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**Pediatric Critical Care Nursing Research Priorities in Asia: An eDelphi Study.**

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**Keywords:** Child; children; intensive care; evidence-based nursing; Delphi technique; research prioritization exercise; Asia nursing research

**Article Tweet:** Nursing research priorities in #Asia varies across countries of different income levels and should be tailored to the local needs. #PedsICU #PedsCICU @PeifenPoh @JosLatour1 @leejanhau @qalb2abbas @PACCMAN\_Asia

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1   **ABSTRACT**

2   **OBJECTIVES:** To identify nursing research priorities in pediatric critical care in Asia.

3   **DESIGN:** We conducted a modified three-round e-Delphi survey with pediatric critical  
4   care nurses in Asia. In Round 1, participants were asked to list three to five research  
5   topics that they deemed important. These topics were thematically analysed and  
6   categorized into a questionnaire. Participants rated the research topics in Rounds 2  
7   on a six-point scale (1=not important to 6=extremely important). In Round 3, the  
8   same questionnaire was used with addition of the calculated mean scores from  
9   Round 2 for each topic. Research topics ranked among the top 10 were considered  
10   extremely important.

11   **SETTINGS:** 22 pediatric intensive care units (PICUs) in eight Asian countries.

12   **PARTICIPANTS:** Clinical nurses, managers, educators, and researchers.

13   **INTERVENTIONS:** None.

14   **MEASUREMENTS AND MAIN RESULTS:** In Round 1, 146 PICU nurses across 8  
15   countries provided 520 research topics. Topics from Round 1 were categorized into  
16   7 domains with 52 research topics. Prioritized research topics included early  
17   recognition of patient deterioration (mean  $5.58 \pm 0.61$ ), prevention of healthcare-  
18   associated infections (mean  $5.47 \pm 0.70$ ), and interventions to reduce compassion  
19   fatigue (mean  $5.45 \pm 0.80$ ). The top three research domains were end-of-life care  
20   (mean  $5.34 \pm 0.68$ ), professionalism (mean  $5.34 \pm 0.69$ ) and management of pain,  
21   sedation, and delirium ( $5.32 \pm 0.72$ ).

1    **CONCLUSIONS:** This first PICU nursing research prioritization exercise within Asia  
2    identified key nursing research themes that should be prioritized and provide a  
3    framework for future collaborative studies.

4

## **REPORT IN CONTEXT**

- Prior nursing research priority exercises conducted in Australia and Europe showed that research priorities vary between countries and across time.
- This is the first PICU nursing research prioritization exercise conducted across Asia.
- In this research prioritization exercise, PICU clinical nursing interventions were ranked highest, followed by professionalism, safety and quality issues.

1

## **At the Bedside**

- Top-rated nursing research priorities in Asia relates to PICU clinical nursing intervention, professionalism and safety, and quality issues.
- Research priorities are different among countries of different income levels and should be tailored to local needs.
- PICU nursing research priorities in Asia are in tandem with other regions and future international multicenter studies should include Asian sites.

## 1 INTRODUCTION

2 Research priorities generated by pediatric intensive care unit (PICU) nurses, may aid  
3 the translation of new knowledge into clinical practice, leading to increase quality of  
4 care (1). Nursing research is important to improve information literacy skills and to  
5 advance the PICU nursing profession (2). Various groups of clinical researchers from  
6 the United Kingdom (UK), Australia and New Zealand have conducted research  
7 prioritization exercises to identify key PICU nursing research topics within their own  
8 region. In these studies, research topics such as clinical nursing practices,  
9 management of pain and nursing quality were ranked high (1,3).

10 Research priorities are likely to be different among geographical regions and  
11 varies according to cultural context, local challenges, and economic resources (1,4).  
12 Notably, the shortage of nursing staff in Asia is among the highest in the world and  
13 the epidemiology of pediatric critical illness is different in Asia (5,6). In particular,  
14 Asia has a much higher burden of common pediatric critical diseases (e.g., pediatric  
15 acute respiratory distress syndrome, severe sepsis and septic shock) as compared  
16 to other regions in the world (7,8). Therefore, nursing research priorities identified in  
17 prior exercises might not be directly applicable in Asia. In addition, when compared  
18 to other regions, less progress has been made in the development of the PICU nurse  
19 academic roles in Asia. Increasing nursing research involvement and production may  
20 also improve staff retention and recruitment in the region (9,10).

21 To the best of our knowledge, there are no established PICU nursing research  
22 priorities in Asia. Research priorities generated by nurses in Asia will improve  
23 contextual research by prioritizing the most relevant topics, improve efficiency and  
24 relevance of nursing research in the region. A list of prioritized topics can also serve



as a roadmap for clinical research in guiding prospective clinical academics, reduce research waste, and improve collaboration (11). To address these gaps, our study aims to identify and prioritize PICU nursing research priorities in Asia. In addition, because nursing research priorities may be different amongst countries from low-, middle- and high-income groups, we examined whether there are differences in nursing research priorities between countries of difference income levels.

## **METHODS**

This study was approved by the Singapore Health Centralised Institutional Review Board (Ref: 2019/2628). Consent was implied upon the return of the survey. In this study, we conducted a three-round Modified eDelphi survey to arrive at the consensus for the PICU nursing research priorities. The Delphi technique is often used within healthcare research to set priorities about important topics (12,13). Instead of using the Delphi method (which is based on iterative, one-on-one interviews conducted sequentially with experts), the Modified eDelphi allows the remote consultation of a large number of experts from different countries using structured questionnaires delivered in three consecutive survey rounds in a timely and cost-efficient manner (13). This study was reported in accordance with the Guidance on Conducting and Reporting Delphi Studies (CREDES) guidelines (14).

### **Participants**

We recruited nurses who were working in a PICU. Based on a previous prioritization study (1), we aimed to recruit at least eight nurses from each centre in each country representing a variety of nursing roles: clinical nurses, nurse managers, nurse educators and nurse researchers or nurses who self-identified to be interested in research or who had participated in research. Nurses who worked in intensive care

units that provide care only to neonates or adults were excluded. Contact details for potential participants were obtained through the Pediatric Acute & Critical Care Medicine Asian Network (PACCMAN) and through personal contacts. Potential participants provided their e-mails for subsequent surveys.

## **Data Collection**

We collected respondent's demographic information (e.g., age, years of PICU experiences, PICU roles) and highest qualification (e.g., general preparation for practice, speciality nursing qualification or postgraduate degrees). In Round 1 (August – October 2020), participants were asked to list three to five research topics important to PICU nursing. Open-ended questions in Round 1 were first developed in English-language and then translated into five languages (Chinese, Malay, Indonesian, Japanese and Vietnamese) by PICU professionals who were native language speakers. Topics provided by the participants from Round 1 were then back translated to English-language for analysis. Surveys were conducted through the Online Surveys platform (JISC, UK).

Round 2 (November 2020) questionnaire was first developed in English-language and translated by native speakers of the respective languages. In this round, participants rated the individual research topics generated in Round 1 on a six-point Likert type scale from not important (1) to extremely important (6). We added an open-ended question "Do you have any additional topics related to clinical nursing practice? If yes, please list them below" at the end of each category to solicit additional topics. *A priori*, we set the criteria of a mean score of less than 4.5 to exclude research topics in Round 3.

In Round 3 (December 2020 – March 2021), all topics scored more than 4.5 and hence participants were provided with the same research topics with the overall group mean scores from Round 2 added as decision-making information. Participants were asked to rate these topics again based on these group mean scores. The Delphi method is an iterative multistage process where responses are summarised between rounds and communicated back to the participants until consensus is reached. Feedback of the group's collective opinion informs participants of the current state of the group's opinion to allow participants the opportunity to change their opinion (15,16) After Round 3, a final list of top research priorities was generated. To reduce attrition and increase the response rates across the three round surveys, three reminders were sent three weeks apart after each survey.

### *Analysis*

Two authors (PFP and QWS) independently analysed and categorized research topics from Round 1 using content analysis, with any discrepancies resolved through discussion with a third author (JML). Research topics that were mentioned at least thrice were retained and categorized into thematic domains according to the content [Electronic Supplementary Material (ESM) 1 and 2]. A research topic with at least 20 occurrences, related to one topic were categorized into one domain. Unique research topics that did not fit into any domains were excluded after Round 1.

Data were exported from the survey platform into Excel software 2010 (Microsoft, Redmond, WA) and imported into IBM SPSS (IBM Statistics for Windows, version 25.0, IBM Corp., Armonk, NY) for analysis. Participants' characteristics were analyzed and presented as frequency and proportions. Mean score and standard

deviation (SD) were calculated for each research topic. We compared for differences of the mean scores between Round 2 and 3 by calculating the Cohen's effect size. The total scores of the topics for each domain were tabulated. Responses from all participants were weighted equally so that no one group of respondents can shift the results of the survey (15,17). Research topics and domain were ranked according to their mean scores from highest to lowest in terms of importance. The top 10 rank topics were considered extremely important. We used one-way ANOVA to examine the differences in research topics, domains priorities and country's income group. Countries were grouped into lower-middle, upper-middle and high income groups according to the World Bank list of economics (18).

## RESULTS

We invited 186 PICU nurses across eight Asian countries, of which 146 nurses (82.9%) from 22 PICUs from PACCMAN agreed to participate and completed Round 1 of the survey. The eight participating countries were lower-middle (India, Pakistan and Vietnam), upper-middle (China, Indonesia and Malaysia) and high (Japan and Singapore) income countries (Table 1). Non-participating areas consisted of both non-teaching and university centres located in the following countries: Thailand (upper-middle), South Korea (high-income), and the Philippines (lower-middle). PICUs were multidisciplinary (admitting patients from medical, surgical, oncology and cardiac disciplines), 8 to 35 bedded, with annual admission of 500 to 1500 patients. Three centres provided extra-corporeal membrane oxygenation support.

Of the 146 nurses who participated in Round 1, 91 (62%) and 95 (65%) completed Round 2 and 3, respectively. There were no differences in the characteristics of respondents across all three rounds of survey (Table 2). There

were 520 individual suggestions for research topics provided in Round 1, and content analysis produced 52 research topics represented in 7 domains. No new suggestions were provided in the open-ended questions in Round 2. The 52 research topics were categorized thematically into seven domains: (1) Clinical nursing care practices (13 topics); (2) Quality and safety (15 topics); (3) Rehabilitation and follow-up after PICU (5 topics); (4) End-of-life (2 topics); (5) Professionalism (8 topics); (6) Pain, sedation, and delirium (4 topics), and (7) Child and family-centred care (5 topics). In Round 3, the mean scores of 21 research topics were statistically lower than in Round 2 (ESM 3).

In Round 3, research topic “Recognizing early deterioration of children and implementing effective supportive care” had the highest mean scores ( $5.58, \pm 0.61$ ). The lowest scoring research topic was “Exploring the feasibility of telehealth in the PICU” ( $4.66, \pm 1.14$ ). The top 25 research topics achieved a mean score of greater than 5.40 ( $\pm 0.69$ ) out of 6 (extremely important). Most of these top priority topics related to day-to-day management of PICU patient care such as improving outcomes of cardiopulmonary resuscitation ( $5.57, \pm 0.66$ ), management of mechanically ventilated patients ( $5.48, \pm 0.70$ ), and reducing healthcare-associated infections ( $5.47, \pm 0.70$ ). (Table 3 and ESM 4).

The top three domains based on the outcomes of Round 3 were: (1) End-of-life care; (2) Professionalism; and (3) Pain, sedation and delirium (Table 4). The top scoring domains were different across lower-middle, upper-middle and high-income country groups. Participants from lower middle-income countries ranked the research topic “Education and support for beginner PICU nurses” as the most important ( $5.53, \pm 0.51$ ). The research topic “Implementing effective pain and sedation management strategies” ( $5.50, \pm 0.69$ ) was ranked the highest amongst

participants from upper middle-income countries. Lastly, “Improving end-of-life and palliative care for children and their family” was rated highest by participants from high income countries ( $5.42 \pm 0.60$ ) (ESM 5). Participants from the upper-middle income countries (China, Indonesia, and Malaysia) ranked the following three domains significantly higher compared to the high-income countries (Japan and Singapore): (1) Clinical Nursing Care Practices ( $5.41 \pm 0.57$  vs  $4.91 \pm 0.64$ ),  $p=.004$ ); (2) Quality and Safety ( $5.32 \pm 0.61$  vs  $4.68 \pm 1.03$ ),  $p=.004$ ); and (3) Rehabilitation and follow-up after PICU ( $5.26 \pm 0.69$  vs  $4.72 \pm 0.91$ ),  $p=.015$ ).

## DISCUSSION

This is the first study exploring nursing research priorities in critically ill children in Asian countries. Collectively, PICU clinical nursing interventions were rated highest, followed by professionalism, safety, and quality issues. Research domain ranking among countries of different income levels were different.

In our study, end-of-life domain emerged as the highest priority research domain. This is not surprising since PICUs are the most common location for pediatric death (19-21). End-of-life experiences varies with cultural norms, religious beliefs, and practices (22). A study conducted in ICUs in Asia found that religious beliefs (e.g., Islam, Hinduism and Shintoism) was associated with families’ request to withhold or withdraw life-sustaining treatments (23). Discussion of end-of-life in Asia is often family-centric rather than patient-centric and vary in Asian countries of different income levels. For example, physicians from high-income countries such as Singapore and Hong Kong were less likely to offer aggressive life-sustaining treatments as compared to physicians from lower-middle income countries (23,24). In our study, the priority scores for end-of-life research domain were lowest in the

1 lower-middle group compared to upper-middle and high-income countries. End-of-life  
2 research may receive less priority due to different socio-cultural belief and the focus  
3 on utilizing resources for patients with the highest chance of cure (25). However,  
4 exposure to end-of-life nursing care seen in high-income countries may raise  
5 awareness of the importance of end-of-life care in nurses working in lower-middle  
6 income countries (23).

7       Topics from the professionalism domain, such as work efficiency, burnout and  
8 job satisfaction emerged within the top 10 research priorities. These results were  
9 similar to a UK study examining priorities areas across 17 PICUs (26). These  
10 findings may reflect a growing concern with nursing staff shortages within the  
11 pediatric intensive care speciality. Globally, the majority of nurse shortages were  
12 observed in low- and middle-income countries (27). Contributing factors includes  
13 heavy workload, insufficient resourcing and burnout (28). Work stresses of nurses  
14 working in an ICU are high because of the fast-paced and volatile nature of their  
15 work (29). Often, PICU nurses are exposed to death and moral dilemma during their  
16 course of work (30). Family-oriented care provided by pediatric nursing is one of the  
17 greatest stressor for PICU nurses (31). Increased work-related stress may explain  
18 the prioritisation of work efficiency at the fifth place in our priority setting. Topics  
19 relating to nursing education were ranked high by the lower-middle income countries,  
20 highlighting the research needs for quality and best practices for continued nurse  
21 education. Collaborative efforts across government bodies, health authorities and  
22 hospital managements are instrumental to combat burnout in healthcare  
23 professionals (32). In addition, partnership with academic hospitals in high-income  
24 countries may be effective in supporting long-term training in low- and middle-income  
25 countries (33).

1 In-line with the prioritisation of optimizing outcomes and recovery, the domain  
2 of pain, sedation and delirium was ranked at third place. The management of pain,  
3 sedation and delirium are emphasized in the PICU Liberation ABCDEF bundle, an  
4 evidence-based guide to improve recovery after critical illness (34). In recognition of  
5 the growing importance of recovery after critical illness, post-intensive care health  
6 outcomes were prioritized within the top 25 research topics. Prioritization of long-  
7 term health outcomes of families after critical illness were not previously highlighted  
8 by PICU nurses in Europe and Australia (1,3). A recent study on consensus for  
9 general child health nursing further echoed the importance of long-term care by  
10 prioritizing “living with a long-term condition” at eight out of tenth place (35).  
11 Alongside with our international counterparts, research interest in post-intensive care  
12 health outcomes of PICU survivors and their families has recently gained traction in  
13 the PICU community. With the conceptualization of the Post Intensive Care  
14 Syndrome – pediatric (PICS-p) framework, several studies are currently conducted  
15 to validate this framework (36). In the UK, the OCEANIC study explores the long-  
16 term health outcomes of families and PICU survivors up to one-year post discharge  
17 (37). In Singapore, the SHACK study is underway to explore the association  
18 between post intensive care health outcomes and ethnicity (38).

19 Among the top 25 topics, two topics related to quality and safety were ranked  
20 at fourth and sixth place. Nurses play an important role to sustain the improvement  
21 initiatives in the PICU and to reduce the incidence of preventable conditions, such as  
22 nosocomial infections. Nurse-led strategies such as care bundles and compliance  
23 surveillance have been associated with the prevention of nosocomial infection (39).  
24 The high importance for nursing research in prevention of healthcare associated  
25 infections can be secondary to the increasing autonomy and resources among PICU



nurses in Asia. Indeed, throughout many geographical regions around the world, nurses are key stakeholders in providing improved bedside care in the PICU through nurse-led strategies (40-42).

Collectively, this research prioritisation study reflected the evolution of nursing needs in the PICU. Research needs evolve with a country's income level such as to first improve nursing practices and quality through nursing education. Middle-income countries focus on improving patient care of the general PICU population, while high-income countries were equipped to go beyond and also focus on unique patient groups to improve their care at end-of-life and to enhance long-term patient outcomes. Future research initiatives should consider collaboration across countries of different income levels. Such collaboration has shown to build capacity in low-middle income countries, improve research literacy and improve patient care (43).

### **Limitations**

To increase response rate for our survey, we performed five translations of the survey by native language speakers. This has helped to strengthen the findings of our study. However, our study has several limitations. Only 22 PICUs within PACCMAN, across eight Asian countries participated in this research prioritization. As such, majority of Asian countries were not represented in our study. We did not have overall data on the total number of potential PICUs in participating countries and thus, not able to compare centres that participated in our survey with non-participating centres. Hence, the results from this nursing research prioritisation study may not be generalizable to the whole of Asia. To improve multicentre participation rate, it is important to identify a liaison person in each country to broaden the reach in their local PICU community and to ensure survey completion.

Survey responses were given equal weightage across all respondent groups and hence we are unable to differentiate whether participants were reporting their individual or overall pediatric critical care nursing community's research priorities. Another limitation is that we only consulted PICU nurses about their research priorities and did not include other stakeholders such as parents, physicians and allied health professionals. A final limitation is that most countries do not have nurse researchers, and this may have introduced bias to our findings.

## **CONCLUSION**

We explored PICU nursing research priorities across Asian countries. Our findings are important to guide clinicians, researchers, and funding organisations in directing resources to support nurse-led research with the highest importance. Emphasis for research should be placed on professionalism, end-of-life care and the emerging interest in the long-term outcomes of PICU survivors and their families after critical illness. Our research priority setting provides direction to encourage collaborative initiatives for nursing research within Asian countries and beyond.

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**Table 1. Distribution of PICU Nursing Respondents from 8 Asian countries**

<b>Country</b>	<b>Numbers of centres</b>	<b>Round 1 (n=146)</b>	<b>Round 2 (n=91)</b>	<b>Round 3 (n=95)</b>
China	7	57	42	45
India	1	3	2	1
Indonesia	3	15	7	4
Japan	3	20	6	6
Malaysia	4	24	14	14
Pakistan	1	1	1	3
Singapore	2	17	10	13
Vietnam	1	9	7	9

**Table 2. Respondent Demographics**

Demographics	R1 (n=146)	R2 (n=91)	R3 (n=95)
Female gender	125 (85%)	64 (88%)	80 (84%)
Age in years; mean (SD)	36.6 (7.3)	35.9 (6.7)	36.5 (6.2)
PICU experience in years; mean (SD)	11.3 (6.5)	10.7 (5.6)	12.3 (5.8)
<b>Main nursing role</b>			
Clinical	73 (50%)	36 (50%)	55 (58%)
Education	14 (9%)	8 (11%)	7 (7%)
Research	8 (5%)	11 (15%)	7 (7%)
Management	22 (15%)	12 (16%)	23 (24%)
Advanced practice	4 (2%)	5 (6%)	3 (3%)
<b>Unit type</b>			
PICU	128 (88%)	64 (88%)	82 (86%)
Pediatric-neonatal ICU combined	8 (5%)	6 (8%)	6 (6%)
Adult ICU*	4 (2%)	2 (2%)	7 (7%)
<b>Education</b>			
Diploma in Nursing	26 (18%)	20 (22%)	20 (21%)
Bachelor of Nursing	73 (50%)	41 (57%)	60 (63%)
Master's in nursing	17 (11%)	11 (15%)	14 (14%)
PhD in Nursing	1 (0.7%)	0	1 (1%)

Categorical variables summarized in counts (percentages) and continuous variables summarized in means (SD=standard deviation).

ICU: Intensive care unit, PICU: Pediatric intensive care unit

\*These ICUs also provided care for critically ill children.

**Table 3. Ranking Pediatric Intensive Care Nursing Research 25 Topics**

No	Research Topic	Mean (SD)	Effect size <sup>a</sup>
1	Recognizing early deterioration of children and implementing effective supportive care.	5.58 (0.61)	0.67
2	Improving outcomes of cardiopulmonary resuscitation.	5.57 (0.66)	0.70
3	Implementing and testing nursing care interventions to optimize respiratory outcomes in mechanically ventilated children.	5.48 (0.70)	0.72
4	Implementing and testing nursing care interventions to reduce healthcare-associated infections.	5.47 (0.70)	0.68
5	Improving work efficiency of the PICU nurse.	5.46 (0.80)	0.73
6	Improving the knowledge of safe medication administration.	5.46 (0.76)	0.71
7	Reducing compassion fatigue, stress, and burnout in PICU nurses.	5.45 (0.80)	0.71
8	Improving job satisfaction and resilience in PICU nurses.	5.43 (0.85)	0.76
9	Improving nutritional support in critically ill children.	5.42 (0.72)	0.80
10	Improving communication and collaboration between parents and PICU staff.	5.42 (0.66)	0.67
11	Education and support for beginner PICU nurses.	5.40 (0.69)	0.64
12	Implementing effective pain and sedation management strategies.	5.39 (0.83)	0.73
13	Evaluating sleep of children in the PICU and implementing interventions to promote comfort care.	5.38 (0.72)	0.72*
14	Improving safety, preventing harm, and managing adverse events.	5.37 (0.83)	0.75*
15	Improving the administration of high-alert medication (e.g., insulin, opiates and narcotics, injectable potassium chloride (or phosphate) concentrate and IV Heparin).	5.36 (0.87)	0.82
16	Understanding and supporting the needs of nurses in end-of-life care.	5.36 (0.74)	0.71
17	Implementing and testing nursing interventions to improve hand hygiene compliance.	5.35 (0.93)	0.82
18	Delivering effective and safe Continuous Renal Replacement Therapy (CRRT) in children.	5.34 (0.93)	0.89
19	Implementing effective withdrawal and delirium management strategies.	5.34 (0.77)	0.70*
20	Identifying the appropriate nurse-patient ratio and associations with clinical outcomes of children.	5.34 (0.75)	0.75
21	Improving end-of-life and palliative care for children and their family.	5.34 (0.72)	0.66
22	Improving early rehabilitation of children.	5.34 (0.68)	0.68*
23	Improving long-term outcomes of children and family after PICU discharge.	5.29 (0.82)	0.85
24	Implementing strategies to improve evidence-based practice.	5.25 (0.82)	0.76
25	Identifying missed care during paediatric emergencies or resuscitation.	5.25 (0.82)	0.79

CRRT: Continuous renal replacement therapy, PICU: Pediatric intensive care unit.

<sup>a</sup>The Cohen's d was used to analyze the effect size between the mean difference of scores between Rounds 2 and 3.

\*p<0.05 mean score difference between Round 2 and 3.



**Table 4. Comparison of Research Domains per Country Income Group, Round 3**

<b>Research Domain</b>	<b>Overall mean</b>	<b>Lower middle (n=13)</b>	<b>Upper middle (n=63)</b>	<b>High (n=19)</b>	<b>p-value</b>
End-of-Life	5.34 (0.68)	4.96 (0.82)	5.42 (0.66)	5.36 (0.61)	0.089
Professionalism	5.34 (0.69)	5.28 (0.59)	5.42 (0.64)	5.13 (0.88)	0.270
Pain, Sedation and Delirium	5.32 (0.72)	5.03 (0.77)	5.45* (0.63)	5.09 (0.89)	0.047
Clinical Nursing Care Practices	5.27 (0.61)	5.15 (0.53)	5.41* (0.57)	4.91 (0.64)	0.004
Quality and Safety	5.16 (0.75)	5.08 (0.63)	5.32* (0.61)	4.68 (1.03)	0.004
Child and Family-Centered Care	5.16 (0.64)	4.93 (0.72)	5.29 (0.60)	4.90 (0.65)	0.026
Rehabilitation and follow-up after PICU	5.10 (0.78)	4.87 (0.78)	5.26* (0.69)	4.72 (0.91)	0.015

PICU: Pediatric intensive care unit

\*p<0.05, domain scores difference between upper-middle income and high-income countries following post-hoc analysis.

**Supplementary Material 1: Example for content analysis of Round 1 data:  
Family-centred care domain**

Responses	Codes	Statement
Evaluation of psychological needs and support program in PICU.	Emotional needs	Recognizing, preventing, and supporting the emotional distress of children and family during PICU admission
Grief care for family in sudden change and severe management	Emotional needs	
Complementary therapy in children who are treated for a long time in the treatment room	Emotional needs	
Humanistic Care of Nurses (empathy)	Emotional needs	
Humanistic care for critically ill children	Emotional needs	
Coping for parents and caregiver	Emotional needs	
Investigation on anxiety of family members of Children in PICU	Emotional needs	
High incidence of depression in children	Emotional needs	
Mental fatigue and shock in a family of children who have been hospitalized for PICU	Emotional needs	
Parents' feelings about tracheostomy decisions	Emotional needs	
Psychological	Emotional needs	
Mental health	Emotional needs	
Child psychology	Emotional needs	
Emotional support	Emotional needs	
Types of stress felt by children in the ICU environment	Emotional needs	
Patient stress relief	Emotional needs	
Child psychology	Emotional needs	
Psychology of severely ill children during hospitalization	Emotional needs	
Psychological assessment of children in PICU	Emotional needs	
Psychology of children and parents	Emotional needs	
Psychological nursing of children with separation anxiety	Emotional needs	
Establishment of a family care center	Parental needs	Improving communication and collaboration between parents and PICU staff
Caring for patient's families	Parental needs	
Family needs of children in PICU during hospitalization	Parental needs	
Needs of parents of children in intensive care	Parental needs	Improving parental involvement in care and
Relationship between nursing care and patient turning point	Collaboration and communication	
Need to work on patient nurse communication	Communication	
Communication problem of approaching patients	Communication	Improving parental involvement in care and
Parent reported levels of satisfaction with care provided in PICU.	Family satisfaction	
Investigate patient satisfaction in clinical departments	Family satisfaction	

Parental involvement in PICU	Parent involvement	parent satisfaction with care
The pros and cons of family presence to the patient's recovery	Parent involvement	
Impact of mother-child separation	Parent involvement	
Family access restrictions	Parent involvement	
Visit restrictions	Parent involvement	
PICU open/closed	Parent involvement	
Patient health education	Health education	Identifying the learning needs of parents to improve health education
Practice and experience of health education for family members in unaccompanied wards	Health education	
Health education for parents of critically ill children	Health education	
Caregiver knowledge and perception of care given to children	Health education	
Comfort level of nurses in allowing parents to take over nursing care for child inclusive of serving oral drugs (long term patients)	Parent involvement	Exploring the perceptions of nurses in supporting parental involvement in the PICU
Nurses' views in parent involvement during ICU stay.	Parent involvement	
Nurses' perspective in the development of a family-cantered nursing model	Parent involvement	

## Supplementary Material 2: Research statements from Round 1.

No.	Statement
	<b>1. Clinical nursing care practices (n=13)</b>
1	Developing and testing nurse-led care procedures and protocols
2	Implementing strategies to improve evidence-based practice
	<b>1.1 Haemodynamic</b>
3	Recognizing early deterioration of children and implementing effective supportive care
4	Improving outcomes of cardiopulmonary resuscitation
5	Delivering effective and safe Continuous Renal Replacement Therapy (CRRT)
6	Improving nursing care of Extra-Corporeal Membrane Oxygenation (ECMO) support
	<b>1.2 Nutrition</b>
7	Improving nutritional support in children
8	Identifying and implementing best practices for nasal gastric tube insertion and care
	<b>1.3 Respiratory and Mechanical Ventilation</b>
9	Evaluating the use of high flow nasal cannula
10	Implementing and testing nursing care interventions to optimize respiratory outcomes in mechanically ventilated children
11	Implementing and testing effective of nurse-driven protocols of non-invasive mechanical ventilation to improve outcomes
	<b>1.4 Neurology</b>
12	Implementing and testing interventions related to therapeutic hypothermia to improve neurological outcomes
13	Implementing and testing nursing care interventions to improve outcome of children with neurological disorders
	Do you have any additional topics related to clinical nursing practice, please list them below: .....
	<b>2. Child and family centred care (n=5)</b>
14	Recognizing, preventing, and supporting the emotional distress of children and family during PICU admission
15	Improving communication and collaboration between parents and PICU staff
16	Improving parental involvement in care and parent satisfaction with care
17	Identifying the learning needs of parents to improve health education
18	Exploring the perceptions of nurses in supporting parental involvement in the PICU
	Do you have any additional topics related to child and family centred care, please list them below: .....
	<b>3. Rehabilitation and follow-up after PICU (n=5)</b>
19	Improving early rehabilitation of children
20	Improving long-term outcomes of children and family after PICU discharge
21	Improving the PICU discharge process
22	Understanding the trajectory of Post-Intensive Care Syndrome (PICS) in children and their family
23	Supporting parents in delivering homecare after PICU discharge
	Do you have any additional topics related to rehabilitation and follow-up after PICU, please list them below: .....
	<b>4. Pain, Sedation and Delirium (n=4)</b>
24	Implementing effective pain and sedation management strategies
25	Identifying risk factors for delirium during PICU admission
26	Implementing effective withdrawal and delirium management strategies
27	Evaluating sleep in the PICU and implementing interventions to promote comfort care

	Do you have any additional topics related to pain, sedation and delirium, please list them below: .....
	<b>5. Quality and Safety (n=15)</b>
28	Evaluating the impact of alarm fatigue among nurses
29	Exploring the feasibility of telehealth in the PICU
30	Exploring the association of severity assessment scoring system and patient outcomes
31	Identifying missed care during paediatric emergencies or resuscitation.
32	Improving safety, preventing harm, and managing adverse events
33	Implementing and testing interventions to improve hand hygiene compliance
34	Implementing and testing nursing care interventions to reduce healthcare-associated infections
35	Improving the knowledge of safe medication administration
36	Implementing and testing nursing care interventions to promote good oral hygiene
37	Improving the administration of high-alert medication (e.g. insulin, opiates and narcotics, injectable potassium chloride (or phosphate) concentrate and IV Heparin)
38	Improving the safe usage of physical restraint
39	Implementing and testing nursing care interventions to prevent keratitis in unconscious or sedated patients
40	Implementing and testing nursing care interventions to prevent Medical adhesive-related skin injuries
41	Implementing and testing nursing care interventions to prevent pressure ulcer
42	Implementing and testing nursing care interventions to prevent hypothermia for children undergoing procedure
	Do you have any additional topics related to quality and safety, please list them below: .....
	<b>6. End-of-life (n=2)</b>
43	Improving end-of-life and palliative care for children and their family
44	Understanding and supporting the needs of nurses in end-of-life care
	Do you have any additional topics related to end-of-life, please list them below: .....
	<b>7. Professional issues in PICU Nursing (n=8)</b>
45	Education and support for beginner PICU nurses
46	Testing the effect of continuous education and training methods on nursing knowledge and competence
47	Identifying the appropriate nurse-patient ratio and associations with clinical outcomes of children
48	Identifying the scope of PICU nursing role and responsibilities
49	Improving clinical leadership, collaboration, and communication
50	Improving job satisfaction and resilience in PICU nurses
51	Improving work efficiency of the PICU nurse
52	Reducing compassion fatigue, stress, and burnout in PICU nurses
	Do you have any additional topics related to professional issues in PICU nursing, please list them below: .....

### Supplementary Material 3. Mean Score Differences in Pediatric Intensive Care Nursing Research Topics in Round 2 and 3

No.	Topics	Round 2	Round 3	p-value	Effect Size*
		mean (SD)			
1	Developing and testing nurse-led care procedures and protocols	5.04 (0.86)	5.37 (0.70)	0.442	0.79
2	Implementing strategies to improve evidence-based practice	5.25 (0.82)	5.35 (0.69)	0.906	0.76
3	Recognizing early deterioration of children and implementing effective supportive care	5.58 (0.61)	5.62 (0.73)	0.515	0.67
4	Improving outcomes of cardiopulmonary resuscitation	5.57 (0.66)	5.47 (0.74)	0.767	0.70
5	Delivering effective and safe continuous renal replacement therapy in children	5.34 (0.92)	5.43 (0.84)	0.585	0.89
6	Improving nursing care of extra-corporeal membrane oxygenation support	5.21 (0.89)	5.37 (0.88)	0.227	0.89
7	Improving nutritional support in critically ill children	5.42 (0.72)	5.43 (0.87)	0.236	0.80
8	Identifying and implementing best practices for nasal gastric tube insertion and care	5.11 (0.99)	5.09 1(.01)	0.607	1.00
9	Evaluating the use of high flow nasal cannula	5.04 (0.9)	5.03 (0.96)	0.801	0.93
10	Implementing and testing nursing care interventions to optimize respiratory outcomes in mechanically ventilated children	5.48 (0.7)	5.56 0.74)	0.741	0.72
11	Implementing and testing effective of nurse-driven protocols of non-invasive mechanical ventilation to improve outcomes	5.23 (0.83)	5.33 (0.88)	0.799	0.86
12	Implementing and testing interventions related to therapeutic hypothermia to improve neurological outcome	5.15 (0.84)	5.31 (0.90)	0.473	0.87
13	Implementing and testing nursing care interventions to improve outcome of children with neurological disorders	5.2 (0.86)	5.2 (0.89)	0.522	0.88
14	Recognizing, preventing, and supporting the emotional distress of children and family during PICU admission	5.16 (0.75)	5.18 (0.68)	0.037	0.72
15	Improving communication and collaboration between parents and PICU staff	5.42 (0.66)	5.31 (0.67)	0.114	0.67
16	Improving parental involvement in care and parent satisfaction with care	5.2 (0.74)	5.13 (0.76)	0.002	0.75
17	Identifying the learning needs of parents to improve health education	5.05 (0.86)	4.97 (0.82)	0.574	0.84
18	Exploring the perceptions of nurses in supporting parental involvement in the PICU	5.01 (0.88)	4.97 (0.90)	0.518	0.89
19	Improving early rehabilitation of children	5.34 (0.68)	5.41 (0.69)	0.016	0.68
20	Improving long-term outcomes of children and family after PICU discharge	5.29 (0.82)	5.17 (0.88)	0.748	0.85
21	Improving the PICU discharge process	4.91 (1.15)	4.95 (0.98)	0.685	1.07
22	Understanding the trajectory of Post-Intensive Care Syndrome (PICS) in children and their family	4.91 (0.97)	5.08 (0.78)	0.015	0.88

23	Supporting parents in delivering homecare after their children's PICU discharge	5.18 (0.84)	5.07 (0.96)	0.545	0.90
24	Implementing effective pain and sedation management strategies	5.39 (0.83)	5.43 (0.61)	0.103	0.73
25	Identifying risk factors for delirium during PICU admission	5.2 (0.96)	5.19 (0.73)	0.353	0.86
26	Implementing effective withdrawal and delirium management strategies	5.34 (0.77)	5.31 (0.64)	0.009	0.70
27	Evaluating sleep of children in the PICU and implementing interventions to promote comfort care	5.38 (0.72)	5.31 (0.72)	0.044	0.72
28	Evaluating the impact of alarm fatigue among nurses	5.11 (1.10)	5.15 (0.85)	0.294	0.98
29	Exploring the feasibility of telehealth in the PICU	4.66 (1.14)	4.73 (0.99)	0.405	1.07
30	Exploring the association of severity assessment scoring system and patient outcomes	4.87 (0.98)	5.00 (0.85)	0.108	0.92
31	Identifying missed care during paediatric emergencies or resuscitation.	5.25 (0.82)	5.20 (0.75)	0.843	0.79
32	Improving safety, preventing harm, and managing adverse events	5.37 (0.83)	5.4 (0.66)	0.036	0.75
33	Implementing and testing nursing interventions to improve hand hygiene compliance	5.35 (0.93)	5.36 (0.7)	0.146	0.82
34	Implementing and testing nursing care interventions to reduce healthcare-associated infections	5.47 (0.70)	5.38 (0.66)	0.663	0.68
35	Improving the knowledge of safe medication administration	5.46 (0.76)	5.40 (0.66)	0.484	0.71
36	Implementing and testing nursing interventions to promote good oral hygiene	5.04 (1.06)	5.06 (0.77)	0.271	0.93
37	Improving the administration of high-alert medication (e.g. insulin, opiates and narcotics, injectable potassium chloride (or phosphate) concentrate and intravenous Heparin)	5.36 (0.87)	5.38 (0.76)	0.657	0.82
38	Improving the safe usage of physical restraint	4.95 (1.05)	4.99 (0.92)	0.287	0.98
39	Implementing and testing nursing care interventions to prevent keratitis in unconscious or sedated patients	5.05 (1.02)	5.05 (0.87)	0.111	0.95
40	Implementing and testing nursing care interventions to prevent Medical adhesive-related skin injuries	5.18 (0.86)	5.04 (0.82)	0.293	0.84
41	Implementing and testing nursing care interventions to prevent pressure ulcer	5.31 (0.80)	5.21 (0.74)	0.233	0.77
42	Implementing and testing nursing care interventions to prevent hypothermia for children undergoing a procedure	5.03 (1.06)	5.01 (0.93)	0.405	0.99
43	Improving end-of-life and palliative care for children and their family	5.34 (0.72)	5.35 (0.60)	0.161	0.66
44	Understanding and supporting the needs of nurses in end-of-life care	5.36 (0.74)	5.27 (0.68)	0.074	0.71
45	Education and support for beginner PICU nurses	5.4 (0.69)	5.35 (0.58)	0.573	0.64

46	Testing the effect of continuous education and training methods on nursing knowledge and competence	5.22 (0.85)	5.23 (0.66)	0.875	0.76
47	Identifying the appropriate nurse-patient ratio and associations with clinical outcomes of children	5.34 (0.75)	5.24 (0.74)	0.382	0.75
48	Identifying the scope of PICU nursing role and responsibilities	5.22 (0.89)	5.19 (0.75)	0.647	0.82
49	Improving clinical leadership, collaboration, and communication	5.23 (0.87)	5.19 (0.70)	0.717	0.79
50	Improving job satisfaction and resilience in PICU nurses	5.43 (0.85)	5.37 (0.65)	0.142	0.76
51	Improving work efficiency of the PICU nurse	5.46 (0.80)	5.36 (0.67)	0.961	0.73
52	Reducing compassion fatigue, stress, and burnout in PICU nurses	5.45 (0.80)	5.4 (0.61)	0.148	0.71

PICU: Pediatric intensive care unit

The Cohen's d was used to analyze the effect size between the mean difference of scores between Round 2 and 3.



## Supplementary Material 4. Ranking Pediatric Intensive Care Nursing 52 Research Topics

No	Topics	mean (SD)
1	Recognizing early deterioration of children and implementing effective supportive care	5.62 (0.73)
2	Implementing and testing nursing care interventions to optimize respiratory outcomes in mechanically ventilated children	5.56 (0.74)
3	Improving outcomes of cardiopulmonary resuscitation	5.47 (0.74)
4	Improving nutritional support in critically ill children	5.43 (0.87)
5	Delivering effective and safe Continuous Renal Replacement Therapy (CRRT) in children	5.43 (0.84)
6	Implementing effective pain and sedation management strategies	5.43 (0.61)
7	Improving early rehabilitation of children	5.41 (0.69)
8	Improving the knowledge of safe medication administration	5.40 (0.66)
9	Improving safety, preventing harm, and managing adverse events	5.40 (0.66)
10	Reducing compassion fatigue, stress, and burnout in PICU nurses	5.40 (0.61)
11	Improving the administration of high-alert medication (e.g. insulin, opiates and narcotics, injectable potassium chloride (or phosphate) concentrate and IV Heparin)	5.38 (0.76)
12	Implementing and testing nursing care interventions to reduce healthcare-associated infections	5.38 (0.66)
13	Improving nursing care of Extra-Corporeal Membrane Oxygenation (ECMO) support	5.37 (0.88)
14	Developing and testing nurse-led care procedures and protocols	5.37 (0.70)
15	Improving job satisfaction and resilience in PICU nurses	5.37 (0.65)
16	Implementing and testing nursing interventions to improve hand hygiene compliance	5.36 (0.7)
17	Improving work efficiency of the PICU nurse	5.36 (0.67)
18	Implementing strategies to improve evidence-based practice	5.35 (0.69)
19	Improving end-of-life and palliative care for children and their family	5.35 (0.60)
20	Education and support for beginner PICU nurses	5.35 (0.58)
21	Implementing and testing effective of nurse-driven protocols of non-invasive mechanical ventilation to improve outcomes	5.33 (0.88)
22	Implementing and testing interventions related to therapeutic hypothermia to improve neurological outcome	5.31 (0.90)
23	Evaluating sleep of children in the PICU and implementing interventions to promote comfort care	5.31 (0.72)
24	Improving communication and collaboration between parents and PICU staff	5.31 (0.67)

25	Implementing effective withdrawal and delirium management strategies	5.31 (0.64)
26	.Understanding and supporting the needs of nurses in end-of-life care	5.27 (0.68)
27	Identifying the appropriate nurse-patient ratio and associations with clinical outcomes of children	5.24 (0.74)
28	Testing the effect of continuous education and training methods on nursing knowledge and competence	5.23 (0.66)
29	Implementing and testing nursing care interventions to prevent pressure ulcer	5.21 (0.74)
30	Identifying missed care during paediatric emergencies or resuscitation.	5.20 (0.75)
31	Implementing and testing nursing care interventions to improve outcome of children with neurological disorders	5.20 (0.89)
32	Identifying the scope of PICU nursing role and responsibilities	5.19 (0.75)
33	Identifying risk factors for delirium during PICU admission	5.19 (0.73)
34	Improving clinical leadership, collaboration, and communication	5.19 (0.70)
35	Recognizing, preventing, and supporting the emotional distress of children and family during PICU admission	5.18 (0.68)
36	Improving long-term outcomes of children and family after PICU discharge	5.17 (0.88)
37	Evaluating the impact of alarm fatigue among nurses	5.15 (0.85)
38	Improving parental involvement in care and parent satisfaction with care	5.13 (0.76)
39	Identifying and implementing best practices for nasal gastric tube insertion and care	5.09 1(.01)
40	Understanding the trajectory of Post-Intensive Care Syndrome (PICS) in children and their family	5.08 (0.78)
41	Supporting parents in delivering homecare after their children's PICU discharge	5.07 (0.96)
42	Implementing and testing nursing interventions to promote good oral hygiene	5.06 (0.77)
43	Implementing and testing nursing care interventions to prevent keratitis in unconscious or sedated patients	5.05 (0.87)
44	Implementing and testing nursing care interventions to prevent Medical adhesive-related skin injuries	5.04 (0.82)
45	Evaluating the use of high flow nasal cannula	5.03 (0.96)
46	Implementing and testing nursing care interventions to prevent hypothermia for children undergoing a procedure	5.01 (0.93)
47	Exploring the association of severity assessment scoring system and patient outcomes	5.00 (0.85)
48	Improving the safe usage of physical restraint	4.99 (0.92)
49	Exploring the perceptions of nurses in supporting parental involvement in the PICU	4.97 (0.90)
50	Identifying the learning needs of parents to improve health education	4.97 (0.82)

51	Improving the PICU discharge process	4.95 (0.98)
52	Exploring the feasibility of telehealth in the PICU	4.73 (0.99)

PICU: Pediatric intensive care unit