



THE EFFECTIVENESS OF LIGHT EMITTING DIODE VEIN FINDER (LED-VF) ON OUTCOME OF PERIPHERAL INTRAVENOUS CANNULATION (PIVC) AMONG PATIENTS IN SELECTED HOSPITAL AT PUDUCHERRY

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Abstract:

Background: Peripheral intravenous (IV) cannulation is a routine clinical procedure but can be challenging, particularly in patients with poorly visible or palpable veins. Aim: This study aimed to evaluate the effectiveness of an LED vein finder in facilitating IV cannulation in selected hospitals in Puducherry. **Materials and Methods:** A post-test only control group design was adopted. Sixty adult patients requiring IV cannulation were selected and randomly assigned to two groups: one underwent cannulation using an LED vein finder, while the other received the conventional approach. Outcomes assessed included the number of cannulation attempts, the level of pain experienced, and the perceived difficulty of the procedure. Data were analyzed using descriptive and inferential statistics. **Results:** Participants in the LED vein finder group required fewer attempts (mean = 1.70) compared to the conventional group (mean = 1.83), reported lower pain scores (mean = 3.57 vs. 4.27), and rated the procedure as less difficult (mean = 4.03 vs. 4.63). These differences were statistically significant. Additionally, correlations were observed between pain, procedural difficulty, and first-attempt success. **Conclusion:** The use of an LED vein finder significantly improved the ease of IV cannulation, reduced patient discomfort, and increased the likelihood of first-attempt success.

Keywords: Peripheral intravenous cannulation, infrared LED vein finder, pain, difficulty.

INTRODUCTION

Intravenous cannulation is a common medical procedure utilized for medication delivery, fluid administration, and blood sampling. Despite its routine nature, the placement of peripheral intravenous catheters often presents challenges, particularly in patients with difficult venous access due to various factors such as obesity, dehydration, or variations in skin pigmentation (Pan et al., 2019; İnal & DEMİR, 2018; Cuper et al., 2011). The advent of light-emitting diode vein finders (LED-VFs) represents a promising enhancement in the localization of blood vessels, aiming to improve the effectiveness of peripheral intravenous cannulation (PIVC).

Research has demonstrated that vein visualization devices that utilize near-infrared (NIR) light technology may decrease the number of attempts required for successful cannulation and reduce the duration of the process (Saju et al., 2019, Guillon et al., 2014, Kaddoum et al., 2012). This synergy between LED technology and traditional techniques is increasingly recognized in various clinical settings, indicating potential benefits across diverse patient demographics, especially in pediatrics (İnal & DEMİR, 2018; Cuper et al., 2011).

Furthermore, environmental factors such as skin pigmentation and vein depth raise concerns, suggesting that LED technology may not universally enhance visibility or accessibility for all patient groups (Helmi et al., 2023; Fernández & Armada, 2017). Therefore, while LED-VFs show promise in improving some cannulation outcomes, additional research is required to fully elucidate their effectiveness across different patient populations and clinical contexts (Chapman et al., 2011; Shah & Thakkar, 2021).

By examining success rates, time to cannulation, and patient comfort levels, we seek to establish a clearer understanding of the role that LED-VFs can play in enhancing clinical practices, thereby potentially improving patient care and operational efficiency within healthcare settings.

NEED FOR THE STUDY

In 2024, global smartphone users reached 4.74 billion, a 2.2% annual rise. China leads with 974.69 million users, India follows with 659 million, and Pakistan has 72.99 million. Chennai's smartphone ownership is 66.1%. China also tops smartphone addiction rates, with a score of 36.18, followed by Saudi Arabia and Malaysia. India ranks 17th, with 34% of users addicted and 66% feeling anxious without their phones. In Tamil Nadu, 27.6% of youth show addiction, slightly higher in boys than girls. In Madurai, 42% of children under 12 spend 2–4 hours daily on screens.

In the US, 47% of students are addicted, checking their phones up to 96 times a day. In India, 44% of students show addiction symptoms. Smartphones, while valuable tools, harm mental and physical health when overused, leading to anxiety, depression, poor sleep, memory loss, and behavioral issues. Addiction in youth is often driven by peer pressure and social approval.

Parents are increasingly concerned. Surveys show 95% worry about screen addiction, while 80% fear gaming addiction and 70% adult content exposure. Problematic smartphone use disrupts daily life, cognitive skills, and sleep. Excessive use in young children also hampers emotional, social, and cognitive development. During the pandemic, smartphones became essential for online learning, but doctors observed rising behavioral problems in children. Educating students about the risks early, through tools like video-assisted teaching, can reduce harm and foster healthier habits. This study focused on assessing the effectiveness of video-assisted teaching in raising awareness about the ill effects of smartphone addiction among students in Madurai.

AIM OF THE STUDY:

The study aimed to evaluate the effectiveness of light-emitting diode vein finder (LED-VF) on outcome of peripheral intravenous cannulation (PIVC) among patients.

MATERIALS AND METHODS

The study used a quantitative research approach, employing a quasi-experimental pre-post control group design to evaluate the effectiveness of an LED vein finder in improving peripheral intravenous cannulation among adult patients. The study was conducted in the medical and surgical emergency wards selected government hospital in Puducherry. Participants were selected through non-probability purposive sampling; 60 adult patients between the ages of 25 and 60 who required intravenous cannulation and met the inclusion criteria were chosen, split into two groups: 30 in each group.

The inclusion criteria comprised patients who were able to understand Tamil or English, required IV cannulation, and were admitted to either the medical or surgical emergency wards. Exclusion criteria included pediatric, adolescent, and geriatric patients; critically ill patients; burn cases; and those undergoing phlebotomy procedures.

The researcher developed a structured tool based on literature review and expert consultation. The tool included four sections: Section A consisted of demographic (age, gender, education) and clinical variables (height, weight, BMI, comorbidities, previous IV experience, etc.); Section B used the Comprehensive Difficult Intravenous Access (C-DIVA) Score to evaluate cannulation difficulty; Section C recorded the number of attempts for IV cannulation; and Section D included the Numerical Pain Intensity Scale to measure post-cannulation pain.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethical Committee, and permission was granted by the Medical Superintendent of IGGGH & PGI, Puducherry. Written informed consent was obtained from all participants after explaining the study, ensuring confidentiality, and emphasizing their right to withdraw at any time. The tool's **content validity** was confirmed by a panel of medical and nursing experts, and **reliability** was

established using the inter-rater method, yielding a reliability coefficient of **0.831** for the pain scale and **0.763** for the C-DIVA score.

Data Collection Procedure

The collection of data was done during one month. The experiments were selected and allocated between the experimental and the control group according to the admission type, medical emergencies into the experimental group and surgical emergencies into the control one. The researcher also got the informed consent and baseline demographic and clinical data. The IV cannulation procedure in the experiment group was infrared LED vein finder whereas the in experiment group had the normal procedure. After the procedures, pain, difficulty level, and the amount of cannulation attempts were noted. The average time of one procedure was 1015 minutes.

Data analysis:

The data were analyzed using descriptive and inferential statistics with SPSS. Frequencies and percentages were used to describe the demographic and clinical features. Inferential statistics, including the chi-square test, independent t-test, and correlation coefficient.

RESULT:

Demographic variables:

Table 1 shows the demographic profile of participants. Most were aged 46–60 years (experimental: 36.7%, control: 40%), followed by 25–35 years (33.3% vs. 20%) and 36–45 years (30% vs. 40%). Males comprised 56.7% of the experimental group and 60% of the control group. Half of the experimental group and 40% of the control group were graduates, while illiteracy rates were 10% and 20%, respectively. Higher secondary education was reported by 26.7% (experimental) and 20% (control), and high school education by 13.3% and 20%.

Clinical Profile:

Table 2 presents the clinical characteristics of participants. Obesity (BMI 25–35) was observed in 40% of the experimental group and 20% of the control group, while normal BMI (19–25) was recorded in 33.3% and 60%, and underweight (BMI <19) in 26.7% and 20%, respectively. Most participants had light to dark brown skin (73.3% experimental, 80% control), with the remainder having pale white to light brown skin. No participants had dark brown to black skin. A history of IV cannulation was reported by 83.3% in the experimental group and 90% in the control group.

Number of Attempts on IV Cannulation:

Table 3 shows the mean and percentage reduction in IV cannulation attempts. The experimental group required an average of 1.70 attempts, compared to 1.83 in the control group—a 4.33% decrease. This suggests that using an infrared LED vein finder improved the likelihood of first-attempt cannulation success.

Post-Test Level of Pain

Table 4 shows that the post-test mean pain score was lower in the experimental group (3.57 ± 1.28) than in the control group (4.27 ± 1.36), with a mean difference of 0.70. The independent t-test confirmed this difference as statistically significant ($t = 2.05$, $p = 0.05$), indicating that the LED vein finder effectively reduced pain during cannulation. Figure 1 visually compares post-test pain levels between the groups.

Post-Test Level of Difficulty in Cannulation

Table 5 outlines the level of difficulty experienced during IV cannulation in both groups. The experimental group reported a lower mean difficulty score (4.03 ± 1.03) compared to the control group (4.63 ± 0.89), resulting in a mean difference of 0.43. The statistical analysis using the independent t-test showed a significant difference ($t = 2.15$, $p = 0.05$), indicating that the infrared LED vein finder helped reduce the difficulty associated with cannulation. This finding is further visualized in Figure 2, which displays the post-test difficulty levels across the groups.

Correlation Between Pain, Difficulty, and First Attempt Success

Table 6 presents the correlation between pain, difficulty, and the first attempt success rate in both groups using Karl Pearson's correlation coefficients. In the experimental group, a moderate positive correlation was observed between pain and difficulty ($r = 0.34$, $p < 0.001$), as well as between pain and first attempt success rate ($r = 0.38$, $p < 0.01$). A stronger correlation was noted between first attempt success and level of difficulty ($r = 0.42$, $p < 0.01$). In contrast, the control group showed weaker but still statistically significant correlations: $r = 0.16$ (pain and difficulty), $r = 0.22$ (pain and first attempt success), and $r = 0.32$ (first attempt success and difficulty), all at $p < 0.05$ or better. These findings suggest a meaningful relationship between these clinical variables and further support the intervention's effectiveness.

Table 1: Demographic profile of the participants (N=60)

Demographic profile		Group			
		Experimental		Control	
		n	%	n	%
AGE	25-35 years	10	33.3	6	20
	36-45 years	9	30	12	40
	46-60 years	11	36.7	12	40
GENDER	Male	17	56.7	18	60
	Female	13	43.3	12	40
EDUCATION	Illiterate	3	10	6	20
	Graduate	15	50	12	40
	Higher secondary	8	26.7	6	20
	High school	4	13.3	6	20

Table 2: Clinical variables among samples in the experimental and control group

CLINICAL VARIABLES		Group			
		Experimental		Control	
		n	%	n	%
BMI	Below 19 (underweight)	8	26.7	6	20
	19-25 (Normal)	10	33.3	18	60
	25-35 (Obese)	12	40	6	20
SKIN COLOR	Pale white to light brown	8	26.7	6	20
	Light to dark brown	22	73.3	24	80
	Dark brown to black	0	0	0	0
PREVIOUS EXPERIENCE	Yes	25	83.3	27	90
	No	5	16.7	3	10

Table 3: Mean and Effective mean of Number attempts on IV cannulation.

	Group	Mean score	%Mean score	Percentage difference in the Number of attempts
Post- test	Experimental	1.70	56.67	4.33
	Control	1.83	61	

Table 4: Mean score of post-test level of pain.

	Experimental		Control		Mean difference	Student independent t-test
	Mean	SD	Mean	SD		
Posttest	3.57	1.28	4.27	1.36	0.70	t=2.05 P=0.05*(S)

Table 5: Mean score of post-test level of difficulty on peripheral intravenous cannulation.

	Experimental		Control		Mean difference	Student independent t-test
	Mean	SD	Mean	SD		
Posttest	4.03	1.03	4.63	0.89	0.43	t=2.15 p=0.05*(S)

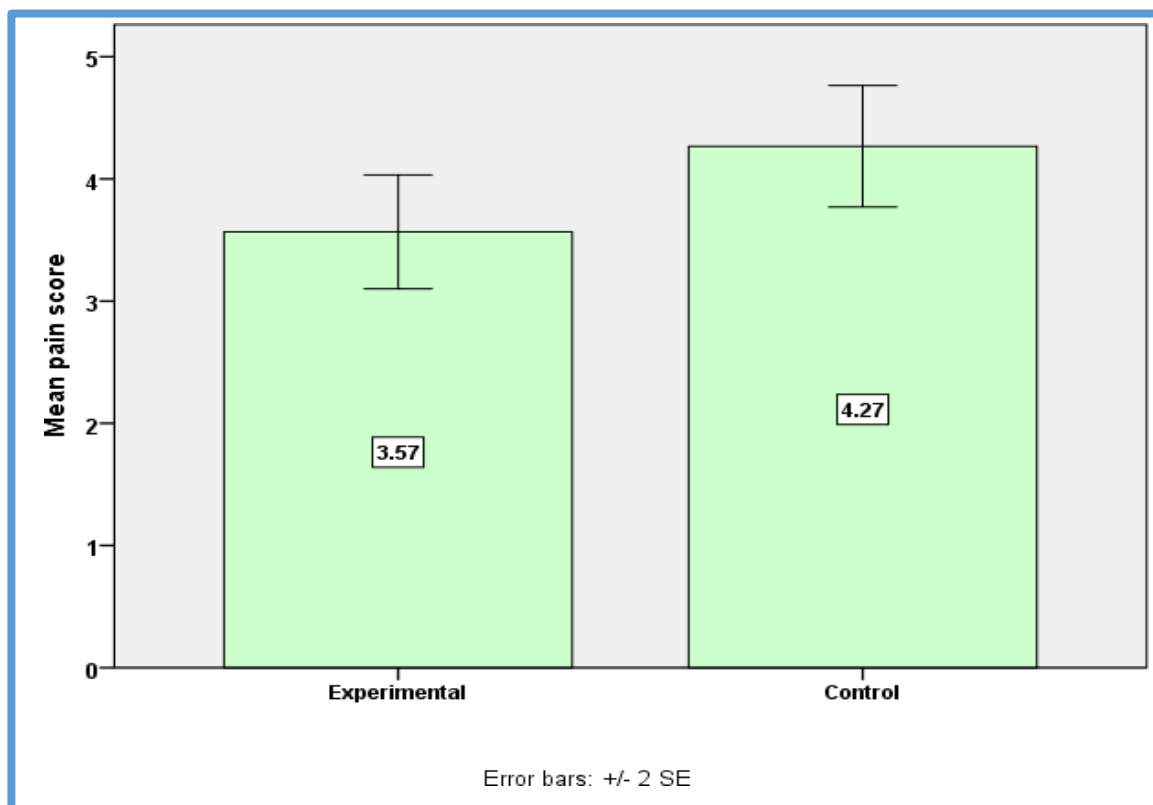


Figure 1: Mean pain score level in post test.

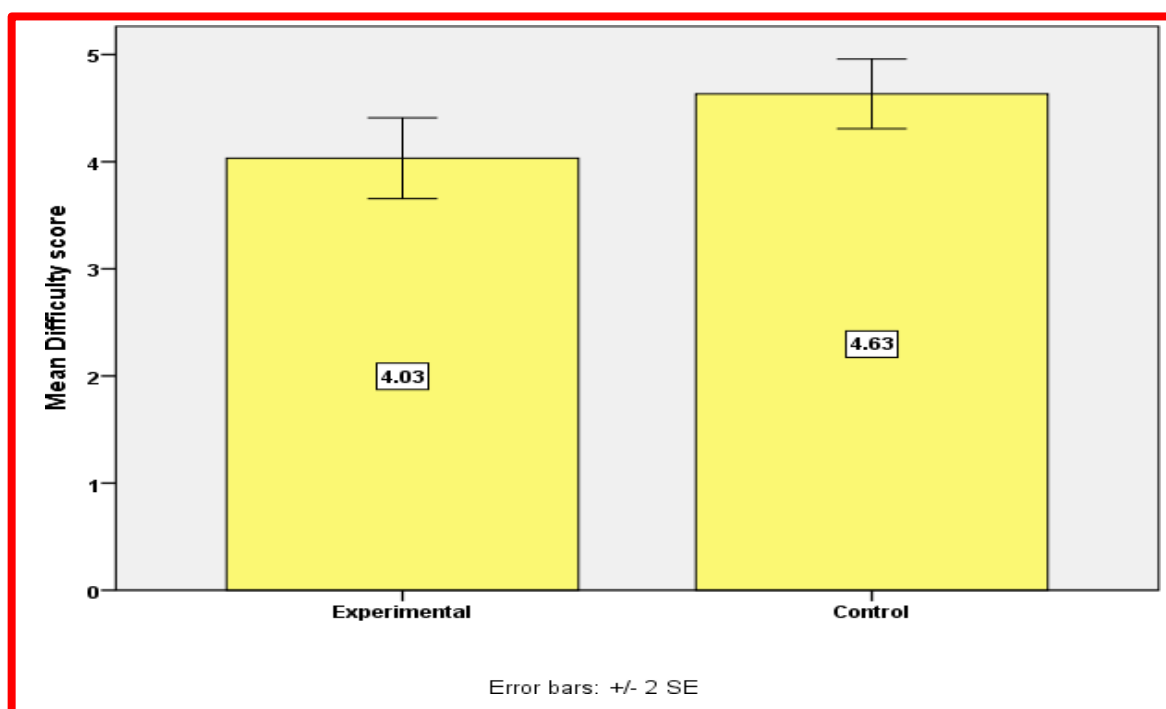


Figure 2: Mean difficult score level in post test.

Table 5: Correlation of level of difficulty on IV cannulation, first attempt success rate and pain level among experimental and control group.

Variables	Experimental group		Control group	
	Mean±SE	Karl Pearson Correlation coefficients	Mean gain score Mean±SE	Karl Pearson Correlation coefficients
Level of Pain and Level of Difficulty	3.57±1.28 4.03±1.03	r= 0.34***	4.27±1.36 4.63±0.89	r= 0.16*
Level of Pain and First attempt success rate	3.57±1.28 1.70±0.88	r= 0.38**	4.27±1.36 1.83±0.87	r= 0.22*
First attempt success rate and Level of difficulty	1.70±0.88 4.03±1.03	r= 0.42**	1.83±0.87 4.63±0.89	r= 0.32**

DISCUSSION:

The study indicate a reduction in the average number of attempts needed for successful catheter insertion in the experimental group, with a mean of 1.70 attempts compared to 1.83 in the control group, resulting in an improvement in first-attempt success rates. This finding aligns with previous literature suggesting that enhanced venous visualization significantly improves the success rates of PIVC Helmi et al. (2023) Loon et al., 2020). By using infrared technology, the vein finder increases the visibility of veins that may not be easily palpable or visible through traditional methods, thus simplifying the cannulation process for healthcare providers (Carr et al., 2015).

Moreover, the study reveals a marked decrease in pain perception among patients in the experimental group, indicated by a mean post-test pain score of 3.57 compared to 4.27 in the control group. The statistical significance of this difference ($t = 2.05$, $p = 0.05$) illustrates the importance of technological aids in reducing patient discomfort during medical procedures. This aspect is critical as pain during cannulation can lead to anxiety, fear, and an overall negative experience for patients, which has been documented in various studies (Lakshmikantha & Lakshman, 2021; Loon et al., 2021). Lower pain levels associated with the use of the LED-VF suggest enhanced procedural comfort for patients and could potentially improve overall satisfaction with their medical care (Cooke et al., 2018).

The associated statistical significance ($t = 2.15$, $p = 0.05$) underscores the effectiveness of the LED-VF in making the cannulation process simpler and more efficient (Keskin et al., 2021). Within the context of challenging venous access, the integration of advanced visibility techniques, such as the LED-VF, has become increasingly essential for clinical practice (Loon et al., 2019; Stolz et al., 2015). The correlation analysis

indicating moderate to strong relationships among pain, difficulty, and first-attempt success further supports the role of the device in improving PIVC outcomes, as it facilitates quicker and less painful procedures (Anderssen et al., 2022).

CONCLUSION:

The study concluded that using an infrared LED vein finder significantly reduced pain and procedural difficulty during peripheral IV cannulation, while improving first-attempt success rates. Overall, the device proved effective in enhancing cannulation outcomes.

RECOMMENDATION:

Future studies could replicate this research with larger samples in diverse settings to enhance generalizability, using probability sampling techniques for improved representation. Similar study can be conducted by comparing with other Transilluminating device for performing IV-line insertion. Similar study can be conducted with pediatric group.

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