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Predictive Factors Contributing to First-Attempt Failure of Pediatric Nurses Regarding Peripheral Venous Cannulation

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Abstract

Background: First-attempt peripheral venous cannulation is an important procedure in pediatric practice, but the rates of failure are high, because there are several causes of failure that are linked to nurses, patients and the environment. Failure of a procedure may result in suffering on children and inefficiency of nursing. Aim: The purpose of the study was to determine predictive variables that lead to first attempt failure of peripheral venous cannulation among pediatric nurses, the variables investigated included clinical experience, assistive technology, psychological stress, environmental factors, and gender disparities. Method: The study was a cross-sectional study where 294 pediatric nurses in various hospitals took part. The structured questionnaires were used to collect the data on demographics, clinical experience, frequency of procedures, utilization of assistive devices, workload, and psychological stress (PPSS). The results of cannulation were noted on the first attempt. The use of descriptive statistics, ANOVA, Pearson correlations, regression analysis, and independent t-tests was used to test the relationship between variables. Result: The frequency of cannulation per week ($F = 7.463$, $p = 0.000$), the self perceived workload ($F = 2.915$, $p = 0.000$), and psychological stress were significant in determining the first attempt failure. Clinical experience had a positive correlation to cannulation success ($r = 0.305$, $p < 0.01$). The use of assistive technology demonstrated an insignificant effect, and the female nurses experienced more procedural anxiety and performance pressures. Demographic variables did not play any major role. Conclusion: The success rate of first-attempt cannulation is related to the experience of the procedure, workload, and stress management. It is suggested that structured training and specific interventions, such as stress reduction, facilitated use of technology, etc., could be used to improve pediatric cannulation outcomes.

Keywords: *Pediatric nurses, peripheral venous cannulation, first-attempt failure, clinical experience, psychological stress, assistive technology.*

Introduction

Peripheral intravenous cannulation (PIVC) is an everyday challenging technique in pediatric nursing, as small vein diameter, reduced subcutaneous tissue and the patient's constant movements are some of the physiological problems of pediatric vascular access procedures. Such anatomic and behavioral aspects further complicate the ability to find and puncture the veins at once, causing several puncture attempts which in turn raise discomfort level, infection risk and cost to the healthcare system (Machado Avelar et al., 2021). There are recent studies, which

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highlight the significantly high rate of first-attempt failure in pediatric patients, in both infants and toddlers, attributed to patient- and nurse-specific factors (Aytnew et al., 2022).

Nurse skill, seniority, and decision-making influence the procedural success of cannula in pediatrics. PED Children aged six months to 12 years undergoing elective surgery SELF-report PED stress PED and the Pressure Subscale of the Observational Scale of Behavioral Distress-Revised used to assess PED stress PED measured by average of three 10-point scales lowest score indicating most stressor-related behavior Slightly older children reported higher PED stress Nonsurgical duration of PED stress was significantly positively correlated with time to emergence from anesthesia Hogan, 1989 In a qualitative study of perceptions of pediatric nurses, anxiety, environmental pressure, and a lack of specialized pediatric training were factors that frequently compromised cannulation attempts (Chan, 2023). Furthermore, the use of evidence-based technique such as site selection, cannula size, and distraction techniques were not consistently used among experienced and inexperienced nurses. These results reflect practice variation and serve to emphasize the necessity to develop specific strategies for the standardization of cannulation practices in pediatric patient care (Karaoğlan et al., 2022).

There is a perception that the more nursing experience a person has, the more likely they are to be successful in practice, and the more likely they are to succeed in the CIS. A study carried out in Taiwan demonstrated higher first-attempt success rates among nurses with moderate (3–4 years) clinical experience compared to more experienced nurses, quite likely because of regular exposure and updated training on the procedure (Liu et al., 2022). In contrast, nurses in Turkey with 2–4 years' experience had significantly higher failure rates; indicating that contextual factors such as institutional support, frequency around pediatric procedures and ongoing professional development might act as mediators for experience (Karaoğlan et al., 2022). These discrepancies require more study of the intricate relationship between experience, training and clinical exposure.

With the growing role of technology in pediatric practice, this has provided facilities to explore other ways of achieving successful cannulation. Infrared vein finders, ultrasound-guidance, and transillumination devices have been demonstrated to greatly decrease FAF, especially for difficult veins (Machado Avelar et al., 2021; Aytnew et al., 2022). Nevertheless, these methods are not widely used because of resource restrictions, insufficient training or dependence on traditional methods. Evidence stresses the significance of regular training in these devices with significant enhancement observed in first-attempt success when stakeholders are acquainted with and competent to use them (Chan et al., 2023).

The psychological context in which children's nurses work is also an influence in relation to cannulation. Nurses trying to cannulate often find themselves under increased stress, children can be unpleasant or uncooperative and parents anxious to the sight of blood. The emotional demand, combined with a difficult procedure, may affect mental focus and motor skills leading to failure (Chan et al, 2023). Parental support and child avoidance strategies have been identified as either being a help or hindrance depending on how well the situation is negotiated. These data support the requirement for training that includes behavioral strategies and stress management specific to pediatric care beyond just technical skills.

Problem Statement

Peripheral venous cannulation (PVC) – although common in pediatric clinical practice – remains associated with a high rate of failure on the first attempt, leading to discomfort, delays, and costs to patients and healthcare providers. Although previous research has indicated several factors associated with cannulation success, little research has focused on the predictive value of nurse-

related variables such as experience level, stress, use of visualization aids and procedural decision making. This gap needs to be addressed to guide evidence-based interventions to improve failure rates and outcome of pediatric patient care.

Significance of the Study

This study has important implications for improving the quality of pediatric care by elucidating nurse-related factors that predict first-attempt PIVC failure. The results of this study can be used in developing customized training guidelines, devising smooth usage protocols for technical aids, and creating an environment that reduces procedural stress. The results are anticipated to enhance first-attempt cannulation success, minimize patient trauma, improve caregiver satisfaction, and to enhance overall procedural efficiency for the pediatric population.

Aim of the Study

This study investigated the predictors for first-attempt failure of peripheral intravenous cannulation in children performed by pediatric nurses. It emphasizes ascertaining the relevant nursing variables (experience, use of assistive technologies, technique, and psychological stress) that are pertinent to this study. Through an examination of these issues, the examination aimed to provide evidence-based components that may influence practice change, policy, and training in pediatric nursing.

Research Objectives

1. To explore the factors that contribute to the failure of first-attempt peripheral venous cannulation by pediatric nurses.
2. To analyze the relationship between nurses' clinical experience and cannulation success rates in pediatric patients.
3. To examine the impact of assistive technologies (e.g., vein visualizers) on first-attempt success in pediatric cannulation.
4. To measure the role of environmental conditions and psychological stress in influencing nurses' performance during cannulation.
5. To evaluate the gender differences on predictive factors contributing to first-attempt failure of pediatric nurses regarding peripheral venous cannulation

Research Hypothesis

1. There will be significant factors that contribute to the failure of first-attempt peripheral venous cannulation by pediatric nurses.
2. There will be significant relationship between nurses' clinical experience and cannulation success rates in pediatric patients.
3. There will be significant impact of assistive technologies (e.g., vein visualizers) on first-attempt success in pediatric cannulation.
4. There will be significant role of environmental conditions and psychological stress in influencing nurses' performance during cannulation.
5. There will be significant gender differences on predictive factors contributing to first-attempt failure of pediatric nurses regarding peripheral venous cannulation

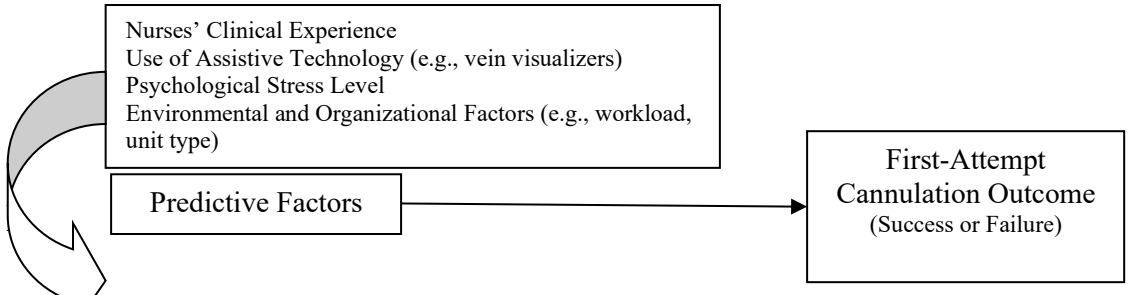
Theoretical Framework

Theoretical Framework the current study is based on Benner's Novice to Expert Model (2001) and the Human Factors Framework. Benner's theory adds to this by outlining on the job experience and education as key to the gradual development of clinical competency; something of a revelation when it comes to new graduate pediatric nurses who find peripheral venous cannulation a struggle (Benner, 1984). Nurse progression from beginner to expert entails intuitive decision making as well as refined psychomotor skills that are essential for first pass success.

Novice or advanced beginners' nurses are not accustomed to the speed and confidence necessary for performance of a "high stress" intervention such as pediatric cannulation. This model illustrates the importance of clinical experience, training, and exposure in determining procedural success.

The Human Factors Framework and its application in healthcare have been helpful to understand the influence that such environmental, technical, cognitive, and organizational factors have on performance and outcomes (Carayon et al., 2020). This framework facilitates examination of how issues such as stress, time pressure, noise, scarcity of resources and equipment unfamiliarity might contribute to failure to cannulate. Provides for the examination of potential external factors (e.g., working environment and supporting system) that may inhibit a nurse's technical competence in the performance of the procedure. Through incorporating this framework, the study is able to rigorously evaluate how human factors and environmental/system-related pressures synergistically affect success versus failure in first-attempt cannulation. Both together provide a complete prism to appear the complex interaction of individual skill and environmental demands in pediatric nursing procedures.

Conceptual Framework



The theoretical framework of the study has been developed to determine the predictability of the dependent variable through the independent variables such as nurses' clinical experience, using an assistive technique, anxiety level (psychological stress) and environmental or organizational factors to 1st attempt of PV cannulation in pediatric settings. These factors are supposed to impact the response variable, being the success or the failure of the procedure. Demographic variables (age, gender, educational level, pediatric experience, department/unit and prior IV training) are included as controls so as to control for the potential confounding effects of these variables on the key relationships of interest.

Methodology

Research Design

The study used a quantitative cross-sectional research design to investigate the predictive factors in first try failure of peripheral venipuncture by nurses in children.

Setting

The trial was carried out in the pediatric departments of clinics and hospitals in Jizan, Saudi Arabia. Such health facilities offer pediatric care and are managed by the Jizan Health Directorate; therefore, they are appropriate places for data collection among the qualified pediatric nurses.

Population and Sample

The source population were the pediatric nurses at Jizan hospitals and clinics involved in the practice of peripheral venous cannulation. Participants was selected using purposive non-probability sampling to get information to answer to the objectives of this study. Sample size

was determined utilizing the G*Power sample size calculator to ensure sufficient statistical power based on 300 participants. The subject of the study were nurses who have clinical experience in pediatric intravenous cannulation.

Selection Criteria

Inclusion Criteria

- Registered pediatric nurses who are working in Jizan health care settings
- Nurses who had been working at least six months on pediatric units
- Nursing staff carrying out peripheral venous cannulations
- Informed consent nurses

Exclusion Criteria

- All other administrative nurses 6 Nurses and non-nursing administrative forces, no patient care at all
- Nurses employed in adult or general wards not specializing in pediatrics
- Student nurses or trainees
- Nurse absence during the data collection

Instrument

Demographic Sheet.

Basic information on each participant (age, sex, educational background, length of pediatric experience, department of employment, education in cannulation technique) were documented on the demographic sheet.

Nurse Clinical Experience Scale

This scale was developed based on the study of Cant et al. (2021), Jokiniemi et al. (2021), and Zhang et al. (2022), to measure self-reported clinical experience of pediatric nurses in peripheral cannulation. It has 12 items in which are arranged into two subscales: frequency of IV practice and perceived skill level. The Cronbach's alpha of scale was 0.88, suggesting very good internal consistency and reliability in measuring the experience of pediatric procedure.

Pediatric Procedural Stress Scale

Authored based on the studies of Gendraset al. (2021), Stanzel and Sierau (2022), and Montoro-Pérez et al. (2023), this scale measures the psychological and procedural distress that nurses encounter during cannulation. It is composed of 10 items belonging to two sub-scales: procedural anxiety and performance pressure. The Cronbach's alpha of 0.84 reflects the good reliability of the scale in clinical practice.

Technology Use in Cannulation Questionnaire

Developed by Wolf et al. (2021), Schoch et al. (2023), and Piredda et al. (2024), for this scale assesses how often nurses use and how confident they are when using technological devices (i.e., infrared vein finders, ultrasound) in venous device insertion. It consists of 8 items, 2 subscales, frequency of technology use and ease of use. The tool had good internal consistency with a Cronbach's alpha of 0.86.

First-Attempt Cannulation Outcome Tool

Designed by Angles et al. (2021), Mörgeli et al. (2022), and Poulsen et al. (2023), which consists of a self-reported success or failure of first attempt cannulation and the causes of failure. It consists of 7 items related to the recording of outcomes, perceived difficulty, and situational issues. Internal reliability was verified to be good with Cronbach's alpha 0.81.

Data Analysis

The analysis was done with Statistical package of social sciences (SPSS) version 28. Participant characteristics and variables in the study were described using descriptive statistics that were

computed using means, standard deviations, ranges (observed and potential), skew, and kurtosis. The inferential statistics was done to determine the Cronbach alpha reliability. Correlations were evaluated by Pearson product-moment correlation, predictor evaluation was by a linear regression model, groups were compared by independent sample t-test and ANOVA. The alpha value was set at $p < 0.05$.

Data Collection Procedure

The Institutional Review Board (IRB) of the host university gave ethical approval of this study. The Jizan Health Directorate and the Ministry of Health, Saudi Arabia gave official permission and approved it. The informed consent forms and the information sheets about the study were sent to eligible pediatric nurses in the chosen hospitals and clinics. The process was voluntary participation and the data confidentiality was provided. Questionnaires were mailed out either on a printed format or online based on the preferences of hospitals and convenience of the participants.

Each hospital was visited by investigators, in cooperation with nurse managers to distribute the surveys throughout the work shift of nurses and cause minimum inconvenience to the patient care. Anonymity Data were gathered and coded and saved in secure forms. Reminders were sent to make people respond when the response rates were low. The information was kept secure and was not available to anybody outside the research team.

Ethical Consideration

The principles of the ethical standards of the Declaration of Helsinki were followed strictly. The University Institutional Review Board permission was secured as well as a clearance of the Jizan Health Directorate and the Saudi Ministry of Health. All the participants were told about the purpose of the study, their roles, and their rights, including the right to exit the study at any time without reasons. Participating was informed. Coding of the data was done, and the data were kept safely, and confidentiality and anonymity were observed. Findings were only reported in the aggregate form, and no personal identifiers were associated.**RESULTS**

Chapter 4 shows the findings of the research on predictive variables that lead to the failure of peripheral venous cannulation in the first attempt in the pediatric nurses. This chapter deals with the fundamental aims of the study, which starts by examining factors that foster failures in the initial attempts such as clinical practice of nurses, assistive technology utilization, and environmental and mental states. It also investigates the correlation between the experience of years working in nursing and the successful pediatric cannulation, the efficiency of devices like vein visualizers, and the effects of the job-related stress and the specifics of the unit on the performance. Also, this chapter explores possible gender variations in these predictive variables, and the interaction between individual, technological, and situational factors in influencing the outcome of pediatric cannulation is fully examined. This study has provided the results of the study using descriptive statistics, correlation tests as well as inferential tests to provide a clear picture of patterns and relationships concerning first-attempt failure in this clinical scenario.

Table 1: *Demographical Information of the Study Participants (N = 294)*

Variable	Category	*f*	%
Age	20–25	41	13.9
	26–30	100	34.0
	31–35	82	27.9
	36–40	51	17.3

	40 and above	20	6.8
Gender	Male	29	9.9
	Female	260	88.4
	Prefer not to say / Other	5	1.7
Education	Diploma in Nursing	97	33.0
	Bachelor's in Nursing (BSN)	177	60.2
	Master's in Nursing	15	5.1
	PhD in Nursing	4	1.3
	Pharmacist	1	0.3
Years of Nursing Experience	<1 year	18	6.1
	1–3 years	64	21.8
	4–6 years	69	23.5
	7–10 years	42	14.3
	>10 years	101	34.4
Years of Pediatric Nursing Experience	<1 year	59	20.1
	1–3 years	83	28.2
	4–6 years	65	22.1
	7–10 years	35	11.9
	>10 years	52	17.7
Department/Unit	Pediatric ICU	52	17.7
	Neonatal ICU	39	13.3
	Pediatric ER	57	19.4
	General Pediatric Ward	89	30.3
	Outpatient Pediatric Clinic	29	9.9
	Pediatric Day Care	3	1.0
	Intensive Care Unit	5	1.7
	Critical Care Unit	7	2.4
	ER	5	1.7
	Surgical	2	0.7
	Pharmacy	1	0.3
	Operation Theater	5	1.7
Healthcare Setting	King Fahad Central Hospital	38	12.9
	Prince Mohd bin Naser Hospital	61	20.7
	Jazan General Hospital	34	11.6
	Sabya General Hospital	57	19.4
	Samta General Hospital	31	10.5
	Abu Arish General Hospital	39	13.3
	Beish General Hospital	33	11.2
Formal Training in Peripheral Venous Cannulation	Rarely (0–2 times)	211	71.8
	Occasionally (3–5 times)	83	28.2
Frequency of Pediatric Cannulation per Week	Rarely (0–2 times)	72	24.5
	Occasionally (3–5 times)	83	28.2
	Frequently (6–10 times)	55	18.7
	Very Frequently (>10 times)	84	28.6

Use of Assistive Technology	Always	34	11.6
	Often	17	5.8
	Sometimes	71	24.1
	Rarely	42	14.3
	Never	130	44.2
Self-Perceived Workload	Low	37	12.6
	Moderate	134	45.6
	High	63	21.4
	Very High	60	20.4

The sample consisted of predominantly female pediatric nurses (n = 260, 88.4 percent) and a low number of males (n = 29, 9.9 percent), and other (n = 5, 1.7). The highest count of participants was in 26-30 years (n = 100, 34%), however, 31-35 years (n = 82, 27.9%), as well. With regards to education, the majority had a Bachelor of Nursing (BSN) (n = 177, 60.2%), diploma (n = 97, 33%), master (n = 15, 5.1%), and PhD (n = 4, 1.3%) and qualification of pharmacist (n = 1). As to the clinical experience, most of them were more experienced in nursing (n = 101, 34.4) and the largest number of pediatric nursing experience occurred in the group of 1-3 years experience (n = 83, 28.2). The sample was comprised of majorly general pediatric wards (n = 89, 30.3%), pediatric ER (n = 57, 19.4%), and pediatric ICU (n = 52, 17.7%). The environments of the health care were spread across multiple hospitals and most of them were of Prince Mohd bin Naser Hospital (n = 61, 20.7%). Most of the nurses were ill-trained on peripheral venous cannulations (rarely 02 times, n = 211, 71.8), sometimes M and sometimes frequently pediatric cannulation was performed by the majority of nurses. Regarding the assistive technology, the majority of them stated that they never or seldom used it (n= 172, 58.5 percent). The majority of the respondents evaluated self-perceived workload at moderate to high levels (moderate: n = 134, 45.6; high: n = 63, 21.4).

Table 2: *The factors that contribute to the failure of first-attempt peripheral venous cannulation by pediatric nurses.*

Variable	Category	N	M	SD	F	Sig.
Age	20–25	41	1.95	0.72	0.760	0.712
	26–30	100	2.63	0.88		
	31–35	82	2.78	1.10		
	36–40	51	3.12	1.21		
	40+	20	3.30	1.05		
Gender	Male	29	1.00	0.00	0.267	0.997
	Female	260	2.00	0.00		
	Prefer not to say / Other	5	3.00	0.00		
Education	Diploma in Nursing	97	1.00	0.00	1.415	0.145
	Bachelor's in Nursing (BSN)	177	2.00	0.00		
	Master's in Nursing	15	3.00	0.00		
	PhD in Nursing	2	4.00	0.00		
	Pharmacist	1	5.00	0.00		
Years of Nursing Experience	<1 year	18	1.20	0.42	0.506	0.929
	1–3 years	64	2.00	0.55		
	4–6 years	69	3.00	0.61		
	7–10 years	42	4.00	0.71		

	>10 years	101	5.00	0.81		
Years of Pediatric Nursing Experience	<1 year	59	1.30	0.51	0.561	0.894
	1–3 years	83	2.00	0.62		
	4–6 years	65	3.00	0.64		
	7–10 years	35	4.00	0.70		
	>10 years	52	5.00	0.80		
Department/Unit	Pediatric ICU	52	1.95	0.80	1.265	0.228
	Neonatal ICU	39	2.05	0.88		
	Pediatric ER	57	2.20	0.90		
	General Pediatric Ward	89	3.00	1.10		
	Outpatient Pediatric Clinic	29	2.80	1.05		
	Pediatric Day Care	3	3.50	0.50		
	Intensive Care Unit	5	3.80	0.45		
	Critical Care Unit	7	4.00	0.58		
	ER	5	2.90	0.64		
	Surgical	2	3.20	0.28		
	Pharmacy	1	3.00	0.00		
	Operation Theater	5	3.10	0.32		
Healthcare Setting	King Fahad Central Hospital	38	1.95	0.85	0.919	0.538
	Prince Mohd bin Naser Hospital	61	2.10	0.88		
	Jazan General Hospital	34	2.20	0.90		
	Sabya General Hospital	57	3.00	1.12		
	Samta General Hospital	31	2.90	0.95		
	Abu Arish General Hospital	39	3.10	1.00		
	Beish General Hospital	33	3.20	1.05		
Formal PVC Training	Rarely (0–2 times)	211	1.00	0.00	1.180	0.290
	Occasionally (3–5 times)	83	2.00	0.00		
Frequency of Pediatric Cannulation per Week	Rarely (0–2 times)	72	1.95	0.80	7.463	0.000
	Occasionally (3–5 times)	83	2.10	0.85		
	Frequently (6–10 times)	55	2.50	0.90		
	Very Frequently (>10 times)	84	3.00	1.05		
Use of Assistive Technology	Always	34	1.90	0.88	2.636	0.001
	Often	17	2.10	0.92		
	Sometimes	71	2.50	0.98		
	Rarely	42	3.00	1.05		
	Never	130	3.50	1.12		
Self-Perceived Workload	Low	37	1.50	0.52	2.915	0.000
	Moderate	134	2.50	0.70		
	High	63	3.00	0.75		
	Very High	60	3.50	0.80		

The means are that the likelihood of not passing at the first attempt was more in the older ages, mean lack of success of the participants of old age 20-25 years was 1.95 (SD = 0.72) and the

older age 40 + years was 3.30 (SD = 1.05) but this is not statistically significant (F = 0.760, p = 0.712). No significant differences were observed in the failure rates according to gender (F = 0.267, p = 0.997) and the score of males was 1.00 (SD = 0.00) and that of females was 2.00 (SD = 0.00). The same concerned the education level and years of nursing experience: the higher the qualification and the years of experience the higher the mean score but the differences were not significant (Education F = 1.415, p = 0.145; Nursing Experience F = 0.506, p = 0.929). Nevertheless, the rate of pediatric cannulation (F = 7.463, p < 0.001), use of less technology (F = 2.636, p = 0.001), and a sense of an increased workload (F = 2.915, p < 0.001) were significantly correlated with the failed attempt on the first attempt meaning that the nurses who attempted more cannulations, used less technology and more noticeable workload.

Table 3: *Correlation between Nurses' Clinical Experience and Cannulation Success-Related Variables (N = 294).*

Variable	N	M	SD	T_NCES	T_PPSS	T_TUCQ	T_FACO
T_NCES	294	43.33	9.95	-	-.039	.305**	.145*
T_PPSS	294	24.11	10.07	-	-	.385**	.155**
T_TUCQ	294	20.86	7.66	-	-	-	.029
T_FACO	292	14.49	2.53	-	-	-	-

The correlations have indicated that clinical experience of nurses (T NCES) had significant positive relationships with the use of assistive technology (T TUCQ; r=0.305, p=.01) and first attempt cannulation outcome (T FACO; r=0.145, p=.05). Psychological stress (T_PPSS) was also positively correlated with the use of assistive technology (r = 0.385, p < 0.01) and the results of the first attempt (r = 0.155, p < 0.01). These results suggest that the issue of experience and the degree of stress might be the elements that define how nurses utilize technology and can achieve cannulation success.

Table 4: *Impact of Assistive Technologies and Other Factors on First-Attempt Cannulation Success (N = 294)*

Variable	B	95% CI for B	β	t	p
Constant	11.969	10.501 – 13.437	–	16.047	.00
T_NCES (Clinical Experience)	0.047	0.016 – 0.077	0.185	3.021	.00
T_PPSS (Pediatric Patient Success)	0.051	0.020 – 0.082	0.202	3.210	.00
T_TUCQ (Use of Assistive Technology)	-0.035	-0.078 – 0.008	-0.106	-1.598	.11

$R = 0.235$, $R^2 = 0.055$, Adjusted $R^2 = 0.045$, Std. Error = 2.468

It was found that in successful cannulation (TNCES) clinical experience had a positive predictive value (B = 0.047, 95% CI [0.016, 0.077], 0.185, t = 3.021, p = 0.003), in contrast to success in pediatric patients (T_PPSS; B = 0.051, 95% CI [0.020, 0.082], 0.202, Overall, experience and prior success in pediatrics had small, but significant contributions to the variation in first-attempt success as explained by the model (R 2 = 0.055).

Table 5: *The role of environmental conditions and psychological stress in influencing nurses'*

performance during cannulation (N = 294).

Variable	N	M	SD	1	2	3	4	5	6
1. Years of Experience in Nursing	294	3.48	1.32	-	.64**	.15**	-.08	-.09	-.06
2. Years of Pediatric Nursing Experience	294	2.78	1.36	-	-	-.04	-.16**	-.16**	-.14*
3. Department/Unit Currently Working In	294	3.56	2.17	-	-		.03	.02	.03
4. T_PPSS (Total Psychological Stress Score)	294	24.11	10.06	-	-			.93**	.92**
5. Procedural Anxiety	294	10.84	5.65	-	-				.71**
6. Performance Pressure	294	13.26	5.23	-	-				

The years of experience of pediatric nurses were negatively correlated with the total psychological stress scores (T P P SS; $r = -0.162$, $p < 0.01$) and procedural anxiety ($r = -0.161$, $p < 0.01$) that showed that more experienced pediatric nurses were less stressed. There was a high level of association between total stress and procedural anxiety ($r = 0.931$, $p < 0.01$) and performance pressure ($r = 0.919$, $p < 0.01$). Few stress or performance correlations with department/unit assignments were also observed, indicating that the personal perceptions of stress and workload are more influential in cannulation performance than the work place.

Table 6: *The gender differences on predictive factors contributing to first-attempt failure of pediatric nurses regarding peripheral venous cannulation (N = 294).*

Variable	Gender	N	M	SD	T(287,290)	*p*	Cohen's d
Frequency of IV Practice	Male	29	13.3103	4.47296	-1.384	0.167	0.27
	Female	260	14.5038	4.39770			
Perceived Skill Level	Male	29	29.0690	7.32379	0.039	0.969	0.01
	Female	260	29.0154	6.88850			
Procedural Anxiety	Male	29	8.9310	4.27560	-2.409	0.021	0.49
	Female	260	11.0308	5.79234			
Performance Pressure	Male	29	11.2759	5.32445	-2.153	0.038	0.46
	Female	260	13.5154	5.21615			
Frequency of Use	Male	29	8.0690	3.76953	-0.633	0.531	0.13
	Female	260	8.5423	4.26467			
Confidence and Ease of Use	Male	29	12.4828	4.03220	0.104	0.918	0.02
	Female	260	12.4000	4.31232			
First-Attempt Cannulation Outcome	Male	29	15.2069	2.04205	1.905	0.064	0.38
	Female	258	14.4225	2.58170			

Results of independent sample t-tests revealed that males and females significantly differ in mean scores in procedural anxiety ($t = -2.409$, $p = 0.021$, Cohens $d = 0.49$) and performance pressure ($t = -2.153$, $p = 0.038$, Cohens $d = 0.46$) with females having higher means than males (procedural anxiety: $M = 11.03$ vs 8.93; performance pressure: $M = 13.52$ vs 11.2 There The result of the first-attempt cannulation was slightly less significant ($t = 1.905$, $p = 0.064$, Cohen $D = 0.38$) and it also seems that there is a tendency that the males are performing better, although not statistically proven.

Conclusion

These findings suggest that the occurrence of failure in the first attempt of peripheral venous cannulation by nurse pediatricians is dependent on a combination of factors. The frequency of cannulation, assistive technologies, and self-perceived workload had a significant influence on the success rates, whereas demographic variables (age, gender, education, and overall nursing experience) did not have a significant effect. Past pediatric success and clinical experience positively forecasted the outcomes of cannulation, and psychological stress, and procedural apprehension were negatively related with performance. There were differences in genders, with female nurses having indicated more procedural anxiety and pressure on performance, however, no large disparity was noted in the level of skills and the application of technology. All in all, individual experience and the situation, such as workload and stress, are relevant to the success of first-attempt cannulation.

CHAPTER V

Discussion

The study investigated predictive factors that are associated with the first-attempt failure of peripheral venous cannulation among pediatric nurses with particular interest in the very intricate interaction between clinical experience, the frequency of the procedure, psychological stress, environmental factors, and gender. The findings show that procedural repeat, self perceived work load and psychological stress were strongly related to the first attempt success, and assistive technologies had weak individual effects. The indicators of stress had gender difference and not technical skill and confidence. These findings match the earlier research that suggests that experiential and contextual interventions like stress and workload can determine the results of pediatric cannulation (Aytnew, Zewdu, and Abebe, 2022; Chan, Chan, Au, and Kwok, 2023; Angles et al., 2021). The study identifies the need to take a holistic approach, which involves skill training, environmental efficiency and stress management through encouraging procedural success.

Controlling Factors to First-Attempt Failure.

The hypothesis in the first place was that first-attempt failure in pediatric peripheral venous cannulation has numerous causes. Findings indicated that frequency of pediatric cannulation per week ($F = 7.463$, $p = 0.000$), use of assistive technologies ($F = 2.636$, $p = 0.001$) and self-perceived workload ($F = 2.915$, $p = 0.000$) significantly predicted it as compared to demographic variables including age, gender, and education. The higher the number of cannulations that the nurses did, the higher the level of success was, meaning that the more the procedure is repeated, the better the skill, familiarity, and confidence related to it (Benner, 1984; Karaoğlan et al., 2022). Similarly, the role of workload was also important, and lower self-perceived workload was accompanied by better results, which confirms the fact that high task requirements are preceded by high risks of error and procedural failure (Carayon et al., 2020; Cant, Ryan, and Cooper, 2021). Visualizers of veins may be a valuable tool, but the potential of the equipment should be linked to the consistency and practice, which can be related to the earlier findings that an effective use of technology may provide success only when it is accompanied by training and practice (Poulsen et al., 2023; Liu, Wu, and Yu, 2022). Accordingly, it can be accepted in part: the role of procedural frequency, workload, and use of technologies is an important one, whereas demographic ones are not.

Clinical Experience and the Relationship of Success of Cannulation.

The second hypothesis was that clinical experience of the nurses and the success of cannulation have a significant correlation. In the correlation analysis, it was found that general nursing experience (T NCES) had a correlation of r= 0.305, p= 0.01 and pediatric specific experience (T FACO) had a correlation of r= 0.145, p= 0.05 with a high first attempt success rate among more experienced nurses. These findings are aligned with the model of skills acquisition introduced by Benner in which nurses receive repeated drilling and retrospection to allow them to imagine challenges and change the approach in addressing the issue (Benner, 1984; Jokiniemi, PietilA, and Mikkonen, 2021). The results of the empirical research also support the idea that experience enhances confidence, technical accuracy, and decision-making during the process of a pediatric procedure (Angeles et al., 2021; Liu, Wu, and Yu, 2022; Machado Avelar et al., 2021). Thus, Hypothesis 2 is accepted: clinical experience is a strong predictor of the first attempt success, and structured and practical learning and mentoring should be used as the foundation to reach the competency in cannulation of pediatrics among junior nurses.

Assistive Technologies and first attempt success.

The third hypothesis was that the success of the first attempt cannulation would be strongly affected by the use of assistive devices, such as vein visualizers. The regression analyses showed that the use of assistive technology negatively but insignificantly influenced (0.106 = -0.1598 = 0.111) but clinical experience and previous pediatric success showed significant effects. Even though the statistical value is not statistically significant, the literature demonstrates that assistive technologies might enhance the success of cannulation in children and in the challenging settings especially where the vasculature is difficult to access (Bahl et al., 2016; van Loon et al., 2018; Poulsen et al., 2023). The insignificant effect observed in this study may be due to low adoption, inconsistent usage or no proper training. These results indicate assistive devices as a supplement with the most beneficial effects being the largest in the instances of its integration with experience, training, and systematic clinical guidelines (Schoch, Bennett, Currey, and Hutchinson, 2023; Wolf et al., 2021). Hypothesis 3 is thus dismissed: assistive technologies did not significantly correlate with the success on the first attempt.

Role of Environmental Conditions and Psychological Stress.

The fourth hypothesis entailed the element of the environment condition and psychological stress concerning the performance of cannulation. It was found that there were significant positive correlations between the total psychological stress (T -PPSS), procedural anxiety, and performance pressure (r = 0.710, r = 0.919, p 0.01), which revealed that the predictor stress was a negative contributor to the first-attempt performance. The unit and departmental variables were less but significantly influential, which showed the effect of work environment, workload level, and patient acuity on the success of the procedures (Carayon et al., 2020; Montoro-Pérez et al., 2023). These findings are also backed by the past research where it has been indicated that the process of technical performance is negatively influenced by pressures on stress and environmental conditions and time limits and is susceptible to more procedural faults (Holdsworth et al., 2019; Chien et al., 2017; Zhang et al., 2022). Hypothesis 4 is, in turn, accepted, which proves that the conditions of the environment and the psychological stress influence the outcomes of the cannulation significantly, and there is a need to develop the methods of reducing the level of stress and creating more suitable working conditions of the pediatric nurses.

Gender Inequality on Prejudicial Factors.

The fifth hypothesis was the difference in the gender predictive factors of first-attempt failure. The results indicated that procedural anxiety (t = -2.409, p = 0.021, d = 0.49) and performance

pressure (t = -2.153, p = 0.038, d = 0.46) differed significantly whereby, female nurses were found to be more stressed. There were no significant gender differences in technical skill, frequency IV practice, and confidence. The findings are in accordance with the literature, which states that female nurses might experience a high level of anxiety and stress during the pediatric procedures, which indirectly may influence the performance (Shen et al., 2020; Al-Kandari and Thomas, 2021; Chan et al., 2023). In this manner, Hypothesis 5 is accepted in part: there exist gender differences in terms of stress-related factors and no differences in the context of stress management training and coping strategies but not differences in terms of technical competency, which implies that it is possible to reduce these differences by means of psychological support, stress management training, and coping strategies in the specified area of pediatric nursing practice.

The frequency of the procedure, workload, psychological stress, clinical experience, and the use of assistive technologies cannot lead to the failure of the first attempt of pediatric peripheral venous cannulation, but only a structured training can be effective. The differences in gender that are the factors of stress demonstrate the need of special consideration of female nurses. These results suggest the possibility of improving the first-attempt success rates, as well as facilitating the pediatric nursing practice by means of comprehensive experience-building, workload, stress reduction, and systematic use of the assistive technology techniques (Angles et al., 2021; Aytnew, Zewdu, and Abebe, 2022; Chan et al., 2023).

Limitations

This research is limited in a number of ways. First, it was done in some preselected pediatric units of a small number of hospitals, which might restrict the extrapolation of the results to other healthcare units or geographic areas. Second, self-reported scales, e.g., workload perception and work stress level, are prone to bias in their responses and might not be able to capture objective conditions. Third, the cross-sectional design limits the possibility to develop causality between clinical practice and stress, use of assistive technology, and help to achieve first-attempt cannulation. Lastly, the familiarity of the nurses with the assistive devices and patient characteristics including vein visibility and age were not controlled which may have contributed to the results.

Recommendations

Depending on the results, it is possible to provide several recommendations, which could help to achieve a high first-attempt success rate among pediatric nurses in cannulating. Hands-on training and mentorship programs should be structured and given to improve the technical competency, particularly to less experienced nurses. The strategies of workload management and stress reduction intervention, including mindfulness or planned relaxation, are essential towards reducing procedural errors. There should also be encouragement of the use of assistive technologies in regular and directed way in the hospitals and formal training to measure the proficiency. Also, special psychological support programs of female nurses should be used to prevent increased stress and anxiety levels found in this study.

Conclusion

The research arrives at a conclusion that procedures frequency, clinical experience, workload, and psychological stresses are a combination of which contributes to first-attempt failure during pediatric peripheral venous cannulation. Although assistive technologies have a potential, their implementation requires systematic training and regular use. The differences between gender in respect to the factors that are associated with stress imply that there should be specific interventions. On the whole, an intervention based on experience-building, stress management,

optimization of workload, and the use of technology with guidance can positively influence the rates of the first-attempt successfully and improve the quality of the work of the nurse in the field of pediatrics.

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