Quality pharmaceutical care in the neonatal intensive care unit: identification of essential pharmacy services and key performance indicators for the Australian setting

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Quality Pharmaceutical Care In The NICU: Identification of Essential Pharmacy Services And Key Performance Indicators for the Australian setting

ABSTRACT

BACKGROUND: When considering sub-specialties of clinical pharmacy practice, such as the neonatal intensive care unit (NICU), no key performance indicators (KPIs) or practice standards have been published by national or international pharmacy organisations.

AIM: To identify a list of essential pharmacist roles that should be performed in the NICU. Also, to identify a set of clinical pharmacy KPIs that can be used to benchmark the quality of pharmaceutical care provided to patients in Australian NICU settings.

METHOD: A modified Delphi technique was used to send 65 indicators and 30 proposed roles to an expert panel of doctors, pharmacists and nurses. The indicators and roles were compiled from a previously conducted literature review. An online survey sent in two consecutive Delphi rounds in August and September 2017 asked experts to rank the indicators and roles against specific criteria.

RESULTS: A total of 15 healthcare professionals from Australia participated as expert panellists. Overall, consensus of 75% was reached for 31 indicators and for 23 roles by Australian panellists. Experts particularly valued the following roles: pharmacists being a source of medication information (100%, Median = 1.00), assisting in off-label prescribing (100%, Median = 1.00), documenting medication errors (100%, Median = 1.00), medication chart review (100%, Median = 1.00), and writing medication protocols for the NICU (100%, Median = 1.00).

CONCLUSION: Future investigation is needed to formalise a set of NICU specific, clinical pharmacy KPIs and a practice model to form the foundations of national and international standardised practice guidelines for this sub-specialty.

KEY WORDS: Delphi technique, KPIs, Quality Measurement, NICU/neonates, clinical pharmacist, pharmaceutical care

INTRODUCTION

The quality and safe use of medicines is a global priority, particularly in high-risk patients such as those in the neonatal intensive care unit (NICU). Medication errors occur commonly in this ward, and are often avoidable.(1) Krzyzaniak and Bajorek highlighted that medication errors in NICU including patient misidentification, delayed dispensing, parental involvement in administering unauthorised medications, erroneous product dilutions, as well as tenfold and 100-fold overdoses, are more prevalent than in other patient populations.(2) The consequences of error can be significant, ranging from impact upon the use of resources resulting in cost increases, to significantly affecting the health outcomes of neonatal patients, i.e. impairing development of organs and body systems.(1, 3-5) As such, the clinical pharmacist has a critical role in preventing errors from occurring and ensuring the safety of pharmacotherapy. The role of the clinical pharmacist has evolved to comprise cognitive roles in patient care, medication management and in hospital quality improvement.(6) When considering the Australian context, overall clinical pharmacy has been shown to be well-established in wards such as the NICU, paediatric care, and palliative care, and pharmacists are found to be highly involved in the pharmacotherapy decision-making process.(7-9) As such, the pharmacist's influence over care can have significant impact upon the quality of patient outcomes. Therefore, it is important to assess the need for a minimum standard of care to be practiced by pharmacists in this setting to achieve the best possible use of pharmacotherapy. Furthermore, in doing so, there must also be a means of measuring the quality of care provided by these health care professionals.

One means of standardising practice both within and between countries is through the development of practice policies and validated quality measurement tools, such as key performance indicators (KPIs).(10) KPIs are viewed as key resources in improving performance, and can be used to benchmark health services to determine whether they are meeting the minimum level of quality.(6) However, when considering clinical pharmacy, no KPIs have been published or adopted by national or international pharmacy organisations. Furthermore, when considering sub-specialties of clinical pharmacy practice, such as the NICU, there is even less literature available to guide pharmacists in their roles. Ng and Harrison sought to develop a set of KPIs that were measureable and relevant to clinical pharmacy, however, these are focused on hospital pharmacy practice overall, and are not specific to practice in any particular ward, especially the NICU.(6) As such, due to the lack of established KPIs, there is an inability to collect and use data to benchmark the quality of pharmaceutical care being provided for neonatal patients.

AIM OF THE STUDY

The purpose of this study was to identify, using an expert panel of stakeholders, the pharmaceutical care services and KPIs that are essential to quality medication management in the Australian NICU setting via a two-round Delphi technique.

Specific Objectives

- To identify the minimum roles and services that NICU pharmacists in Australia should be consistently performing whilst on the ward to promote medication safety and positive patient outcomes.
- To identify pharmacy-relevant key performance indicators within Donabedian's domains of structure, process and outcome that are suitable for Australian NICU settings

METHOD

An online, self-administered survey was distributed to panellists in the form of a two round Delphi technique between August and September 2017.(6) Ethics approval was sought and obtained from the ethics committee at the University of Technology Sydney (UTS), Australia (UTS HREC REF NO. ETH17-1584). Panellists were assured of confidentiality and were informed that their responses would be de-identified.

PANELLISTS

The study population was made up of key stakeholders/experts involved in NICU care including: pharmacists, nurses and medical doctors as identified from neonatal organisations as well as data papers and articles. Panellists were specifically sought and recruited from within Australia. Publicly available registers in Australia included the Australian New Zealand Neonatal Network (ANZNN) that identified hospitals with neonatal intensive care units.

Experts were defined as: 1) Frontline medical doctors, nurses, hospital pharmacists, members of national hospital pharmacy organisations or pharmacists based in academia, 2) who had experience with hospital based clinical pharmacy services, and where possible 3) experience in caring for neonatal patients.

INITIAL CONSTRUCTION OF INDICATORS

To collate a list of potential pharmacist roles and key performance indicators, a review of the literature was undertaken relating to quality and pharmacist-specific key performance indicators

used in neonatal and paediatric care settings.(11) Based on the findings of this review, 30 potential pharmacist roles and 66 potential indicators that were deemed sensitive to clinical pharmacy practice were included in round 1 for Australian panellists. This list of roles and indicators was collated by the research team (NK, IP, BB), each of whom hold post-graduate qualifications in pharmacy.

All indicators were categorised according to structure, process and outcome.

SURVEY

The structures of the surveys used in the Delphi rounds were adapted from two previous studies by Wilson et.al. who sought to develop a set of nursing indicators for paediatric hospitals in Australia and Fernandes et.al. who developed a set of clinical pharmacy key performance indicators for hospital pharmacists.(12, 13)

A survey consisting of three distinct sections, including panellist demographics (Section A), essential pharmacist roles in NICU (Section B) and a preliminary set of indicators (Section C), was distributed to panellists in round 1. In section B, relating to pharmacist roles, the panellists were asked to determine whether each proposed pharmacy role/service fit three criteria:

1) the role should be provided to NICU
2) that the role is realistically able to be performed for the NICU
3) the role reflects an ideal level of pharmacy practice in the NICU

In section C, the panellists were asked to determine how well the proposed key performance indicators fit the selection criteria. This selection criteria was adapted from the study performed by Fernandes et.al. and includes the following points - that the item:

1) reflects a desired level of quality practice;
2) links to direct patient care in the NICU;
3) is pharmacy or pharmacist sensitive;
4) is feasible to measure;
5) is generalisable to all hospital pharmacy types and;
6) is important for optimal medication management in this setting.(13)

The panellists were asked to rate each item on a 5 point Likert scale ranging from strongly agree (1) to strongly disagree (5). Panellists were invited to comment at the end of the survey and suggest additional indicators/roles. Any comments provided were used to rephrase questions and suggested

indicators/roles were included in the next round of questionnaires. In round 2, the modified set of KPIs/roles were rated again using the same selection criteria.

The surveys were delivered via 2 rounds, over 2 months. The online software program Survey Monkey™ was used for each round. The surveys took approximately 15 minutes to complete and each round was open for 2 weeks. Reminders were emailed at the beginning and at the end of week 2. Round 1 was piloted by a small number of pharmacists.

DATA ANALYSIS

Quantitative data were analysed using descriptive statistics (percentages, frequencies) using the Statistical Package for the Social Sciences (SPSS) Version 22™. After each round of Delphi ratings, consensus was deemed to have been attained when 75% or more of panellists rated 'agreed' for an indicator. All scores listed as 1 and 2 were combined as agree, and all scores listed as 4 and 5 were combined as disagree. Scores of 3 (unsure) were excluded. All items with ≥ 75% agreement were included in the final set. If an indicator did not reach this consensus, it was not included in the subsequent round.

RESULTS

Overall, 15 healthcare professionals from a possible 27 in Australia, became expert panellists and participated in at least one Delphi round. The remaining individuals did not respond. Ten experts completed both Delphi rounds. Approximately half of panellists in each round were pharmacists or directors of pharmacy, and the remaining experts consisted of neonatologists, nurses, and midwives (Table 1).

ROUND 1

A total of 14 panellists completed round 1.

PHARMACIST ROLES

A list of 30 pharmacist roles was presented to panellists. Overall, respondents strongly agreed to the proposed services. Australian panellists achieved consensus for 26 roles, and the remaining four including: immunisations (71.4%), monitoring of TPN (71.4%), extemporaneous compounding (57.1%), and house-keeping activities (64.3%), were removed from inclusion in the following round

(Table 2). Median scores ranged from 1.00 (IQR = 0) for patient medication chart review to 2.00 (IQR = 2.00) for house-keeping activities. No new roles were proposed by panellists for the subsequent round.

PROPOSED INDICATORS FOR ASSESSING THE QUALITY OF PHARMACY SERVICES IN THE NICU

Overall, 13 structure (Table 3), 24 process (Table 4) and 28 outcome indicators (Table 5) were presented to Australian panellists (total = 65). Of these, only 28 reached consensus, the remaining 37 were excluded from analysis in round 2. Median scores ranged from 1.00 (IQR = 0) to 3.00 (IQR = 1). Panellists recommended 16 indicators to be included into the next round.

ROUND 2

A total of 10 panellists completed round 2.

PHARMACIST ROLES

Consensus was reached for 23 roles by panellists (Table 2). Australian panellists particularly valued the following roles: pharmacists being a source of medication information (100%, Median = 1.00), assisting in off-label prescribing (100%, Median = 1.00), documenting medication errors (100%, Median = 1.00), medication chart review (100%, Median = 1.00), and writing medication protocols for the NICU (100%, Median = 1.00). Experts excluded another three roles comprising: dispensing (60%), evaluating patient laboratory test results (60%), and managing the drug budget (70%). Median scores achieved by Australian experts ranged from 1.00 (IQR = 0) – 2.00 (IQR = 2). Overall, panellists responded strongly to the proposed pharmacist roles, with the majority responding 'strongly agree'.

PROPOSED INDICATORS FOR ASSESSING THE QUALITY OF PHARMACY SERVICES IN THE NICU

A total of 44 indicators were presented to Australian experts, comprising: 12 structure, 13 process and 19 outcome indicators. Consensus of > 75% was achieved for 31 items. Panellists responded strongly to structure indicators, with the majority reaching a consensus of 90% and higher. The median scores ranged from 1.00 (IQR = 0) to 2.50 (2).

DISCUSSION

This is the first study to investigate the development of practice standards and a standardised national set of KPIs for pharmacy practice in Australian NICUs.

The findings highlight that pharmacists, nurses and doctors alike value the integrated roles of the pharmacist in the NICU therapeutic team. Australian panellists excluded all provision of medicines roles, which indicates that where practice is established, having pharmacists moving further into a patient-care capacity is being encouraged. The experts also indicated their agreement with pharmacists undertaking clinical roles. These perceptions may be a reflection of familiarity with current practice as hospital pharmacists in Australia are often an ingrained part of the multidisciplinary treating team.

When considering the indicators selected by panellists, the responses obtained are also encouraging. First, Australian experts were selective with the indicators that they chose, excluding a total of 50. However, they 'strongly agreed' to the remaining indicators. Interestingly, many indicators in the outcomes domain did not reach consensus by experts. This may be attributed to the fact that patient outcomes in the NICU are the result of a collaborative effort from a team of experts from the medical, nursing and other allied health fields. As such, it is difficult to attribute outcomes specifically to pharmacist input.

Clinical pharmacists, as pharmacotherapy experts, are key resources in improving the safety and quality of medicines used. Literature demonstrates the positive contributions of pharmacist involvement in pharmacotherapy-related decision-making and in reducing medication errors in the NICU, and there is a need to further embed pharmacists into this specialty field of practice.(5, 14, 15) The World Health Organisation (WHO) recently launched the Global Patient Safety Challenge on Medication Safety, which aims to reduce medication errors on a global scale by 50% in 5 years.(16) One of the proposed strategies by WHO to reduce these errors is to develop global norms and standards to address deficiencies in healthcare systems that lead to medication errors and any resulting patient harm.(16) Ng and Harrison argue that there is a need for a 'centralised governance model' in clinical pharmacy to allow the profession to advance.(6) A standardised system for measuring the quality of pharmaceutical care being provided is a valuable means of promoting the value of pharmacists in this ward, and allowing pharmacists to prioritise patient care activities.(10) As such, there is a need to further build upon the findings presented, to develop a robust, valid and generalisable set of practice standards on a national as well as global scale to promote the standardisation of quality pharmacy practice.

LIMITATIONS

There are several limitations to consider. Firstly, the expert panels were comprised of only a very small number of panellists. This may be attributed to the very specific nature of this research, which may have put-off potential respondents from contributing their expertise. Furthermore,

agreement/disagreement with a structure/process/outcome indicator may be associated with the local or national expectations of professional pharmacist practice or experience of each panellist. Therefore, the results may be influenced by the professional roles of the participants, years of working experience, as well as the range in working experience between panellists (noting that within the category of '1 to 5 years of experience', there could be much variability in actual experience and exposure to the NICU). This may affect the generalisability of the results and they should be interpreted with caution.

Despite the small size of the panel groups, the experts who responded to the surveys worked in a variety of different roles and contributed a diverse range of neonatal and pharmacy experiences and expertise.

Some of the indicators presented have been proposed by panellists, and as such they have not been tested for validity, reliability or measurability.

The study was undertaken in the context of the Australian healthcare system. As such, the results may not be generalisable or applicable to countries with different healthcare systems.

In addition, due to the nature of the survey and the way that the question was delivered to participants, we are unable to differentiate which participants were NICU pharmacists and those who were Directors of Pharmacy. In hindsight, this would have been a useful differentiation for the study.

CONCLUSION

The findings of this study present a baseline list of pharmacist roles and clinical pharmacy indicators that have been identified by stakeholders as reflecting a quality standard of practice in NICUs in Australia. The findings are a first step in standardising practice within this country. Future investigation is needed to formalise a set of NICU specific, clinical pharmacy KPIs and a practice model to form the foundations of national and international standardised practice guidelines for this sub-specialty.

CONFLICT OF INTEREST: The authors declare no conflict of interest.

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TABLE 1 – CHARACTERISTICS OF EXPERT PANEL

	ROUND 1 (%)	**ROUND 2 (%)**
NUMBER OF PANELLISTS	14	10
GENDER OF PANELLISTS		
Female	9 (64.3)	6 (60)
SPECIALISED QUALIFICATIONS RELATING TO NEONATES		
Yes	5 (35.7)	1 (10)
No	9 (64.3)	9 (90)
Specialisation in neonatology/paediatrics – Fellow of the Royal Australasian College of Physicians (FRACP), Membership of the Royal College of Paediatrics and Child Health (MRCPCH)	1	
Hospital/Clinical Pharmacy specialisation		
PhD	1	1
Postgraduate certificate in neonatal nursing	2	
Diploma in Child Health	1	
POSITION IN THE HOSPITAL		
NICU pharmacist/Director of pharmacy	7 (50)	5 (50)
Neonatologist/NICU Doctor	4 (28.6)	3 (30)
NICU Nurse/Midwife	3 (21.4)	2 (20)
YEARS WORKING IN CURRENT POSITION		
Between 1-5 Years	8 (57.1)	5 (50)
Between 6-10 Years	3 (21.4)	3 (30)
> 10 Years	3 (21.4)	2 (20)

TABLE 2 – Roles that pharmacists should perform in the NICU according to the Australian expert panel

Pharmacist Services/Roles	**ROUND 1**		**ROUND 2**	
	MEDIAN (IQR) ⁎	**CONSENSUS %**	**MEDIAN (IQR) ⁎**	**CONSENSUS %**
ADMINISTRATIVE ROLES				
Development/implementation of a drug formulary service	1.00 (1)	92.9	1.00 (0)	100
Attendance at non-clinical meetings i.e. Drug and Therapeutics Committee	2.00 (1)	85.7	1.50 (1)	90
Conducting quality assurance measures i.e. drug usage evaluations, workload documentation, auditing	1.00 (1)	100	1.00 (1)	100
Management of the drug budget	2.00 (0)	85.7	2.00 (1)	70
Evaluation, selection and purchasing of pharmaceuticals for the unit	1.50 (1)	85.7	2.00 (1)	90
Development of drug policies/protocols/guidelines for the NICU	1.00 (0)	100	1.00 (0)	100
CLINICAL ROLES				
Patient medication chart review	1.00 (0)	100	1.00 (0)	100
Participation in medical ward rounds	1.50 (1)	85.7	1.00 (1)	100
Monitoring the efficacy of pharmacotherapy in patients	1.00 (1)	100	1.00 (1)	100
Documenting/monitoring side-effects and Adverse Drug Events/Reactions	1.00 (1)	85.7	1.00 (1)	100
Documenting Medication Errors	1.00 (0)	85.7	1.00 (0)	100
Evaluating patients clinical laboratory tests	2.00 (0)	78.6	2.00 (2)	60
Therapeutic Drug Monitoring (TDM)	1.00 (1)	100	1.00 (1)	100
Immunisations	2.00 (2)	71.4	-	-
Monitoring Total Parenteral Nutrition (TPN)	2.00 (2)	71.4	-	-
Participation in clinical meetings	1.00 (1)	100	1.50 (1)	100

Calculating and recommending doses and dosing schedules for specific patients	1.50 (1)	92.9	1.00 (0)	90
Assisting doctors in prescribing off-label/unlicensed medicines	1.50 (1)	100	1.00 (0)	100
Identifying and performing interventions for individual patients to prevent or resolve drug therapy problems i.e. interactions, incompatibilities, allergies etc.	1.00 (1)	100	1.00 (0)	100
Recommending drugs and contributing to the pharmacotherapy decision making process for specific patients	2.00 (1)	92.9	1.00 (1)	100
Collaborating and discussing specific patients with doctors and nurses	1.50 (1)	100	1.00 (1)	100
EDUCATIONAL ROLES				
Providing training/in-services for other health professionals on NICU related topics and drug related problems	1.00 (0)	100	1.00 (1)	100
Contributing to and/or attending NICU related conferences	2.00 (1)	92.9	2.00 (1)	100
Involved in clinical trials	2.00 (1)	78.6	1.50 (1)	90
Involved in research related to neonatal pharmacotherapy	2.00 (1)	85.7	1.00 (1)	90
Source of drug information - responding to information requests from health professionals on the ward	1.00 (1)	100	1.00 (0)	100
Counselling parents/carers of neonatal patients on medication	2.00 (1)	85.7	1.50 (1)	80
PROVISION OF MEDICINES ROLES				
Dispensing prescriptions	2.00 (1)	78.6	1.50 (2)	60
Extemporaneous compounding of formulations for the NICU	2.00 (2)	57.1	-	-
Stocking the ward with essential medicines/house-keeping activities i.e. checking expiry dates, fridge temperatures etc.	2.00 (2)	64.3	-	-
⁎ 1 – 5 Likert rating scale used				

- Role that did not achieve consensus in initial round

TABLE 3 – STRUCTURE INDICATORS

	ROUND 1		ROUND 2	
	MEDIAN (IQR) ⁎	**CONSENSUS %**	**MEDIAN (IQR) ⁎**	**CONSENSUS %**
PERSONNEL				
Availability of a funded NICU clinical pharmacist position (full-time/part-time) in the hospital (17)	1.00 (0)	100	1.00 (0)	100
NICU pharmacist holds qualifications in clinical pharmacy or NICU/paediatric pharmacy (18-20)	1.00 (1)	100	1.00 (2)	70
FACILITIES/ENVIRONMENT/RESOURCES				
Dedicated area/station on the ward for the pharmacist that is a well-lit, with sufficient workspace, minimal distractions (21)	2.00 (2)	64.3	-	-
Availability of suitable fridges for vaccines and TPN on the ward (22)	1.00 (0)	100	1.00 (0)	90
Dedicated area on the ward for medication preparation that contains the relevant instruments needed (17, 22)	1.50 (2)	71.4	-	-
Direct availability on the ward of essential medicines for specific use within the NICU (23)	1.00 (0)	100	1.00 (0)	90
Availability of written policies/protocols/guidelines for high-risk medications i.e. antibiotics, pain-relief, parenteral nutrition (19, 21, 23, 24)	1.00 (0)	100	1.00 (0)	100
Availability of clear policies on how to prescribe, dispense, administer and monitor medications in the NICU (21)	1.00 (0)	100	1.00 (0)	100
Easily accessible neonatal formulary with standard concentrations (4, 21, 25)	1.00 (0)	100	1.00 (0)	100
Availability of emergency medicines sheets, with listed doses per weight (4, 25)	1.00 (1)	85.7	1.50 (1)	100
Availability of standard neonatal/paediatric references for use in the selection, use and evaluation of	2.00 (1)	92.9	1.50 (1)	90

medications i.e. textbooks (BNF P, Neofax), online resources (21)				
Availability of electronic medication error and adverse drug event reporting (systems) (19, 21, 24, 26)	1.00 (1)	85.7	1.00 (1)	90
Availability of safety technology including: CPOE, CDSS, barcode verification, smart pumps, computerised calculation of orders, automated drug dispensing units, electronic health records (4, 21, 25, 27-30)	1.00 (1)	92.9	1.00 (0)	90
Availability of clear guidelines and documents developed by pharmacists for Morphine – relating to dosing, pain scores, weaning, and adequately treating withdrawal in infants △	-	-	1.00 (0)	100

※ 1 – 5 Likert rating scale used

\- Indicator that did not achieve consensus in initial round

△ Indicator proposed by panellists

TABLE 4 – PROCESS INDICATORS

	ROUND 1		ROUND 2	
	MEDIAN (IQR) ⁎	**CONSENSUS %**	**MEDIAN (IQR) ⁎**	**CONSENSUS %**
Proportion of medicine charts reviewed by clinical pharmacists within 24 hours of admission (6, 31)	1.00 (1)	100	1.00 (1)	100
Proportion of patients who receive formal documented admission medication reconciliation by a pharmacist (includes medication history from the mother of patient) (6, 13)	2.00 (2)	71.4	-	-
Number of potential or actual drug related problems identified by a pharmacist per patient per bed day (6, 13)	2.00 (1)	71.4	-	-
Monthly audit of the number of total drug therapy problems resolved by pharmacists in the NICU (13)	2.00 (1)	78.6	1.50 (1)	90
Number of drug therapy problems resolved for 'high-alert' medications by pharmacists (13)	2.00 (1)	78.6	2.00 (1)	90
Proportion of patients for whom pharmacists have completed a medication action plan (13)	3.00 (1)	42.9	-	-
Proportion of patients prescribed narrow therapeutic index medications (i.e. aminoglycosides, digoxin) who are monitored by a pharmacist (Therapeutic Drug Monitoring) (19, 24)	1.50 (1)	78.6	1.50 (1)	100
Proportion of NICU inpatients parents/carers that received verbal counselling and/or written information about their medicines prior to discharge (6, 24, 26, 31)	2.00 (2)	71.4	-	-
Proportion of unlicensed/off-label prescriptions that involved the consultation of a pharmacist (19)	2.00 (1)	78.6	2.00 (2)	70
Proportion of Adverse Drug Events that were identified, monitored, rectified, prevented, and reported per number of admissions (6, 19, 24, 26)	2.00 (1)	78.6	2.00 (0.876)	70
Proportion of dispensing errors identified and rectified by pharmacist per number of admissions (21)	2.00 (2)	57.1	-	-
Number of education/training sessions provided by pharmacists relating to pharmacotherapy in the NICU for other health professionals (19, 21, 24, 26, 27, 32)	2.00 (1)	85.7	2.00 (1)	80
Number of pharmacotherapy related consultations provided to medical personnel by pharmacists (19, 24)	2.00 (1)	78.6	2.00 (1)	80
Participation in multi-disciplinary ward rounds and meetings (24, 26) – proportion of pharmacists who	2.00 (2)	64.3	-	-

actively participate in interprofessional patient care rounds to improve medication management				
Proportion of TPN regimens that have been monitored/optimised by a pharmacist (19, 23)	2.00 (2)	71.4	-	-
Proportion of IV medications that have been monitored by a pharmacist (19)	2.00 (1)	78.6	2.00 (1)	80
Number of pharmacists involved in conducting drug use evaluations in the NICU (33)	2.00 (1)	71.4	-	-
Use of pain protocols for patient groups and specific procedures (33)	2.00 (1)	71.4	-	-
Proportion of pharmacists involved in NICU related clinical research (24, 26)	2.00 (1)	85.7	2.00 (1)	90
Proportion of dose calculations checked by pharmacist before administration (21)	2.00 (2)	71.4	-	-
The percentage of discharge prescriptions reviewed and reconciled by a pharmacist prior to dispensing (31)	2.00 (2)	71.4	-	-
Proportion of pharmacists involved in a prescribing error feedback programme (34)	2.00 (1)	78.6	2.00 (1)	80
Proportion of multiple birth babies that have were correctly identified and had the correct medicines prescribed and administered (35)	2.00 (1)	57.1	-	-
Proportion of IV medications whose doses were checked prior to administration (19)	2.00 (2)	64.3	-	-
Number of pharmacist reviews provided verifying the appropriateness of medications prescribed for infants △	-	-	2.00 (1)	100
Proportion of neonatal patients monitored with pain scores △	-	-	2.50 (2)	60

⁎ 1 – 5 Likert rating scale used

- Indicator that did not achieve consensus in initial round

△ Indicator proposed by panellists

TABLE 5 – OUTCOME INDICATORS

	ROUND 1		ROUND 2	
	MEDIAN (IQR) ⁎	**CONSENSUS %**	**MEDIAN (IQR) ⁎**	**CONSENSUS %**
Monthly audit of medication charts with a target of at least 80% correct time of administration (wrong time defined as more than 1 hour of prescribing for stat/PRN medications and regular medications doses not given prior to the next scheduled dose) (32)	2.00 (2)	64.3	-	-
Prescribing errors: Identification and resolution of unintentional departure from recommended prescribing practices per patient per bed day (6)	2.00 (1)	78.6	2.00 (1)	90
Monthly audit of the labelling of all lines – to be labelled with access type and fluid/medication being administered with a target of at least 90% correct labels (32)	2.00 (3)	64.3	-	-
Monthly audit of prescribing against prescribing guidelines – target 90% (32)	1.50 (2)	78.6	1.00 (1)	90
Monthly audit of prescribing pain relief against pain protocols for specific procedures (33)	2.50 (2)	50	-	-
Monthly audit of episodes of ineffective empiric antibiotic therapy (organism/antibiotic mismatch) (36)	1.50 (2)	64.3	-	-
Mean time to target vancomycin trough concentration for infants with known MRSA infection (36)	2.00 (2)	57.1	-	-
Proportion of infants receiving appropriate dosing and timing of perioperative prophylaxis (6, 36)	3.00 (2)	42.9	-	-
Monthly audit of episodes of antibiotic-associated adverse events (36)	2.00 (2)	57.1	-	-
Duration of treatment for culture-negative presumed late onset sepsis (36)	2.00 (2)	64.3	-	-
Monthly audit of rates of infections with multi-drug resistant gram-negative infections (36)	2.00 (2)	50	-	-
Proportion of patients with toxic or sub-therapeutic aminoglycoside concentration whose dosage has been adjusted prior to next dose (6)	2.00 (1)	85.7	1.50 (1)	90
Proportion of prescriptions for restricted antibiotics that are concordant with hospital approved criteria (6)	2.00 (2)	71.4	-	-
Proportion of patients prescribed hospital initiated warfarin whose loading doses are consistent with a hospital approved protocol (6, 37)	3.00 (2)	35.7	-	-
Percentage of patients who received at least 1 pain management intervention during heel sticks, PIV	3.00 (2)	50	-	-

insertions, venipunctures, umbilical arterial catheterisations, nasogastric tube placements and EET suctioning (33)				
Percentage of all defined procedures that were treated with a pain treatment intervention (33)	3.00 (2)	50	-	-
Administration errors: identification and resolution of unintended departure from recommended administration practices per patient per bed day (6)	2.00 (2)	71.4	-	-
Proportion of patients families that have had a face-to-face discussion about medicines related information (6)	2.00 (2)	64.3	-	-
Incidence of nosocomial infection (23, 38, 39)	2.50 (2)	50	-	-
Percentage of medication orders that include the correct dose per kilogram (or body surface area) AND an effective and safe total dose (6)	2.00 (2)	71.4	-	-
Incidence of neonatal sepsis (38, 39)	2.00 (1)	64.3	-	-
Mean length of stay (38)	2.50 (1)	50	-	-
Days on TPN (23, 38)	2.00 (1)	78.6	2.00 (3)	70
Growth velocity (daily weight gain) (23, 38)	3.00 (1)	42.9	-	-
Mortality rates (38-41)	3.00 (1)	42.9	-	-
Medication Error rates/reports per 6 months (42)	2.00 (1)	92.9	1.50 (1)	90
Adverse Drug Event rates/reports per 6 months (42)	2.00 (1)	78.6	1.00 (1)	90
Number of pharmacotherapy related critical incident /root case analyses performed per 6 months (21, 25)	2.00 (2)	71.4	-	-
Percentage of medication guidelines that have been updated within the previous 1-2 years △	-	-	1.00 (0)	100
Percentage of medications used in the NICU for which a medication guidelines is available △	-	-	1.50 (1)	100
Percentage of infants with therapeutic hypothermia who have appropriate doses and levels of Gentamicin △	-	-	1.50 (2)	60
Percentage of infants who receive appropriate pain management △	-	-	2.00 (1)	70
Proportion of infants that had antibiotics ceased at the earliest opportunity △	-	-	1.50 (2)	70
Proportion of infants that were monitored with pain scores △	-	-	2.00 (2)	70

Proportion of infants that received doses of surfactant when indicated and/or did not receive surfactant when not indicated △	-	-	2.00 (2)	70
Proportion of infants that had their coagulation profiles checked by a pharmacist △	-	-	2.50 (1)	50
Proportion of infants that had their electrolytes measured within 5 days of starting Frusemide △	-	-	2.00 (1)	80
Proportion of patients that had Ranitidine ceased immediately when the indication was no longer present △	-	-	2.50 (2)	50
Duration of treatment △	-	-	1.50 (2)	60
Proportion of infants who received a targeted treatment (for a confirmed indication) vs. empirical treatment △	-	-	1.50 (1)	90
Proportion of infants who experienced a medication related adverse effect and the time required until review of medication and/or treatment reversal of adverse effect △	-	-	1.50 (1)	90

※ 1 – 5 Likert rating scale used

- Indicator that did not achieve consensus in initial round

△ Indicator proposed by panellists