
\] | The numerator refers to the occurrence of infection acquired in the hospital during or after discharge, but does not include infection before admission or within the latency time of infection after admission or infection within 48 hours of birth | Encourage reports of adverse events in a non-punitive way in the hospital. The number of cases of nosocomial infections can be obtained from the adverse events reporting system and electronic medical records. The total number of hospitalised patients is automatically calculated by the information system |
| Rate of accidental endotracheal tube extubations (%) | Neonatal endotracheal tubes are generally not cuffed and can easily prolapse. If not handled properly or detected in a timely manner, this can be a cause of death | Number of accidental extubations within the statistical period \(\times\) 1000 \[
\frac{\text{Number of accidental extubations within the statistical period}}{\text{Number of intubations within the statistical period}}
\] | Accidental extubations include accidental slippage or removal of an endotracheal tube by nonmedical practices. Detachment and removal criteria include the following: (1) clear pulled tube, (2) obvious crying, (3) stomach contents in the tube and (4) SPO2 decline and use of comprehensive judgment with a variety of means | The number of cases of accidental endotracheal extubation can be obtained from the adverse events reporting system and electronic medical records. The total number of intubations can be calculated by the information system |
| Errors in medication administration (%)   | The NICU is recognised as a department with a high incidence of errors in medication administration, resulting in unpredictable harm to the newborns because of their small size, physiological immaturity and limited ability to compensate | Number of errors of medication administration within the statistical period \(\times\) 1000 \[
\frac{\text{Number of errors of medication administration within the statistical period}}{\text{Number of administrations within the statistical period}}
\] | Errors of medication administration refer to abnormal events associated with the administration process, such as giving children the wrong drug, wrong dose, wrong concentration, wrong way, at the wrong time or even to the wrong patient | The number of errors of medication administration is obtained from adverse event reports. The total number of administrations is calculated automatically by the information system |
Table 4 (continued)

<table>
<thead>
<tr>
<th>Index</th>
<th>Significance</th>
<th>Formula</th>
<th>Interpretation</th>
<th>Methods of collecting information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain management (%)</td>
<td>Pain management is measured as a nursing-sensitive indicator internationally. Untreated pain can do great harm to newborns and result in a high metabolic state, cardiopulmonary dysfunction or arrhythmias, and ultimately, complications and poor recovery</td>
<td>Number of pharmacological interventions in babies with pain score $&gt; 4$ within the statistical period / Number of all medical procedures within the statistical period $\times 100$</td>
<td>The denominator refers to medical procedures that included invasive procedures, such as arterial or venous puncture, central venous insertion, intratracheal suction, ROP eye examination, nasogastric tube insertion, heel blood sampling, intramuscular injection, lumbar puncture and catheterisation. The numerator refers to the number of pharmacological interventions to babies with pain score $&gt; 4$ within the statistical period</td>
<td>Use electronic medical records, automated screening, or check medical records personally to collect the number of episodes of pain</td>
</tr>
<tr>
<td>Peripheral venous extravasation (%)</td>
<td>The skin of newborns is fragile and lacks subcutaneous tissue protection, so extravasation of an intravenous infusion can cause partial or total loss of the skin. In severe cases, it will cause damage and permanent dysfunction of the muscles and nerves</td>
<td>Number of peripheral venous extravasations within the statistical period / Number of peripheral venous injections within the statistical period $\times 1000$</td>
<td>The numerator refers to blister agents or nonblister agents accidentally seeping into the subcutaneous tissue and causing peripheral venous extravasation above grade III during infusion due to negligence, excluding central venous catheterisation</td>
<td>The number of peripheral venous extravasations above grade III is obtained from adverse event reports and automated screening of electronic medical records. The total number of peripheral venous extravasations is calculated automatically by the information system</td>
</tr>
<tr>
<td>Index</td>
<td>Significance</td>
<td>Formula</td>
<td>Interpretation</td>
<td>Methods of collecting information</td>
</tr>
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<td>-------------------------------</td>
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<tr>
<td>Handwashing (%)</td>
<td>Handwashing can significantly reduce the number of bacteria on the hands, thereby reducing incidents of hospital infection. Internationally, handwashing is a basic measure for preventing and guarding against hospital infections.</td>
<td>Number of actual times hands were washed / Number of times hand washing was required × 100</td>
<td>The denominator refers to the number of handwashings required during the monitored period, and the numerator refers to actual number of implementations in this period.</td>
<td>Check the implementation of handwashing by the nursing staff, doing so in a relatively concealed manner in accordance with the predesigned form during the period of the operation.</td>
</tr>
<tr>
<td>Incidence of pressure ulcers (%)</td>
<td>The skin of the newborn is thin and tender, rich in subcutaneous blood vessels, and poor in local defence function, so pressure ulcers often occur in the NICU. These can lead to infection, sepsis, prolonged hospitalisation, or even a threat to the life of the low-birthweight newborn.</td>
<td>Number of hand sanitisers requisitioned within the statistical period / Number of bed days within the statistical period × 100</td>
<td>The numerator refers to the number of hand sanitisers requisitioned by the department. The denominator refers to the number of hand Sanitisers requisitioned within the statistical period.</td>
<td>The numbers of hand sanitisers and bed days are calculated automatically by the information system.</td>
</tr>
<tr>
<td>Noise (%)</td>
<td>The reported hearing loss in newborns in the NICU is 20—40%, and many studies have shown that it is related to noise in the NICU. Noise can also lead to intellectual impairment in preterm children</td>
<td>Number of occurrences of noise within the statistical period / Number of monitored sounds within the statistical period × 100</td>
<td>In 2002, the US Environmental Protection Agency regulated the sound level in NICUs to 50 dB, and limited impulse noise to &lt;55 dB. The numerator refers to noises beyond the recommended noise standards. The denominator refers to the total number of sounds monitored at different times and regions.</td>
<td>Collect data according to the department, at different times and in different regions.</td>
</tr>
<tr>
<td>Index</td>
<td>Significance</td>
<td>Formula</td>
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<tr>
<td>Bed-care ratio</td>
<td>A nursing shortage in the NICU is a worldwide problem and has a serious impact on the safety of children. It is reported in the literature that increasing the nurse-to-patient ratio will significantly reduce the mortality of newborns and prevent the occurrence of various types of adverse events</td>
<td>Number of registered nurses within the statistical period in the NICU / Number of beds within the statistical period in the NICU</td>
<td>The numerator refers to the number of registered nurses in the NICU; the denominator refers to the number of actual beds in the NICU</td>
<td>Obtain the number of registered nurses in the NICU from the Personnel Section or Nursing Section and personally check the actual number of beds in the NICU</td>
</tr>
<tr>
<td>Proportion of nurses working more than five years (%)</td>
<td>Qualified nurses with strong operational capabilities, extensive clinical experience, and high consistency of care can effectively reduce the number of mechanical ventilations, days of parenteral nutrition and incidence of nosocomial infections and result in shorter hospital stays</td>
<td>Number of nurses working more than five years in the NICU within the statistical period / Number of registered nurses in the NICU within the statistical period × 100</td>
<td>The numerator refers to the number of registered nurses working greater than five years in the NICU</td>
<td>Obtain the total number of nurses and those working greater than five years in the NICU from the Personnel Section or Nursing Section</td>
</tr>
<tr>
<td>ROP (%)</td>
<td>Retinopathy of the preterm child (ROP) is a serious retinal disease impacting visual function and is the leading cause of blindness in children. It is reported that continuous oxygen therapy is an independent factor for ROP, whereas light intensity and exposure time to the environment are potential factors</td>
<td>Number of ROPs within the statistical period / Number of retinopathy screenings conducted within the statistical period × 100</td>
<td>Screening standards in ‘Oxygen Therapy and Retinopathy Prevention Guide for Premature Children’ issued in 2004 by the Ministry of Health: (1) premature and low-birthweight children (&lt;2000 g) and (2) premature children with severe disease could be screened with a relatively looser standard</td>
<td>Obtain the number of retinopathy screenings and the number of ROPs from the information system</td>
</tr>
</tbody>
</table>
of pain and invasive procedures that would cause pain in NICU newborns. In the current study, the panel recommended that all NICU nurses change their perspective, pay attention to pain management and implement an international assessment scale, such as the Neonatal Infant Pain Scale (Lawrence et al. 1993), for newborns or CRIES (C – crying; R – requires increased oxygen administration; I – increased vital signs; E – expression; S – sleeplessness; Krechel & Bildner 1995) for older infants. All children require routine pain assessments during invasive procedures as described by The National Database of Nursing Quality Indicators using the paediatric/neonatal population (assessment, identify the need for a pharmacologic intervention; intervention, pharmacologic intervention; and reassessment, assess pain within 2 hours following an intervention) AIR cycle. Specifically, after the initial pain assessment, a reassessment should be performed within 2 hours of any pharmacologic intervention. An ongoing process for assessing pain is known as the AIR cycle. A reassessment is not required for analgesics that are given on a scheduled basis. Pain scores of 1–3 should be managed with nonpharmacological interventions, such as environmental changes, while pain with a score of ≥4 should be managed with adequate analgesia and monitored closely. Parents should also be involved in observing their infants for signs of pain.

Limitations

Although this study developed nursing-sensitive quality indicators, most of the data collection required support from reliable information systems. In China, hospitals vary in their digital infrastructure, which will present difficulties in the data collection process. Second, this study involved representatives from only 18 tertiary hospitals from six Chinese provinces and thus had limited participation. In addition, the measure of pain management considered the number of pharmacological interventions to babies with pain score >4 within the statistical period, which may result in an overestimation as compared to using the number of babies with pain score >4. Finally, this study is limited to current measures. In the ever-changing world of Chinese NICU medicine, family satisfaction, breastfeeding rates, growth rate and FCC may be gradually incorporated as indicators of nursing-sensitive quality care.

Conclusions

Eleven NICU nursing-sensitive quality indicators were identified using the Delphi method in consideration of Chinese hospital practices and culture. These provide a basis for nursing management and the monitoring of nursing quality. The most valid indicators identified are those available from case notes, and difficulties regarding the reliability and feasibility of data collection are recognised. The indicators included in this study need to be further tested in practice, verified and revised in clinical applications.

Relevance to clinical practice

This study suggests nursing-sensitive quality indicators for NICU care that are suitable for current practices in China.

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Contributions

Study design: LC, L-HH, M-YX, Z-XF; Data collection and analysis: LC, L-HH, L-WS, M-YZ; Manuscript preparation: LC, L-HH, M-YX, R-YS.

Conflict of interest

The authors declare no conflict of interest.

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References


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