Clinical and Experimental Health Sciences

Clinical Pharmacist's Input in Identification and Resolution of Drug-Related Problems in the Neonatal and Pediatric Intensive Care Units

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ABSTRACT

Objective: Patients in the pediatric intensive care unit (PICU) and neonatal intensive care unit (NICU) are at high risk for drug-related problems (DRPs). It is crucial to assess pharmacotherapy with the active involvement of clinical pharmacist (CP). The study aims to investigate the effect of CPs in identifying and resolving DRPs in the NICU and PICU settings.

Method: This study with a retrospective and prospective design was conducted within the timeframe of October 2020 – August 2021 at the NICU (n=200) and PICU (n=200) of a university-affiliated state hospital in Türkiye. The Pharmaceutical Care Network Europe (PCNE) Classification V9.1. was used for classifications of the DRPs. DRPs identified by the CP and the regarding intervention proposals were communicated with the attending physician.

Results: A total of 1247 DRPs were identified for all patients. The median (interquartile range [IQR]) number of DRPs per patient was 3 (1-6) for the pediatrics and 1 (0-1) for the neonates (p<.001). The most frequently observed DRPs in the prospective part of this study were 'drug selection' (41%) in the PICU, while it was 'dose selection' (34%) in the NICU.

Conclusion: The study findings demonstrate role of the CPs in the NICU and PICU settings in identifying and resolving DRPs.

Keywords: Clinical pharmacist, drug-drug interactions, drug-related problems, neonatal intensive care unit, pediatric intensive care unit

1. INTRODUCTION

The Pharmaceutical Care Network Europe (PCNE) defines 'drug-related problems (DRPs)' as events or circumstances involving drug therapy that actually or potentially interferes with desired health outcomes (1). The risk of developing DRPs is higher in pediatric patients than in adults since there is a higher rate of off-label drug use and pharmacokinetic and pharmacodynamic properties of drugs are affected by age-specific characteristics such as physiological immaturity and weight changes (2-4). In a cohort study, potential adverse drug events (ADEs) were found to be three times higher in pediatrics than in adults, and a significantly higher rate of potential ADEs was reported in neonates in the neonatal intensive care unit (NICU) (5). DRPs may worsen the clinical outcomes of the patient, prolong hospital stays, lead to the emergence of new complications and increase morbidity, mortality and healthcare costs (6, 7). Although the risk of DRPs is high in the NICU and pediatric intensive care unit (PICU), most DRPs are predictable and preventable (8, 9).

Despite this high risk, studies conducted in the NICU and PICU on clinical pharmacists' (CPs) involvement in the identification and resolution of DRPs remain limited. It is emphasized in the literature that the most common DRPs detected by CPs in the NICU and PICU are generally related to drug selection and/or dose selection (10-12). Additionally, issues such as lack of pediatric oral dosage forms, drug administration through enteral feeding tubes, interactions between enteral or parenteral nutrition solutions and administered drugs, potential drug-drug interactions (pDDIs), and intravenous drug incompatibilities are frequently observed (13-15). Studies from India, Brazil, and United States revealed that CPs working in collaboration with the multidisciplinary team identified DRPs in the NICU and PICU and contributed to the reduction of ADEs and prescription-related costs with their interventions (7, 16, 17). CPs play a critical role in optimizing pharmacotherapy by providing recommendations on dose adjustments based on patients' hepatic and renal function, selecting appropriate dosage forms,

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modifying drug administration routes (e.g., continuous infusion and bolus administration), preventing medication duplication, discontinuing or introducing medications, monitoring pDDIs, and conducting therapeutic drug monitoring, thereby reducing or preventing DRPs (10, 12).

In Türkiye, studies revealing the positive impact of CPs in the identification and resolution of DRPs in adult ICUs and pediatric wards exist (18, 19); however, to our current knowledge, there is a lack of such studies conducted in the NICU and PICU. The study aims to investigate the impact of a CP in the identification and resolution of DRPs in the NICU and PICU, through a two-phase (retrospective and prospective) study design.

2. METHODS

2.1. Study Design

This study with a bi-directional (retrospective and prospective) design was conducted within the timeframe of October 2020 – August 2021 at the NICU and PICU of a university-affiliated state hospital in Türkiye. It was granted ethical approval by the Ethics Committee of Marmara University, Institute of Health Sciences, Noninvasive Clinic Ethics Committee (Approval date 16.03.2020; Number: 41). Before starting the study, legal guardians of neonatal and pediatric patients were informed, and their written and verbal consents were obtained.

2.2. Study Population

Sample size was calculated via an online calculator at a confidence level of 80% and a margin of error of 5%. Population proportions were considered as 9.07% for the neonates, which was the NICU admission rate reported in the literature (20) and as 15.5% for the pediatric patients, which was the prevalence of PICU admission rate among hospitalized children reported in the literature (21). The minimum number of subjects to be included was calculated as 55 for the neonates and 86 for the pediatric patients. Therefore, it was planned to include 100 patients in each group.

The inclusion criteria were being under 18 years of age, staying in the NICU and PICU for at least 24 hours, and receiving at least 1 medication. The study excluded patients who were prescribed solely blood products. parenteral nutrition, electrolytes, oxygen therapy, vitamin and mineral supplements, diagnostic agents, as well as those with admitted less than 24 hours and those without any prescribed medications.

For the retrospective part, the first retrospectively consecutive 100 patients meeting the inclusion criteria from the NICU (n=100) and the PICU (n=100) were included in the study. The retrospective patient groups were aimed to serve as control groups of the study groups. All data of the retrospective patient groups were gathered from the hospital records.

For the prospective part, the first prospectively consecutive 100 patients meeting the inclusion criteria and whose parents after being informed about the study gave their consent, from the NICU (n=100) and the PICU (n=100) were included in the study. Retrospective NICU and PICU patients were assigned as 'Control Group N and 'Control Group P', respectively, and prospective NICU and PICU patients participating in the study were assigned as 'Study Group N and Study Group P', respectively.

2.3. Data Collection

Data such as age, gender, weight, diagnosis, length of stay in the NICU or PICU were recorded for each patient. The International Statistical Classification of Diseases and Related Health Problems version 11 (WHO-ICD 11) was used for recording the diagnosis of the patients.

A comprehensive list of all medications (including prescription and non-prescription medications; nutritional and herbal supplements) was created for each patient. Clinical and medication-related information such as the dosage form of the medication or for how long and for which indication the medication has been used were obtained from the patient records. Data on routine laboratory test results and daily medication orders throughout the patients' hospitalization period were gathered right after the daily ICU rounds. The age of the neonate patients was expressed as 'last menstrual period (LMP) – based gestational age' in terms of weeks.

2.4. Interventions

In this study, the CP (ZYA; Ph.D. candidate) actively worked in the NICU and PICU and closely followed up with the patients from their admission to discharge or demise. In the prospective part, CP attended medical rounds in the NICU and the PICU 3-5 days per week, during which patients were assessed based on treatment effectiveness, treatment safety, drug selection, drug formulation, dose determination, and treatment duration.

Evidence-based guidelines, and databases such as UpToDate®, Micromedex®, and Medscape® were used as up-to-date resources for identifying DRPs. Lexidrug™ database was used for the identification of pDDIs. Lexidrug™ D-level interactions (i.e., DDIs necessitating consideration of therapy modification) and X-level interactions (i.e., DDIs necessitating avoidance of combination) were considered pDDIs.

Using the Turkish version of the PCNE Classification for Drug-Related Problems V9.1 patients' current treatments were assessed for the presence of any potential and/or manifest DRPs. For each patient, the number of administered drugs, the presence and characteristics of DRPs were recorded and analyzed. Following discussions with the attending physician, it was decided that off-label drug use would not be classified as a DRP, and therefore, off-label drug use was not recorded under the category "C1.2 (No indication for drug)" in the DRP list. The presence of pediatric polypharmacy, defined as the simultaneous use of two or more drugs by a patient for more than one day, a definition commonly used in the pediatric population, was also recorded and analyzed (22). The CP communicated with the attending physician regarding the DRPs she identified as well as intervention proposals for the resolution of each DRP. Due to

the setting of the study, no intervention was proposed at the patient level.

2.5. Data Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), Version 11.5 (SPSS Inc., Chicago, IL). According to the results of the Kolmogorov-Smirnov test, it was determined that continuous variables showed non-normal distribution. Data for continuous variables were presented using median (interquartile range [IQR]) values. Differences between two groups were compared using the Mann Whitney U test, which is used for nonparametric data. Differences between four groups were compared using the Kruskal Wallis H test. Whether the presence of different clinical conditions posed a risk for DRPs was determined using the Odds ratio. A p value <.05 was considered statistically significant.

3. RESULTS

A total of 400 patients were included in the study (Study Group P [n=100]; Control Group P [n=100]; Study Group N [n=100]; Control Group N [n=100]). In table 1 presents major clinical and medication-related patient characteristics.

Table 1. *Major clinical and medication-related patient characteristics*

Patient Characteristics	Study Group P (n=100)	Control Group P (n=100)	p	Study Group N (n=100)	Control Group N (n=100)	p
Age (months); median (IQR)	34.50 (10.25-100.50)	27 (10.00-149.25)	NS	-	-	-
Gestational age (weeks); median (IQR)	-	-	-	38 (37-39)	38 (35-39)	NS
Male gender; n (%)	52 (52)	56 (56)	NS	57 (57)	56 (56)	NS
Length of hospital stay (day); median (IQR)	3 (2-6)	5 (2.0-11.5)	**.008**	8 (6.00-11.75)	7 (5.00-9.75)	NS
Number of drugs used; median (IQR)	7 (4-12)	10 (6-14)	**.005**	4 (3-5.75)	4 (3-5)	NS
Number of drug-related problems; median (IQR)	2 (1-5)	3 (2-6)	**.018**	0.5 (0-1)	1 (1-2)	**< .001**
Mechanical ventilation; n (%)	58 (58)	67 (67)	NS	52 (52)	35 (35)	**.015**

Study Group P: prospective pediatric intensive care unit patients; Control Group P: retrospective pediatric intensive care unit patients; Study Group N: prospective neonatal intensive care unit patients; Control Group N: retrospective neonatal intensive care unit patients; NS: non-significant

The median (IQR) age of all pediatric patients was 30.50 (10.00-127.75) months and 54% of them were male. The control and study groups had similar age and gender distributions (p>.05, for both). The two most frequently reported diagnoses in the PICU were diseases of the respiratory system (45% of Control Group P and 38% of Study Group P), and diseases of the nervous system (21% of Control Group P and 14% of Study Group P) (p>.05, for both). The median (IQR) length of hospital stay was 4 (2.00-7.75) days and the median (IQR) number of drugs used was 8 (5-13) for PICU patients. The median (IQR) length of hospital stay and the median (IQR) number of drugs used were higher for the control group (p<.05, for both). Polypharmacy was observed in 92% of PICU patients in the prospective part and 97% of PICU patients in the retrospective part (p>.05).

The median (IQR) age of all neonate patients was 38 (36-39) weeks and 56.5% of them were male. The control and study groups had similar age and gender distributions (p>.05, for both). The most frequently reported diagnoses in the NICU were certain conditions originating in the perinatal period such as lower respiratory tract infection, asphyxia, bronchopulmonary dysplasia, low birth weight, hypoxic ischemic encephalopathy, congenital anomaly, congenital pneumonia, meconium aspiration, polycythemia, jaundice, septicemia, thrombocythemia, transient tachypnea of the newborn and urinary tract infection of the newborn (94% of Control Group N and 96% of Study Group N) (p>.05). The median (IQR) length of hospital stay was 7 (6-10) days and the median (IQR) number of drugs used was 4 (3-5) for NICU patients. The median (IQR) length of hospital stay and the median (IQR) number of drugs used were similar for the study and the control groups (p>.05, for both). Polypharmacy was observed in 100% of NICU patients in the prospective and retrospective part.

Of all patients, 80.25% had at least one DRP, and pDDIs were observed in 25.5% of all patients.

A total of 1247 DRPs were detected across all groups. 2 (1-5) for the Study Group P and 3 (2-6) for the Control Group P (p<.05) whereas it was 0.5 (0-1) for the Study Group N and 1 (1-2) for the Control Group N (p <.001) were the median (IQR) numbers of DRPs per patient. The causes of the DRPs are classified in Table 2.

Interventions were proposed to the physicians for 95.5% (n=447/468) of the DRPs in Study Group P and 91.5% were accepted; while interventions were proposed for 88.7% (n=86/97) of the DRPs in Study Group N and all were accepted. Proposed interventions for Study Group P were mostly about other interventions (such as monitoring drug treatment, storage conditions, etc.) [32.7%], formulation change [22.4%], and changing the instructions for use [16.3%]; while for Study Group N these were mostly about dosage change [26.7%], other interventions [23.3%], and starting a new drug [21%] as detailed in Table 3.

The most drugs causing DRPs in the PICU were fentanyl (13.73%), midazolam (6.16%), levetiracetam (5.88%), ampicillin (3.78%) and ampicillin-sulbactam (3.64%). The most common drugs causing DRPs in the NICU were vitamin D (44.56%), ampicillin (8.07%), gentamicin (8.07%), cefotaxime (4.56%) and vancomycin (4.21%).

For 400 patients, 389 pDDIs of which 6.4% were contraindicated were identified. (Table 4).

Table 2. *Causes of the drug-related problems (n=100, for each group)*

Causes	Study P	Control P	p	Study	Control	p
	n (%)	n (%)		n (%)	n (%)	
1. Drug selection						
C1.1 Inappropriate drug according to guidelines/ formulary	8 (1.7)	6 (1.2)	NS	1 (1)	1 (0.6)	NS
C1.2 No indication for drug	7 (1.5)	4 (0.8)	NS	2 (2.1)	2 (1.2)	NS
C1.3 Inappropriate combination of drugs or drugs and herbal medications or drugs and dietary supplements	136 (29.1)	240 (46.8)	**.033**	7 (7.2)	12 (7.1)	NS
C1.4 Inappropriate duplication of therapeutic group or active ingredient	1 (0.2)	0	NS	0	0	NS
C1.5 No or incomplete drug treatment in spite of existing indication	40 (8.5)	24 (4.7)	NS	16 (16.5)	6 (3.6)	**.024**
C1.6 Too many different drugs/active ingredients prescribed for indication	0	1 (0.2)	NS	0	0	NS
2. Drug form						
C2.1 Inappropriate drug form/formulation (for this patient)	96 (20.5)	143 (27.9)	**.008**	10 (10.3)	16 (9.5)	NS
3. Dose selection						
C3.1 Drug dose too low	22 (4.7)	13 (2.5)	NS	19 (19.6)	27 (16)	NS
C3.2 Drug dose of a single active ingredient too high	19 (4.1)	5 (1)	**.028**	4 (4.1)	92 (54.4)	**< .001**
C3.3 Dosage regimen not frequent enough	30 (6.4)	31 (6)	NS	10 (10.3)	7 (4.1)	NS
C3.4 Dosage regimen too frequent	6 (1.3)	1 (0.2)	NS	0	1 (0.6)	NS
4. Treatment duration						
C4.1 Duration of treatment too short	2 (0.4)	0	NS	0	0	NS
C4.2 Duration of treatment too long	11 (2.4)	0	**.002**	0	0	NS
5. Dispensing						
C5.1 Prescribed drug not available	23 (4.9)	8 (1.6)	NS	6 (6.2)	4 (2.4)	NS
C5.2 Necessary information not provided or incorrect advice provided	1 (0.2)	0	NS	2 (2.1)	0	NS
6. Drug use process						
C6.1 Inappropriate timing of administration or dosing intervals by a health professional	15 (3.2)	35 (6.8)	NS	3 (3.1)	0	NS
C6.2 Drug under-administered by a health professional	3 (0.6)	1 (0.2)	NS	2 (2.1)	0	NS
C6.3 Drug over-administered by a health professional	0	1 (0.2)	NS	2 (2.1)	0	NS
C6.4 Drug not administered at all by a health professional	8 (1.7)	0	**.044**	6 (6.2)	1 (0.6)	NS
C6.6 Drug administered via the wrong route by a health professional	2 (0.4)	0	NS	0	0	NS
8. Patient transfer related						
C8.1 Medication reconciliation problem	4 (0.9)	0	**.044**	0	0	NS
9. Other						
C9.1 No or inappropriate outcome monitoring (incl. TDM)	24 (5.1)	0	**.001**	0	0	NS
C9.2 Other cause; specify	10 (2.1)	0	**.007**	7 (7.2)	0	**.044**
Total number of DRPs	468	513		97	169	

C: cause; DRP: drug-related problem; NS: non-significant; TDM: therapeutic drug monitoring

Table 3. *Analysis of interventions in study groups*

The planned interventions	Study Group P	Study Group N
	n (%)	n (%)
I0.1 No intervention	21 (4.5)	11 (11.3)
I1.3 Intervention proposed to prescriber	12 (2.6)	0
I1.4 Intervention discussed with prescriber	3 (0.6)	0
I3.1 Drug changed to …	2 (0.4)	1 (1)
I3.2 Dosage changed to …	43 (9.2)	23 (23.7)
I3.3 Formulation changed to …	100 (21.4)	10 (10.3)
I3.4 Instructions for use changed to …	73 (15.6)	12 (12.4)
I3.5 Drug paused or stopped	24 (5.1)	2 (2.1)
I3.6 Drug started	44 (9.4)	18 (18.6)
I4.1 Other intervention (specify)	146 (31.2)	20 (20.6)
Total number of DRPs	468	97

DRP: drug-related problem; I: intervention

Table 4*. The most common D-level and X-level potential drug-drug interactions*

PICU		NICU	
D-Level (n)	X-Level (n)	D-Level (n)	X-Level (n)
fentanyl-midazolam (58)	acetazolamide – topiramate (4)	fentanyl-midazolam (7)	fluconazole-domperidone (1)
fentanyl-levetiracetam (40)	desmopressin-dexamethasone (3)	fluconazole-midazolam (3)	
fentanyl-ketamine (26)	desmopressin – furosemide (2)	amikacin – vancomycin (3)	
fentanyl-propofol (14)	desmopressin – hydrocortisone (2)		
dexmedetomidine – midazolam (11)	topiramate-zonisamide (2)		

D-level: interactions necessitating consideration of therapy modification, according to Lexidrug™; X-level: contraindicated to use interacting drugs concomitantly, according to Lexidrug™; PICU: pediatric intensive care unit; NICU: neonatal intensive care unit

Table 5. *Factors that increase the risk of DRP in the pediatric intensive care unit*

	Odds Ratio of having at least one DRP	95% Confidence Interval		p
		Lower	Upper	
Antibiotic use	15.027	5.703	39.590	**< .001**
Polypharmacy*	28.833	6.953	119.563	**< .001**
Mechanical ventilation	11	3.590	33.708	**< .001**

**Presence of a minimum of two drugs in the treatment regimen; DRP: drug-related problem*

In Study Group P number of DRPs was correlated with length of hospital stay (r=0.637; p<.001), number of drugs used (r=0.835; p<.001), and number of pDDIs (r=0.640; p<.001). In Study Group N number of DRPs was correlated with the number of drugs used (r=0.448; p<.001), and the number of pDDIs (r=0.283; p<.001); whereas it was not significantly correlated with length of hospital stay (p>.05).

For all patients in the study, age (day) was correlated with the number of DRPs (r=0.413; p<.001). However, when each group was evaluated separately, there were no significant correlations between the number of DRPs and age. DRPs were more common in the pediatric group than in neonates (n=981 vs. n=266, respectively; p<.001). The median (IQR) number of DRPs was 3 (1-6) for the pediatric patients and 1 (0-1) for the neonate patients (p<.001).

DRP risk in PICU patients increased with the presence of antibiotic use, polypharmacy, and mechanical ventilation (Table 5). No significance was noted for NICU patients concerning the same factors.

4. DISCUSSION

Although many studies analyze CP's input in the identification and resolution of DRPs in patients hospitalized in the general pediatric ward, only a limited number of such studies have been conducted in the NICU and PICU settings (17, 23-25). As far as we know, our study is the first one aiming to assess the CP's input in identifying and intervening in the DRPs encountered in the NICU and PICU settings in Türkiye.

In our study DRPs were more common in the pediatric group than in the neonates (p<.001). The median number of DRPs per patient was 3 for the Control Group P and 1 for the Control Group N. Tawhari et al (26) reported the number of DRPs per patient as 1.9 in the PICU and 0.9 in the NICU. In another one, the number of DRPs per patient was determined 2.5 in the PICU, 1.4 in the NICU, and 1.6 in the pediatric ward (27). A systematic review indicated an increased occurrence of medication errors in the PICU in comparison to the NICU (28). Similar results were recorded in studies from United Kingdom and Saudi Arabia, showing that DRP risk in children is higher in the PICU than in other services and that DRP incidence, as well as the number of DRPs per patient, is higher in the PICU than in other services and NICU (8, 29). In contrast, DRPs were more common in newborns in Ethiopia than in other age groups (30). The rationale behind this increased rate of DRPs in the PICU compared to the NICU can be attributed to the higher number of medications administered to the PICU patients. A study conducted in Saudi Arabia, similar to this study, found that the probability of DRPs in PICU was higher than in NICU and that the incidence of DRPs increased proportionally with the number of medications (29). This may be attributed to the more complexity of medication regimens in the PICU compared to the NICU.

The number of DRPs per patient in the retrospective part of our study was higher than that was calculated for the prospective part for both the pediatric and neonatal patients. This may be explained by a possible Hawthorne effect that might be caused by the presence of the CP in the PICU and NICU; healthcare professionals might have behaved more cautiously knowing they were being watched (31).

The most frequently observed DRPs and their rates in the prospective part of this study were in agreement with those reported from other studies where 'drug use process' (32.6%) and 'dose selection' (30.8%) were the most common causes of DRPs in the NICU (30) and, 'dose selection' and 'drug selection' in pediatrics (29).

Similarly, studies conducted at the NICU, PICU, and general pediatric service found out that 'drug selection' and 'dose problems' were the most frequently observed DRPs (25.5-27.5%, 34.2-50.7%, respectively) (11, 27). In another study conducted in the NICU, the most common causes of DRPs which were 'dose selection' (72.1%) and 'drug selection' (14%) were reported with about twice the frequency that we observed (27). The main reason for the DRPs caused by dose selection was that the drug doses remained at the sub-dose as the body weight of the newborns changed within a few days after birth.

In this study, 'too low drug dose' (19.6%) and 'no/incomplete drug treatment in spite of existing indications' (16.5%) were the most common causes of DRPs in the prospective NICU patients, while it was 'inappropriate combination of drugs' (29.1%) and 'inappropriate drug form/formulation' (20.5%) in the prospective PICU patients. This is similar to the finding that the most DRP causes in the general pediatric ward were an 'inappropriate combination of drugs' (69%) and 'no or inappropriate outcome monitoring' (10%)(19). In another study conducted in the NICU, the 3 most frequently observed DRPs were 'wrong drug administered' (14.4%), 'prescription error' (13.8%), and 'drug dose too low' (13.5%) (26). In another study conducted in NICU, PICU, and general pediatrics, the 2 most common DRPs were 'inappropriate drug form' (13.6%) and 'no drug treatment in spite of existing indication' (12.6%)(29).

In pediatrics, as the number of drugs used by patients increases, the risk of DRP may also increase(25, 29). In our PICU patients, DRP risk was increased by 29-fold by the presence of polypharmacy; this was similar to the results of a pediatric study where polypharmacy increased DRP risk by 32-fold (19).

In our study, the most common pDDIs in the PICU were related to the concomitant use of fentanyl-midazolam, fentanyl-levetiracetam, and fentanyl-ketamine. Like our results, in a pediatric study in the literature phenobarbital, diazepam, and hydrocortisone were among the drugs causing the majority of pDDIs (32). Interactions involving these groups of drugs are common due to the high need for opioid analgesics, anesthesia, and seizure monitoring in intensive care conditions.

Since our study was conducted in the intensive care setting, interventions were not performed at the patient level as in other studies in the literature (8, 33, 34).

In our study, the majority of the proposed interventions (91.5% for PICU, 100% for NICU) were accepted by the physicians similar to the high acceptance rates reported in other studies (24, 25, 35, 36). In studies conducted in the general pediatric service, the acceptance rates of interventions ranged from 81% to 97% (23, 34), while Jafarian et al. reported a lower acceptance rate (59.2%) in their study conducted in the NICU, PICU, and general pediatrics (27).

Although this novel study is one of the first studies from Türkiye reporting the results of CP's involvement in the NICU and PICU healthcare teams through identification and intervention regarding DRPs, it has some limitations. As this was not a randomized controlled trial, the real impact of the CP on the resolution or prevention of DRPs could not be assessed. Additionally, the severity and preventability of DRPs could not be assessed. As the study was carried out in a single center, the results of the study may not be generalized. The possibility that the Hawthorne effect is a type of human behavioral reactivity in which individuals change an aspect of their behavior in response to their awareness could also be considered one of the limitations of the study. In the future, multicenter studies employing a randomized controlled trial design with larger patient populations should be conducted to assess the long-term impact of CPs in the NICU and PICU.

5. CONCLUSION

The study findings demonstrate the potential of CPs in the NICU and PICU settings to identify and resolve DRPs. Physicians' high acceptance rate of the CP's intervention proposals suggests that involvement of the CP in the healthcare team can make a positive contribution to the success of the treatment. Additionally, the results of the study are anticipated to inform decision-makers in the future, guiding the implementation of formal policies to ensure the inclusion of CPs in the NICU and PICU.

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Research idea: ZYA, SA
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Acquisition of data for the study: ZYA, SB
Analysis of data for the study: ZYA, MS
Interpretation of data for the study: ZYA, SA
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