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Quality Pharmacy Services And Key Performance Indicators in Polish Neonatal Intensive Care Units: A Delphi Approach

INTRODUCTION

Despite its widespread adoption and implementation in the US, UK, Australia and Canada, clinical pharmacy practice within hospital settings in Poland is still in its infancy [1-6]. Indeed, hospital pharmacy practice as a whole is predominantly limited to dispensary-based activities focussed on the safety and effectiveness of medicines rather than patient-centred care. Pawłowska et.al. highlighted that only 7% of hospital pharmacists surveyed had contact with patients, and that their roles in the hospital were mainly associated with the provision of medicines [7]. Piecuch further indicated that pharmacists are not involved in the provision of direct, individualised care to patients and as such often have little to no input in the pharmacotherapy decision-making process [8]. Whilst pharmacists have the ability to acquire post-graduate specialisations in clinical and hospital pharmacy, their skills in these fields are unable to manifest on hospital wards due to several barriers. These include: lack of appropriate legislation specifically outlining the authority of the pharmacist in this setting, insufficient staffing of hospital pharmacies, lack of financing for additional pharmaceutical care services as well as a limited awareness of other members of the healthcare team towards the possible benefits of pharmacist involvement in the hospital structure [9].

Studies worldwide indicate that pharmacists are an integral component of patient care, and demonstrate their impact upon optimising patient outcomes, improving the rational use of resources and decreasing medication error rates [10, 2, 11, 12]. This is of particular importance to high-risk hospitalised patient groups, especially infants admitted to the neonatal intensive care unit (NICU). These children have a high level of exposure to medications throughout their admission, and due to their unique pharmacokinetic and physical characteristics, are prone to medication misadventure which may have significant impact upon their development [13]. Studies show that pharmacists in the NICU: have prevented significant errors from occurring, including 10 – 100 fold overdoses; can optimise pharmacotherapy, such as total parenteral nutrition regimens (TPN); and are highly valued by doctors and nurses on the ward [14-16, 13, 17, 18].

However, clinical pharmacy services are relatively absent in the Polish hospital setting, in comparison to other countries. This raises questions relating to the quality pharmaceutical care being provided to NICU patients, and whether the services being provided are achieving the best possible patient outcomes. Healthcare service quality is most commonly measured

via key performance indicators (KPIs) or other quality indicators that assess practice performance, helping to identify where improvements are needed to minimise service gaps[19]. These indicators are formulated using nationally or internationally agreed clinical practice guidelines based on meaningful, reliable evidence [20]. Currently, there is no literature describing what a quality level of practice entails in Polish NICUs, nor are there any means of currently measuring the quality of pharmaceutical care provided to NICU patients.

The European Directorate for the Quality of Medicines and Healthcare (EDQM) has coordinated the development of generally applicable indicators for the implementation of pharmaceutical care in Europe [21]. However, these indicators have been designed for use both in community and hospital settings, and are not specific to sub-speciality patient groups, such as neonates. As such, apart from the pharmaceutical law regulating which activities should be provided by hospital pharmacies to all inpatients, there are no guidance documents to support hospitals pharmacists in meeting the needs of the neonatal patient population and they are unable to measure their performance to benchmark against other settings nationally. Scobie et.al. state that the measurement of safety and quality is fundamental to health delivery [22].

AIM OF THE STUDY

The purpose of this Delphi study was to identify essential pharmacist roles and KPIs that reflect quality pharmaceutical care in a Polish NICU setting. Specific objectives were to:

- identify a set of pharmacy-based key performance indicators in Donabedian's domains of process, structure and outcome that can be used to benchmark the quality of pharmaceutical care provided to patients in Polish NICU settings.
- identify the minimum level of pharmacy services that should be consistently provided to NICU patients.

ETHICS APPROVAL

Ethics approval was sought and obtained from the respective ethics committees at the University of Technology Sydney (UTS), Australia (UTS HREC REF NO. ETH17-1584) and the Medical University of Gdansk (GUMed), Poland (GUMed HREC REF NO. NKBBN/424-184/2017). Panellists were assured of confidentiality and were informed that their responses would be de-identified.

METHOD

PANEL SELECTION

Experts were recruited using a combined purposive and criterion sampling approach [23]. Potential panellists were identified from neonatal organisations as well as data papers and articles publicly available registers in Poland including the Polish Register of Facilities delivering Medical Activities (Rejestr Podmiotów Wykonujących Działalność Leczniczą – RPWDL) to identify hospitals with neonatal intensive care units.

The expert panel was made up of key stakeholders involved in NICU care, and were defined as: 1) hospital pharmacists, or pharmacists based in academia, as well as leading medical doctors and nurses, 2) people who had experience with hospital based clinical pharmacy services, and where possible, 3) people with experience in the NICU.

COLLATING PHARMACY-SENSITIVE INDICATORS

To find quality and pharmacist-specific key performance indicators used in neonatal and paediatric care settings, a review of the literature was undertaken [24]. Due to the nature of hospital pharmacy practice in Poland (i.e., less well established level of pharmaceutical care and clinical practice; focused mainly on dispensary-based activities), the proposed indicators were carefully considered for relevance to the Polish system. Two of the researchers (NK, IP) consulted a small group of Polish health professionals to assess the applicability of indicators to current Polish pharmacy practice and canvas whether the indicators would be understood by panellists in this country. Only those indicators that pharmacists would reasonably be expected to understand in the context of current Polish pharmacy practice were included. This was based on a recent study conducted by Krzyzaniak et.al. who highlighted that pharmaceutical care services delivered to NICUs in Poland were mostly dispensary based, i.e., compounding, with little to no involvement in clinical, ward-based roles. Therefore, many concepts and terms such as medication reconciliation, medication action plans are foreign to Polish pharmacists. In order to minimise the incidence of misunderstanding as well as any social desirability bias, indicators that contained concepts and terms that were abstract to the Polish pharmacy practice setting were excluded. Overall, a modified list of 32 indicators, categorized according to Donabedian's domains of structure, process and outcome, was provided to Polish panellists.

DATA COLLECTION

The surveys used in the Delphi rounds were structured on the basis of two previous studies by Fernandes et.al. and Wilson et.al. who published a set of pharmacy and nursing indicators respectively for hospital practice [23, 26].

The study comprised two Delphi rounds, structured as two consecutive surveys delivered between August and September 2017 via the online software program Survey Monkey™. Mullen highlights that when a sample size is small, often no more than one round is needed to obtain consensus. However, in order to allow feedback and 'revision of responses', a minimum of two rounds are recommended. As the target group of individuals for this study practice within a sub-specialty of care, there are a subsequent limited number of possible participants. Therefore, a two-round Delphi survey was considered upfront as the most appropriate to ensure maximum response rate as well as to minimise the possibility of participant fatigue. Each Delphi round comprised three parts. These included: panellist demographics (Part A), essential pharmacist roles in the NICU (Part B) and a baseline set of key performance indicators (Part C). Panellists were asked to rate each item on a 5 point Likert scale ranging from strongly agree (1) to strongly disagree (5) against pre-set criteria (Figure 1).

At the end of Round 1, panellists were invited to suggest additional indicators/roles and to provide any comments. These suggestions were used to rephrase questions and refine the list of indicators/roles for inclusion in the next round of surveys. In Round 2, the modified set of KPIs/roles were rated again using the same selection criteria.

Each Delphi round was open for 2 weeks, and reminders were emailed at the beginning and at the end of each 2-week period. Each survey took approximately 15 minutes to complete. The non-completion of the previous round did not rule out panellists from contributing to the following round. Round 1 was piloted by a small number of pharmacists.

DATA ANALYSIS

Descriptive statistics (percentages, frequencies) were used to analyse the quantitative data, via the Statistical Package for the Social Sciences (SPSS) Version 22™. All Likert scale 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. Consensus was considered to have been reached when 75% or more of panellists rated 'agreed' for an indicator. If an indicator did not reach this consensus, it was not included in the subsequent round. All items with $\geq 75\%$ agreement were included in the final set. According to Keeney et.al. a consensus level of 75% is considered to be the minimum in ensuring accuracy and confidence in the consensus achieved by participants [30].

RESULTS

Overall, of the 29 panellists who agreed to participate in this research, only 16 became expert panellists and participated in at least one Delphi round (response rate = 55.2%). The remaining individuals did not respond. Seven experts completed both Delphi rounds. Approximately half of panellists in each round were pharmacists or directors of pharmacy, and the remaining panellists comprised neonatologists, nurses, midwives and academic pharmacists (Table 1).

ROUND 1

A total of 13 panellists completed round 1.

PHARMACIST ROLES

A list of 30 pharmacist roles was presented to panellists. Overall, respondents strongly agreed to the majority of the proposed roles. Polish experts achieved consensus for 28 roles; two services pertaining to evaluating laboratory tests (69.2%) and immunisations (46.2%) were excluded (Table 2). Using the 5-point Likert scale, the range of median scores was from 1.00 (IQR = 0) for extemporaneous compounding to 3.00 (IQR = 2) for involvement in immunisations. A new role was proposed for inclusion in the next round, that being the preparation of individual, unit dose parenteral and oral dose forms for neonatal patients.

PHARMACY-BASED KEY PERFORMANCE INDICATORS FOR QUALITY PHARMACEUTICAL CARE IN THE NICU

Polish experts were presented with 10 structure, 11 process and 11 outcome indicators (total = 32). A consensus of $> 75\%$ was achieved for 25 items (Table 3). Therefore, 7 items were excluded from subsequent analysis. These items included: dedicated area/station on the ward for the pharmacist (69.2%), number of education/training sessions provided by pharmacists relating to pharmacotherapy in the NICU for other health professionals (69.2%),

proportion of pharmacists involved in NICU related clinical research (61.5%), monthly audit of episodes of ineffective empiric antibiotic therapy (organism/antibiotic mismatch) (69.2%), proportion of infants receiving appropriate dosing and timing of perioperative prophylaxis (69.2%), proportion of patients families that have had a face-to-face discussion about medicines related information (53.8%) and incidence of neonatal sepsis (61.5%).

Panellists did not recommend any new indicators for inclusion in round 2. Median scores for panellists ranged from 1.00 (IQR = 0) to 2.00 (IQR = 2).

ROUND 2

A total of 12 panellists completed round 2.

PHARMACIST ROLES

Consensus was reached for 28 roles (Table 2). Overall, panellists responded strongly to the proposed pharmacist roles, with the majority responding 'strongly agree'. Polish experts most strongly responded to pharmacist roles in the provision domain, including: extemporaneous compounding (100%, Median = 1.00), stocking the ward with medication (100%, Median = 1.00) and the newly added role, preparing unit doses for parenteral and oral medicines (100%, Median = 1.00). Counselling of the families of NICU patients did not reach consensus by Polish panellists (58.3%); median scores achieved by Polish experts ranged from 1.00 (IQR = 0) – 2.00 (IQR = 2).

PHARMACY-BASED KEY PERFORMANCE INDICATORS FOR QUALITY PHARMACEUTICAL CARE IN THE NICU

A total of 27 indicators were rated by panellists, and were split evenly across Donabedian's domains, with 9 structure, 9 process and 9 outcome indicators. Consensus was reached for 25 indicators. Median scores were similar to the previous round for most indicators and ranged from 1.00 (IQR = 0) to 2.00 (IQR = 2). Polish panellists responded strongly throughout each of the structure, process and outcome domains, with consensus higher than 90% for the majority of indicators. Two indicators in the outcomes domain did not achieve consensus: percentage of patients who received at least 1 pain management intervention during heel sticks, PIV insertions, venipunctures, umbilical arterial catheterizations, nasogastric tube placements and EET suctioning (66.7%) and proportion of prescriptions for restricted antibiotics that are concordant with hospital approved criteria (66.7%).

DISCUSSION

This is the first study in Poland to identify a set of pharmacist roles and KPIs that may be useful in structuring and guiding future practice in the NICU. Furthermore, this research is the first of its kind to combine the concept of clinical pharmacy practice and a sub-specialty of pharmacy, such as the NICU setting, in Poland.

In considering pharmacy services, experts highly valued traditional pharmacy roles, such as dispensing and extemporaneous compounding, but were still highly supportive of roles in the other domains, such as educational and clinical services, to be included as essential for NICU practice. These traditional perceptions may stem from ingrained practice cultures in Poland, whereby pharmacists are predominantly perceived to be based in the dispensary [7]. However, it is extremely encouraging that, despite these attitudes, medical and pharmacy staff alike are open to the pharmacists providing ward-based services to the NICU and being involved in the pharmacotherapy decision-making process. Similarly, experts expressed strong levels of support for the key performance indicators. This is of particular significance, as currently Poland does not have any national initiatives for quality assurance for hospital pharmacy practice. As such, it is encouraging that despite having little to no experience with clinical pharmacy KPIs, the experts were extremely enthusiastic towards selecting indicators, with high levels of agreement for those remaining in the final list.

These findings demonstrate that there is a need to determine a minimum standard of practice for Polish pharmacists to encourage the progression and standardisation of hospital pharmacy services to meet the level of practice seen worldwide. According to the World Health Organisation (WHO), the concept of health equity is a priority for healthcare systems worldwide, and it is a fundamental right of each human being to receive the highest standard of health care [31, 32]. The literature highlights that Polish pharmacists are aware of the differences in practice evident between Poland and other industrialised countries, such as Australia and the UK [8, 33, 9]. However, Urbanczyk highlights that the clinical pharmacist is simply not viewed by policy-makers or other healthcare professionals as a medicines expert, and does not hold the relevant position or authority to be able to directly influence pharmacotherapy [9]. This is a point of concern, as the studies demonstrate the positive contributions of pharmacist involvement in pharmacotherapy-related decision making and in reducing medication errors in the NICU [14, 34, 17]. Neonatal patients are a priority for each healthcare profession, and the key to stepping forward in the Polish setting is to accept the pharmacist as an essential member of the interdisciplinary therapeutic team

and then develop strategies to embed pharmacists into this setting. The International Pharmaceutical Federation (FIP) endorses the development of standardised national pharmacy guidelines and services to identify good practices and adopt coherent policies to promote practice consistency [35]. The findings presented here may be useful for the future development of quality pharmacy practice resources in Poland. These resources are important for quality improvement activities, such as benchmarking to demonstrate differences between settings on a national scale, pharmacy practice accreditation, as well as enhancing transparency about hospital pharmacy service quality, which are important for the progression of hospital pharmacy practice in Poland [36]. The findings of this research may be transposable to practice in other countries, particularly those in Eastern Europe, as the healthcare system issues faced in Poland are similar to those experienced in these countries. This may be attributed to the impact of historical events upon the political, economic and societal climate.

LIMITATIONS

There are several limitations to consider. First, the expert panels comprised only a small number of panellists. This may be attributed to the very specific nature of this research, which may have deterred potential respondents from contributing their expertise. Therefore, this may affect the generalisability of the results and they should be interpreted with caution.

Despite the small size of the panel, care was taken to ensure that the experts who responded to the surveys reflected a range of expertise and contributed a diverse range of neonatal and pharmacy experiences. However, this panel cannot be said to be representative of each profession in Poland.

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

Furthermore, the key performance indicators are not a comprehensive set of indicators for the assessment of hospital pharmacy practice in a Polish context. They simply represent consensus amongst experts in defining a preliminary quality level of pharmacy practice in the NICU.

CONCLUSION

The baseline quality indicators and pharmacy services identified, give insight in to what experts deem to be essential aspects of quality pharmaceutical care in Polish NICU settings. These findings are the first to consider the integration of the clinical pharmacist into NICU settings in Poland. The practical considerations of applying these indicators will need careful consideration before they can be seen as valid performance measurement tools. There are several barriers in the current healthcare system limiting pharmacy services on the NICU, which require attention. Further research is needed to established the validity, acceptability and feasibility of the proposed indicators to practice on a national level, as well as to develop strategies to further integrate the pharmacist into the NICU therapeutic team.

CONFLICTS OF INTEREST: The authors declare no conflicts of interest.

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TABLE 1 – CHARACTERISTICS OF EXPERT PANEL

	ROUND 1	ROUND 2
	POLAND (%)	POLAND (%)
NUMBER OF PANELLISTS	13	12
GENDER OF PANELLISTS		
Female	12 (92.3)	11 (91.7)
SPECIALISED QUALIFICATIONS RELATING TO NEONATES		
Yes	5 (38.5)	4 (33.3)
No	8 (61.5)	8 (66.7)
Specialisation in neonatology/paediatrics	1	3
Hospital/Clinical Pharmacy specialisation	3	1
Postgraduate certificate in neonatal nursing	1	
POSITION IN THE HOSPITAL		
NICU pharmacist/Director of pharmacy	9 (69.2)	6 (50)
Pharmacist in academia	2 (15.4)	2 (16.7)
Neonatologist/NICU Doctor	1 (7.7)	4 (33.3)
NICU Nurse/Midwife	1 (7.7)	0
PARTICIPANTS WHO COMPLETED BOTH DELPHI ROUNDS		
NICU pharmacist/Director of pharmacy		6
Pharmacist in academia		2
Neonatologist/NICU Doctor		1
EXPERIENCE		
Between 1-5 Years	3 (23.1)	2 (16.7)
Between 6-10 Years	1 (7.7)	1 (8.3)
> 10 Years	9 (69.2)	9 (75)

Table 2 – Roles that pharmacists should perform in the NICU according to the Polish 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 (0)	100	1.00 (0)	100
Attendance at non-clinical meetings i.e. Drug and Therapeutics Committee	1.00 (1)	100	1.00 (1)	100
Conducting quality assurance measures i.e. drug usage evaluations, workload documentation, auditing	1.00 (1)	92.3	1.00 (1)	100
Management of the drug budget	2.00 (1)	100	1.00 (1)	91.7
Evaluation, selection and purchasing of pharmaceuticals for the unit	1.00 (0)	100	1.00 (0)	100
Development of drug policies/protocols/guidelines for the NICU	1.00 (1)	100	1.00 (1)	100
CLINICAL ROLES				
Patient medication chart review	1.00 (0)	100	1.00 (1)	100
Participation in medical ward rounds	1.00 (1)	84.6	1.50 (1)	83.3
Monitoring the efficacy of pharmacotherapy in patients	1.00 (1)	84.6	2.00 (1)	91.7
Documenting/monitoring side-effects and Adverse Drug Events/Reactions	1.00 (0)	100	1.00 (0)	100
Documenting Medication Errors	1.00 (1)	100	1.00 (1)	100
Evaluating patients clinical laboratory tests	2.00 (2)	69.2	-	-
Therapeutic Drug Monitoring (TDM)	1.00 (1)	92.3	2.00 (1)	91.7
Immunisations	3.00 (2)	46.2	-	-
Monitoring Total Parenteral Nutrition (TPN)	1.00 (0)	100	1.00 (0)	100
Participation in clinical meetings	2.00 (1)	84.6	2.00 (1)	83.3

Calculating and recommending doses and dosing schedules for specific patients	1.00 (1)	84.6	1.00 (1)	91.7
Assisting doctors in prescribing off-label/unlicensed medicines	1.00 (1)	92.3	1.00 (1)	100
Identifying and performing interventions for individual patients to prevent or resolve drug therapy problems i.e. interactions, incompatibilities, allergies etc.	1.00 (0)	100	1.00 (1)	100
Recommending drugs and contributing to the pharmacotherapy decision making process for specific patients	1.00 (1)	100	1.00 (1)	100
Collaborating and discussing specific patients with doctors and nurses	1.00 (1)	92.3	1.00 (1)	100
EDUCATIONAL ROLES				
Providing training/in-services for other health professionals on NICU related topics and drug related problems	1.00 (1)	84.6	1.00 (1)	91.7
Contributing to and/or attending NICU related conferences	1.00 (0)	100	1.00 (1)	100
Involved in clinical trials	1.00 (1)	100	1.00 (1)	91.7
Involved in research related to neonatal pharmacotherapy	1.00 (1)	100	1.00 (1)	91.7
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 (2)	76.9	2.00 (2)	58.3
PROVISION OF MEDICINES ROLES				
Dispensing prescriptions	1.00 (0)	100	1.00 (0)	100
Extemporaneous compounding of formulations for the NICU	1.00 (0)	100	1.00 (0)	100
Stocking the ward with essential medicines/house-keeping activities i.e. checking expiry dates, fridge temperatures etc.	1.00 (0)	100	1.00 (0)	100
Preparing unit doses for parenteral and oral medicines †	-	-	1.00 (0)	100
* 1 – 5 Likert rating scale used				
† Role proposed by panellists				

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 [37]	1.00 (2)	76.9	2.00 (2)	75
NICU pharmacist holds qualifications in clinical pharmacy or NICU/paediatric pharmacy [38-40]	2.00 (2)	76.9	1.50 (1)	91.7
FACILITIES/ENVIRONMENT/RESOURCES				
Dedicated area/station on the ward for the pharmacist that is a well-lit, with sufficient workspace, minimal distractions [41]	2.00 (2)	69.2	-	-
Availability of suitable fridges for vaccines and TPN on the ward [42]	1.00 (1)	92.3	1.00 (1)	91.7
Direct availability on the ward of essential medicines for specific use within the NICU [43]	1.00 (1)	100	1.00 (1)	91.7
Availability of written policies/protocols/guidelines for high-risk medications i.e. antibiotics, pain-relief, parenteral nutrition [39, 44, 43, 41]	1.00 (0)	100	1.00 (0)	100
Availability of clear policies on how to prescribe, dispense, administer and monitor medications in the NICU [41]	1.00 (0)	100	1.00 (1)	91.7
Availability of emergency medicines sheets, with listed doses per weight [45, 46]	1.00 (0)	100	1.00 (0)	100
Availability of standard neonatal/paediatric references for use in the selection, use and evaluation of medications i.e. textbooks (BNF P, Neofax), online resources [41]	1.00 (0)	100	1.00 (0)	100
Availability of electronic medication error and adverse drug event reporting (systems) [39, 47, 44, 41]	1.00 (0)	100	1.00 (0)	100
* 1 – 5 Likert rating scale used				

TABLE 4 – PROCESS INDICATORS

	ROUND 1		ROUND 2	
	MEDIAN (IQR) *	CONSENSUS %	MEDIAN (IQR) *	CONSENSUS %
Proportion of unlicensed/off-label prescriptions that involved the consultation of a pharmacist [39]	2.00 (1)	92.3	2.00 (1)	100
Proportion of Adverse Drug Events that were identified, monitored, rectified, prevented, and reported per number of admissions [39, 47, 44]	1.00 (1)	100	1.00 (1)	91.7
Proportion of dispensing errors identified and rectified by pharmacist per number of admissions [48]	2.00 (2)	76.9	1.00 (1)	91.7
Number of education/training sessions provided by pharmacists relating to pharmacotherapy in the NICU for other health professionals [39, 47, 44, 41, 49, 50]	2.00 (2)	69.2	-	-
Number of pharmacotherapy related consultations provided to medical personnel by pharmacists [39, 47, 44, 41, 49, 50]	1.00 (1)	92.3	1.00 (1)	100
Proportion of TPN regimens that have been monitored/optimised by a pharmacist [39, 43]	1.00 (0)	92.3	1.00 (0)	100
Proportion of IV medications that have been monitored by a pharmacist [39]	1.00 (1)	92.3	1.00 (1)	100
Proportion of pharmacists involved in NICU related clinical research [47, 44]	2.00 (2)	61.5	-	-
Proportion of dose calculations checked by pharmacist before administration [41]	2.00 (2)	76.9	1.00 (1)	100
Proportion of patients whose therapy is being monitored by a pharmacist [51]	2.00 (2)	76.9	2.00 (1)	100
Proportion of extemporaneous medications that have been prepared and monitored by a pharmacist for the NICU [41]	1.00 (0)	100	1.00 (0)	100
* 1 – 5 Likert rating scale used				

TABLE 5 – OUTCOME INDICATORS

	ROUND 1		ROUND 2	
	MEDIAN (IQR) *	CONSENSUS %	MEDIAN (IQR) *	CONSENSUS %
Monthly audit of episodes of ineffective empiric antibiotic therapy (organism/antibiotic mismatch) [52]	1.00 (2)	69.2	-	-
Proportion of infants receiving appropriate dosing and timing of perioperative prophylaxis [52]	2.00 (2)	69.2	-	-
Monthly audit of episodes of antibiotic-associated adverse events [52]	1.00 (2)	76.9	1.00 (1)	83.3
Proportion of prescriptions for restricted antibiotics that are concordant with hospital approved criteria [51]	1.00 (1)	84.6	1.00 (2)	66.7
Percentage of patients who received at least 1 pain management intervention during heel sticks, PIV insertions, venepunctures, umbilical arterial catheterizations, nasogastric tube placements and EET suctioning [53]	2.00 (2)	76.9	2.00 (2)	66.7
Proportion of patients families that have had a face-to-face discussion about medicines related information [51]	2.00 (2)	53.8	-	-
Percentage of medication orders that include the correct dose per kilogram (or body surface area) AND an effective and safe total dose [51]	1.00 (1)	92.3	1.00 (1)	91.7
Incidence of neonatal sepsis [54, 55]	2.00 (2)	61.5	-	-
Medication Error rates/reports per 6 months [48]	1.00 (1)	92.3	1.00 (1)	83.3
Adverse Drug Event rates/reports per 6 months [48]	1.00 (1)	84.6	1.00 (1)	91.7
Costs of Therapy [48]	2.00 (1)	92.3	1.00 (2)	75
* 1 – 5 Likert rating scale used				

Figure 1 – Criteria used by the expert Delphi panel to assess essential pharmacy services and key performance indicators for NICU practice

