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EFFECTIVENESS OF PROCESS MAPPING FOR LABORATORY CRITICAL VALUES NOTIFICATION ON NURSES' COMPETENCY

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Abstract

Background: Critical values in laboratory reports represent life-threatening abnormalities that demand immediate clinical attention. Nurses play a crucial role in recognizing and communicating these critical results promptly to ensure patient safety. This study aimed to evaluate the effectiveness of a process mapping–based educational intervention on nurses' competency in laboratory critical value notification.

Materials and methods: A quasi-experimental pre- and post-intervention design was adopted among 80 ward nurses from tertiary care hospital. Hospital, Chennai. Participants were selected through consecutive sampling and divided equally into control and intervention groups. The data were collected using Baseline data on demographic variables and competency (knowledge and skill) related to critical value notification were collected using validated tools. Data were analyzed using descriptive and inferential statistics.

Results: Post-intervention, nurses in the experimental group demonstrated a significant

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improvement in knowledge (mean difference = 3.15, $p < 0.001$) and moderate improvement in skills compared to the control group. Correlation analysis revealed a positive association between knowledge and skill levels in both groups. Attendance in continuing nursing education (CNE) sessions was significantly associated with overall competency ($p < 0.001$). Most participants found the process mapping method acceptable and beneficial for clinical application.

Conclusion:

The findings confirmed that process mapping is an effective educational strategy for enhancing nurses' knowledge and skills in laboratory critical value notification. Incorporating process mapping into routine training can promote better competency, faster communication, and improved patient safety outcomes.

Keywords: Critical value notification, Process Mapping, Competency, Nurses, Instructional program

BACKGROUND

A critical value is defined as a laboratory result so extremely abnormal that it indicates a potentially life-threatening condition requiring immediate clinical intervention (1). Prompt communication of such results is essential for timely decision-making and improved patient outcomes. Multiple international organizations, including the Joint Commission, emphasize the importance of critical value notification, with studies indicating that nearly two-thirds of these results lead to changes in therapy (1,2). Laboratory accreditation bodies worldwide, such as ISO and NABL, mandate immediate critical value reporting as part of good laboratory practice under ISO 15189:2012 standards (3,32).Despite these standards, global surveys reveal substantial variability in defining critical tests, notification thresholds, communication timelines, and reporting mechanisms. Lippi et al. (4) noted that although major organizations—such as the Joint Commission, CLSI, and the Royal College of Pathologists—agree on the need for rapid notification, implementation remains inconsistent worldwide. In India, the National Accreditation Board for Hospitals and Healthcare Providers (NABH) requires critical values to be communicated within 30 minutes of verification (5). However, compliance remains inconsistent across institutions. Nursing councils, including the Canadian Nurses Association (CNA) and the UK Nursing and Midwifery Council (NMC), underscore that prompt communication of critical results is a key component of nursing competency, encompassing both

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technical proficiency and effective communication (6,7).

A study conducted at a tertiary care hospital in Bengaluru reported that only 25.4% of critical values were communicated by telephone, 40.3% documented in the Laboratory Information System (LIS), and 9% were not reported at all, with a median turnaround time of 72–76 minutes (8). Such findings highlight gaps in critical value communication and documentation. Although many hospitals have adopted electronic health records and laboratory information systems, direct telephone notification remains the most common method of communication (9). Guidelines, however, do not consistently define who should receive the notification—physician or nurse—leading to variability in accountability. The Joint Commission's National Patient Safety Goals (NPSG 02.03.01) specifically prioritize the safe and timely communication of critical results (2,10).Recent studies emphasize that continuous improvement in critical value notification protocols is essential for maintaining accreditation and ensuring patient safety (11,12). Hospitals such as Bima Regional General Hospital have implemented national indicators targeting 100% compliance with critical value reporting (12). Effective systems must include defined thresholds, timely communication, verification procedures, documentation, and clear role delineation. Despite global standardization efforts by ISO 15189:2022, the College of American Pathologists (CAP), and the Clinical and Laboratory Standards Institute (CLSI), practice variation persists (13). Therefore, structured process improvement strategies, such as process mapping, are needed to streamline workflows, enhance communication, and strengthen nursing competencies in the management of critical laboratory values (16,33).

OBJECTIVES

The objectives of the Study was to assess the pre-intervention and post-intervention competency on process mapping for laboratory critical values notification among control and intervention group of ward nurses in tertiary care hospital nurses . The second objectives of the study to find the association between the level of competency on process mapping for laboratory critical values notification and the selected demographic variables among control and intervention group of ward nurses.

MATERIALS AND METHODS

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A quasi-experimental pre–post design was adopted for this study conducted in two tertiary care centers at Chennai. A total of 80 ward nurses (40 in each group) were selected using a consecutive sampling technique. Data were collected using pretested and predetermined tools such as demographic variables proforma, structured knowledge questionnaire, and Objective Structured Clinical Examination (OSCE) checklist. After obtaining ethical clearance from the Institutional Ethics Committee and necessary administrative permissions, a pilot study was conducted to assess feasibilit. Pre-intervention competency (knowledge and skill) was assessed for both groups using the same validated tools. The intervention group received a structured instructional program on *Process Mapping for Laboratory Critical Values Notification,* consisting of a 20-minute didactic PowerPoint presentation followed by hands-on OSCE-based skill station training, while the control group continued with their routine clinical education activities. Post-intervention assessment was conducted five days after completion of the training for both groups using the same tools to measure changes in competency levels. Program acceptability was also evaluated among the intervention group. Data were analyzed using descriptive and inferential statistics to determine the effectiveness of the process mapping intervention.

Ethical Considerations:

The study was reviewed and approved by the institutional ethical committee and review board. Each participant was given a thorough explanation on a subject information sheet before to being included in the trial, and their written informed consent was obtained.

Instruments

The study instruments consisted of demographic data performa including– age, gender, educational status, working experience and previous CNE attended, The structured knowledge questionnaire was developed by the researcher which was used to assess the knowledge of ward nurses, which consisted of 25 multiple choice questions. Each question has 4 options with one right answer, Each correct response was awarded with “1” mark and wrong response was scored as “0”. Hence, the total obtainable score ranges from 0 to 25. The total obtained score was converted to percentage and interpreted as following categories: Adequate (21-25), Moderately adequate (16-20), Needs improvement (≤ 15), The **skills of ward nurses** on process mapping of laboratory critical value notification were assessed using an **observation checklist** through a

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structured OSCE setup consisting of **2 manned** and **3 unmanned stations**. The 1st manned station was focused to assess the nurse's ability to receive and notify critical values, while the 2nd station was focused on receiving orders and implementing interventions. The 3 unmanned stations included identifying signs and symptoms of critical values, matching critical values with affected organ images, and identifying critical values from a list. A **structured checklist** was developed by the investigator for 5 station (each with 10 items to be scored) was used to evaluate performance. Each station was allotted **5 minutes**, and scoring was done for each item in the checklist as "**1" if performed** and "**0" for not performed**, with a global score ranging from 0 to **50.** The total obtained score was converted into **percentage** and categorized to interpret as follows: Adequate skill (36-50), Moderately adequate skills (21- 35) and Need improvement in skills(≤ 20). Rating scale to assess acceptability of the program (intervention group),The rating scale was designed by the investigator to assess the level of acceptability among the intervention group of ward nurses, regarding acceptability of process mapping for laboratory critical values notification among ward nurses. Obtainable score scale range from is 0-3 for each item in 4-point rating scale as follows : Highly acceptable (24-30), Acceptable (17-23), Unacceptable (9-16) and Highly unacceptable (0-8).

Validity and Reliability

The content validity of the instruments was ensured by subject experts. On the advice of the subject matter experts, necessary amendments were made to the instruments. instruments. The reliability of the structured knowledge questionnaire was determined using the test-retest reliability method, which showed a reliability coefficient of 0.87, which was very stable. The reliability of the OSCE checklist was determined using the inter-rater reliability method, and a very high reliability coefficient of 0.98 was shown

Pilot Study

The pilot study was conducted with 10% of the sample size to determine the feasibility and reliability of the instrument within the local population. The sampled participants were not included in the main study.

Data Collection Procedure:

After obtaining institutional IEC clearance and permission hospital from authority, a total of 80 ward nurses from two settings, who fulfil the inclusion criteria were selected by consecutive sampling technique and was allocated for the interventional and control group. The researcher

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introduced herself, briefed the purpose of the study and the informed consent was obtained from the ward nurses to participate in the study. Pre-intervention assessment was done by administering the predetermined data collection instruments among the control and intervention group of ward nurses using the demographic variables proforma, followed by assessment of baseline competency. The intervention was delivered only to the intervention group (fig.1), while the control group continued with routine duties and received no training during the study period. The program was planned for the ward nurses at Apollo cancer centre, Chennai.

For ease of scheduling and to minimize disruption of routine clinical work, the 40 nurses in the intervention group were divided into two batches of 20 participants each. Each batch underwent the intervention (didactic session on process mapping for critical value notification-fig-1) separately, and the schedule was aligned with their respective shift duties to ensure maximum participation without compromising patient care. The total duration for each batch was approximately two hours, including briefing, rotation, and debriefing. Thus, for each batch of 20 participants, the intervention session lasted approximately 2 hours, including briefing, skill rotation, and debriefing. Over the course of the intervention period, all 40 nurses in the intervention group completed the structured training, ensuring uniform exposure. Both groups underwent the post-intervention assessment using the same structured knowledge questionnaire and OSCE checklist five days after completion of the intervention for the intervention group. Additionally, the level of acceptability rating scale was administered to the intervention group of nurse training. The collected data was organized for analysis.

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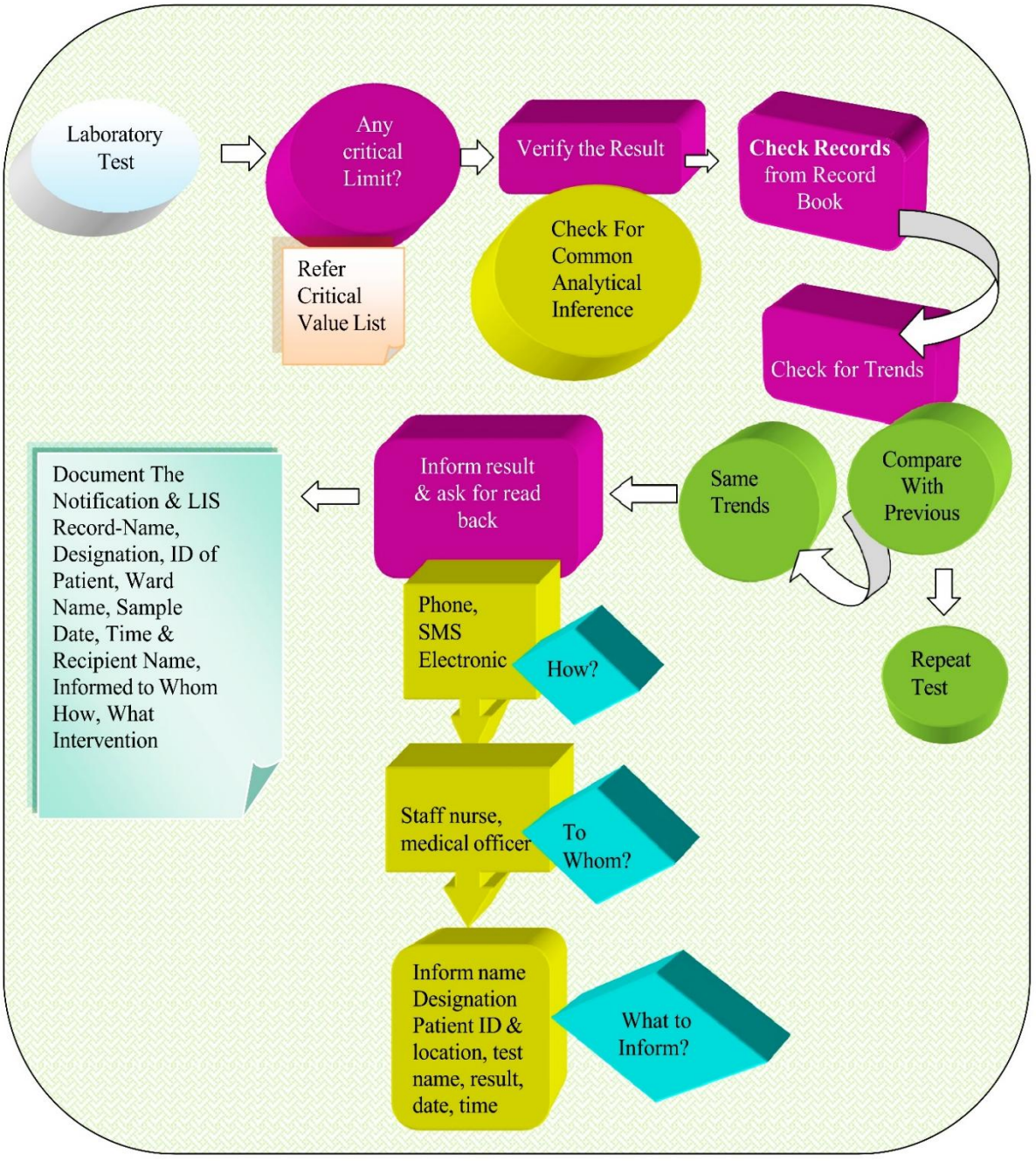

FIG:1 Process Mapping on Critical Value Notification

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Table 1. Frequency and Percentage Distribution of Background Variables of Ward Nurses **N=80**

Demographic variables	Control group (n=40)		Intervention group (n=40)	
	f	%	f	%
Age (in years)				
21-25	34	85	36	90
26-30	6	15	4	10
>30	0	0	0	0
Mean age ± SD	Mean =23.4 ±1.17		Mean =23.72 ±1.37	
Sex				
Male	0	0	21	52.5
Female	40	100	19	47.5
Educational status				
GNM	3	7.5	0	0
B.Sc (N) / P.BBSc (N)	37	92.5	40	100
Msc(N)	0	0	0	0
Working experience in years				
< 1	20	50	36	90
1-3	15	37.5	1	2.5
>3	5	12.5	3	7.5
Previous CNE attended				
Yes	22	55	17	42.5
No	18	45	23	57.5

Table 2: Comparison of Pre-intervention and Post- intervention Knowledge Scores of Ward Nurses Regarding Process Mapping on Critical Value Notification in Control

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Group (n=40)

Components	Max obtainable score	Pre-intervention		Post intervention		Mean Diff (MD)	% of MD	Paired 't' & 'p' value
		Mean	SD	Mean	SD			
Concepts & purpose	4	1.87	0.64	1.92	0.65	0.05	0.125	1.43 0.15
Critical values	7	4.85	1.44	4.9	1.29	0.05	0.125	0.57 0.57
Notification	9	4.37	1.40	4.3	1.18	0.07	0.175	0.90 0.37
Responsive & documentation	5	3.25	0.66	3.27	0.71	0.02	0.05	0.57 0.57
Global score	**25**	**14.34**	**4.14**	**14.39**	**3.83**	**0.05**	**0.125**	**0.29 0.76**

Table 3. Comparison of Pre-intervention and Post - intervention Knowledge Scores of Ward Nurses Regarding Process Mapping on Critical Value Notification in Intervention Group

n=40

Components	Max obtainable score	Pre-intervention		Post intervention		Mean Diff (MD)	% of MD	Paired t & p value
		Mean	SD	Mean	SD			
Concepts & purpose	4	1.87	0.93	2.95	0.67	1.08	2.7	6.81 <0.001
Critical values		4.1	1.29	5.3	1.32	1.2	3	5.90 <0.001

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	7							
Notification	9	4.15	1.29	5.8	1.24	1.65	4.12	7.62 <0.001
Responsive & documentation	5	2.42	0.95	3.5	0.87	1.08	2.7	7.65 <0.001
Global score	**25**	**12.54**	**4.46**	**17.55**	**4.1**	**5.01**	**12.52**	**27.98 0.00004**

Table 4. Comparison of Pre intervention and Post intervention Skill Scores of Ward Nurses Regarding Process Mapping on Critical Value Notification in Control Group

n=40

Stations	Pre intervention		Post intervention		Mean Diff (MD)	% of MD	Paired 't' & 'p' value
	Mean	SD	Mean	SD			
Critical Values Information receiving and notification process (Manned)	4.37	1.12	4.52	1.13	0.15	0.37	2.22 0.03
Critical Values- receiving the order and Implementation process (Manned)	4.3	0.96	4.32	0.94	0.02	0.05	0.57 0.51
Critical Values signs and symptoms (Unmanned)	2.65	1.45	3.02	1.09	0.37	0.92	3.06 0.003
Match the critical value with the affected organ picture (Unmanned)	4	2.12	4.35	1.84	0.35	0.87	3.00 0.004

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Identifying the critical laboratory values (Unmanned)	6.17	1.85	6.27	1.73	0.1	0.25	1.66 0.10
Global scores	**21.49**	**7.5**	**22.48**	**6.73**	**0.99**	**2.47**	**4.654** **0.004**

Table 5: Comparison of Pre-intervention and Post-intervention Skill Scores of Ward Nurses Regarding Process Mapping on Critical Value Notification in Intervention Group

(n=40)

Stations	Max obtainable score	Pre intervention		Post intervention		Mean Diff (MD)	% of MD	Paired t & p value
		Mean	SD	Mean	SD			
Critical Values Information receiving and notification process (Manned)	10	5.12	1.06	5.6	1.29	6.4	16	2.55 <0.01
Critical Values-receiving the order and Implementation process (Manned)	10	4.75	1.00	5.25	1.21	0.5	1.25	2.59 <0.01
Critical Values signs and symptoms (Unmanned)	10	2.1	1.48	2.75	1.73	0.65	1.62	2.45 <0.01
Match the critical value with the affected organ picture (Unmanned)	10	3.15	1.29	5.4	3.01	2.25	5.62	4.74 <0.001
Identifying the critical laboratory	10	4.42	4.46	5.47	1.82	1.05	2.62	3.53 <0.001

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values (Unmanned)								
Global scores	**50**	**19.54**	**9.29**	**24.47**	**9.06**	**10.85**	**27.12**	**4.55 0.005**

Table 6: Comparison of Knowledge and skill Scores on Process Mapping on Critical Value Notification between Control and Intervention Group of ward Nurses

(N=80)

Variables	**Assessment**	**Control group (n=40)**		**Intervention group (n=40)**		**MD* (%)**	**t & p value**
		Mean	**SD**	**Mean**	**SD**		
Knowledge	Pre Intervention	14.34	4.14	12.55	4.46	1.8	2.25
	Post Intervention	14.39	3.83	17.55	4.1	3.15	3.93
Skill	Pre-Intervention	21.5	7.5	19.55	9.29	1.95	2.43
	Post Intervention	22.5	6.73	24.47	9.06	1.97	2.46

*MD – Mean Difference

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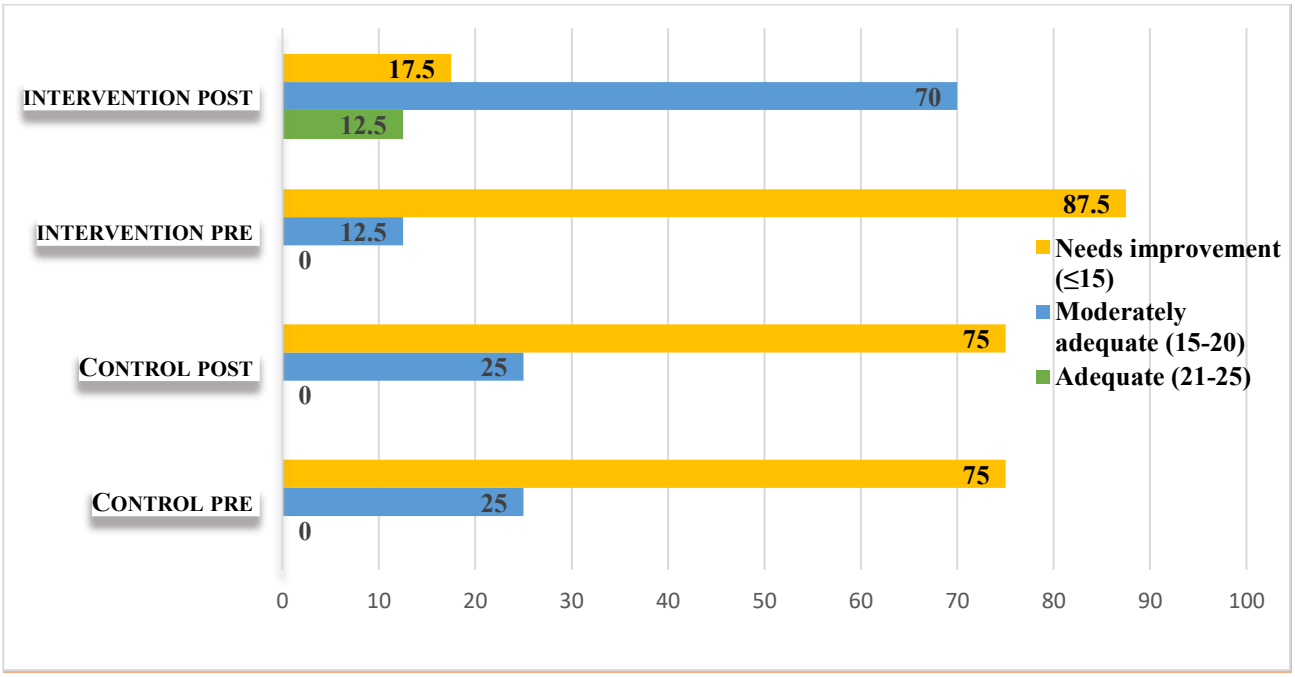

Fig.2 Frequency and Percentage Distribution of Level of Knowledge among Ward Nurses Regarding Process Mapping on Critical Value Notification on Control and Intervention group

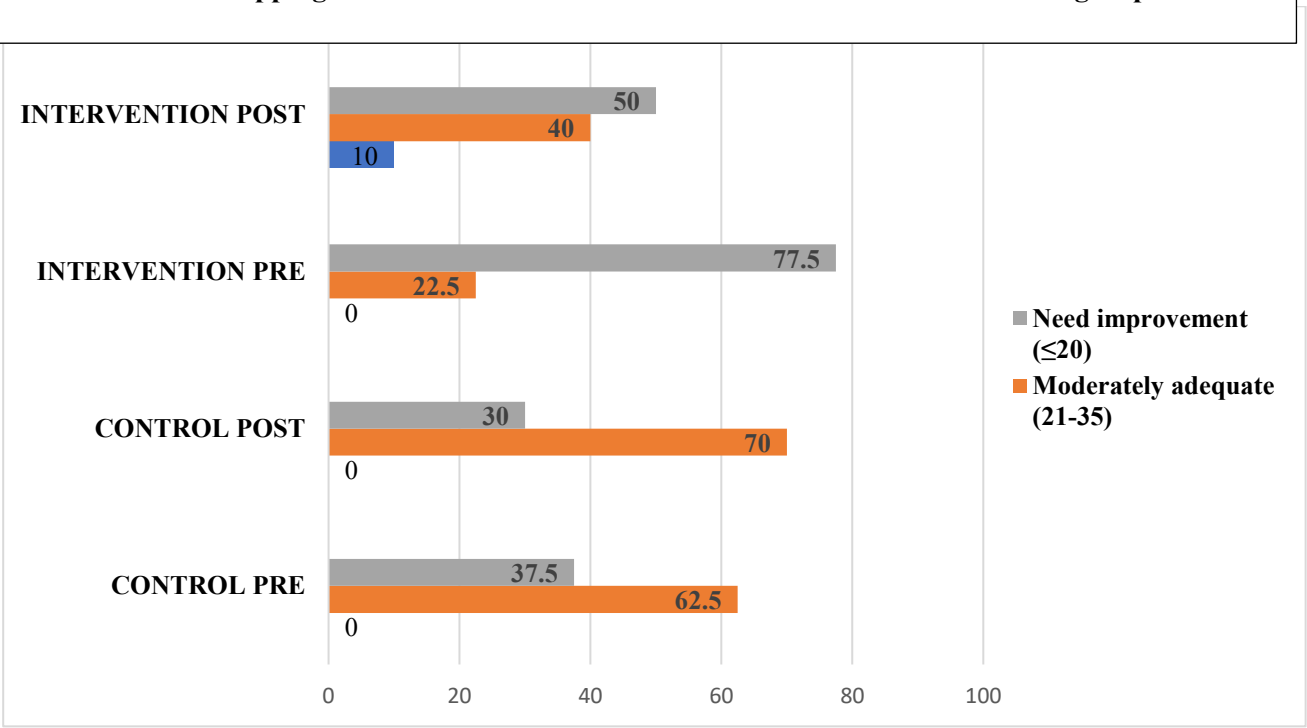

Fig.3 Frequency and Percentage Distribution of Level of Skill among Ward Nurses Regarding Process Mapping on Critical Value Notification on Control and Intervention group

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RESULTS

The distribution of background variables of ward nurses is presented in **Table 1**. The majority of participants in both the control and intervention groups were aged **21–25 years** (85% and 90%, respectively), with comparable mean ages (23.4 ± 1.17 years in the control group and 23.72 ± 1.37 years in the intervention group). All nurses in the control group were female, whereas the intervention group comprised **52.5% males and 47.5% females**. Regarding educational status**, 92.5% of nurses in the control group** and **100% in the intervention group** had completed **B.Sc. Nursing or P.B.B.Sc. Nursing**. In terms of work experience, **50% of nurses in the control group** and **90% in the intervention group** had **less than one year of experience.** Attendance at previous Continuing Nursing Education (CNE) programs on critical value notification was reported by **55% of nurses in the control group** and **42.5% in the intervention group**. Comparison of pre-intervention and post-intervention knowledge scores in the control group is shown in **Table 2**. Minimal changes were observed across all knowledge components, including concepts and purpose, critical values, notification, and responsive documentation. The global knowledge score increased marginally from **14.34 ± 4.14** to **14.39 ± 3.83,** and the difference was **not statistically significant (p = 0.76),** indicating no meaningful improvement in knowledge among nurses who did not receive the intervention. In intervention group demonstrated a **statistically significant improvement** in knowledge following the process-mapping intervention, as shown in **Table 3.** The post-test global knowledge score **(17.55 ± 4.10)** was significantly higher than the pre-test score **(12.55 ± 4.46; p < 0.001)** and also significantly higher than the post-test knowledge score of the control group **(14.39 ± 3.83; Table 6).** Significant improvements were observed across all domains of knowledge, including **concepts and purpose, understanding of critical values, notification procedures, and responsive documentation** ($p < 0.001$ for all components).The comparison of pre- and post-intervention skill scores in the control group is presented in **Table 4.** Although statistically significant improvements were observed in selected skill stations such as **critical value information receiving and notification, recognition of signs and symptoms,** and **matching critical values with affected organs,** the overall improvement was limited. The global skill score increased from **21.49 ± 7.50** to **22.48 ± 6.73,** indicating only a modest enhancement in skill performance. Skill scores in the intervention group, as shown in (**Table 5),** demonstrated a

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marked improvement following the intervention. The post-intervention global skill score **(24.47 ± 9.06)** was higher than the pre-intervention score (**19.54 ± 9.29; p = 0.005).** Significant improvements were noted across all skill stations, with the highest gains observed in **matching critical laboratory values with affected organs** and **identifying critical laboratory values** ($p < 0.001$). These findings are further illustrated in **Figure 3**, which depicts the improvement in overall skill performance following the intervention. A comparison of knowledge and skill scores between the control and intervention groups is summarized in **Table 6**. At baseline, both groups were comparable in knowledge and skill scores. Post-intervention analysis revealed significantly higher knowledge scores in the intervention group compared to the control group, while post-intervention skill scores also showed an upward trend in the intervention group. Additionally, a **statistically significant positive correlation** was observed between knowledge and skill scores in both pre-test and post-test assessments among nurses in the intervention group **($p < 0.01$),** as illustrated in **Figure 2.** Acceptability assessment revealed that the majority of nurses in the intervention group **(70%)** rated the process-mapping strategy as **highly acceptable (Figure 1).** Among the demographic variables, **attendance of CNE programs** was the only factor significantly associated with competency levels in the control group **($p < 0.001$**).

Discussion

The present study demonstrated that process mapping is an effective educational strategy for improving ward nurses' competency in managing laboratory critical value notifications. The statistically significant improvement in post-test knowledge scores among nurses in the intervention group indicates that structured and visual learning approaches enhance comprehension of complex clinical workflows. Process mapping enables nurses to clearly visualize sequential steps, roles, and communication pathways involved in critical value notification, thereby reducing ambiguity and promoting standardization of practice. Similar findings were reported by previous studies (14), which highlighted that the incorporation of process maps in laboratory workflows resulted in improved communication efficiency and reduced delays in critical value reporting.The significant improvement observed across all knowledge domains—concepts and purpose, understanding of critical values, notification

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procedures, and responsive documentation suggests that process mapping supports both conceptual clarity and procedural understanding. These findings align with reports by other investigators (16,17), who emphasized that process mapping enhances system transparency and facilitates shared understanding among healthcare professionals, leading to improved adherence to safety protocols.Although the improvement in skill scores in the intervention group was evident, the difference between pre- and post-test skill performance was comparatively less pronounced than knowledge gains. This finding may be attributed to the fact that psychomotor skills and clinical judgment often require repeated practice and prolonged exposure to achieve measurable improvement. Nevertheless, the upward trend in skill scores indicates meaningful practical benefits of the intervention. Similar observations have been reported in earlier studies (14), where skill-related outcomes showed gradual improvement following structured workflow-based interventions.

A significant positive correlation between knowledge and skill scores in both pre-test and post-test assessments among nurses in the intervention group further reinforces the interrelationship between theoretical understanding and clinical performance. This finding supports the premise that enhanced knowledge directly translates into improved skill execution. Consistent with this, earlier studies (15) reported that educational interventions significantly improved nurses' evidence-based practice knowledge, skills, and confidence, thereby strengthening clinical decision-making and patient safety outcomes.High acceptability of the process-mapping approach among nurses in the intervention group underscores its feasibility and relevance in clinical settings. The majority of participants rated the intervention as highly acceptable, indicating that process mapping is perceived as a user-friendly, collaborative, and engaging learning method. This finding is consistent with prior research (16,17), which identified process mapping as an effective quality improvement tool that promotes stakeholder engagement, interdisciplinary collaboration, and system clarity. In the present study, no significant association was found between demographic variables and competency levels in the intervention group, suggesting that process mapping benefits nurses irrespective of age, gender, educational qualification, or years of experience. This highlights the universal applicability of process mapping as a training strategy. Similar conclusions were drawn by previous researchers (16,33), who reported that process mapping enhanced performance across diverse healthcare

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contexts and professional backgrounds. However, among nurses in the control group, attendance at Continuing Nursing Education programs was significantly associated with competency levels, emphasizing the importance of ongoing professional education in the absence of structured interventions. This finding underscores the need for systematic educational strategies rather than reliance on routine clinical exposure alone.Despite the strengths of the study, certain limitations must be acknowledged. The study was conducted in a single center with a relatively small sample size, which may limit the generalizability of the findings. Additionally, the post-test assessment was conducted shortly after the intervention, preventing evaluation of long-term knowledge retention and sustained skill performance. Future multicentric studies with larger sample sizes and longitudinal follow-up are recommended to assess the durability of learning outcomes and the impact of process mapping on patient safety indicators, such as timeliness of critical value notification and adverse event reduction. Overall, the findings of this study provide strong evidence that process mapping is an effective and acceptable educational intervention for strengthening nurses' competency in laboratory critical value notification. Integrating process mapping into in-service education programs and undergraduate and postgraduate nursing curricula can enhance communication efficiency, foster teamwork, and promote a culture of safety and accountability within hospital settings.

Conclusion

Process mapping significantly improved nurses' knowledge and competency in managing laboratory critical value notifications and was well accepted among participants. The intervention demonstrates potential for integration into nursing education and hospital quality-improvement frameworks to enhance communication efficiency and patient safety.

Conflict of Interest: Nil

Limitation

The study was limited to the data collection period of eight weeks only and ward nurses working in selected tertiary care hospitals, Chennai. A true experimental study could not conducted due to practical constraints.

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