Original Article

doi:10.31674/mjn.2025.v17i02.023

MJN

Exploring Knowledge and Practice of Critical Care Unit Nurses with a View to Develop and Evaluate the Effectiveness of Hemodynamic Monitoring Guidelines

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ABSTRACT

Background: Critically ill patients often suffer from a complex cardiopulmonary instability. This instability requires an integrated approach of continuous monitoring. Nurses working in critical care units often found themselves having limited knowledge and practices, which led to inappropriate interventions. **Objectives:** To assess knowledge and practice of CCU nurses on monitoring selected haemodynamic parameters. To develop and evaluate the effectiveness of selected haemodynamic monitoring guidelines in terms of improvement of knowledge and practice. **Methods:** The 1st phase was an exploratory study among 300, and the 2nd phase was a quasi-experimental study among 60 nurses. Data was collected using the convenience sampling technique with a self-reported knowledge questionnaire and practice observation checklist. **Results:** Most of the first-phase nurses (57.67%) were in the age group of 25-28 years, and 212 (70.67%) were diploma nurses (GNM). As per level of knowledge, 11 (3.67%) and 146 (49%) had poor and average knowledge, whereas only 65 (21.67%) and 78 (26%) had good and very good knowledge. Regarding practice, the majority, 181 (60.33%), had an average practice score, while only 107 (35.67%) demonstrated good practice. The statistical data revealed a significant positive association between the level of knowledge and the stream of nursing education (χ^2=16.21), professional qualification (χ^2=17.19), and critical care specialisation (χ^2=77.47). In the 2nd phase, a paired t-test highlighted that the pre-test and post-test mean knowledge score difference was 18.93, SD 5.24, with a significant *t*-value of 27.99, and the pre-test and post-test mean practice score difference was 26.95, SD 7.88, with a significant *t*-value of 26.50, at $P<0.05$. **Conclusion:** Hence, haemodynamic monitoring guidelines were able to improve CCU nurses' knowledge and practices.

Keywords: Critical Care Unit; Guidelines; Hemodynamic Monitoring

INTRODUCTION

Monitoring of central venous pressure, arterial blood pressure, pulmonary artery wedge pressure and peripheral oxygen saturation is an important dimension of a patient's vital assessment. Its effectiveness depends on nurses' knowledge and practice (Pinsky *et al*., 2022). Nurses' adequate knowledge and practice can enable them to identify the errors quickly (Brezić *et al*., 2021) as they are playing a pivotal role in caring (Howthan, 2024). Nearly 60% of the healthcare workforce is occupied by nurses, and they could drive transformative changes in health care (Fokeladeh *et al.*, 2024). Haemodynamic monitoring monitors the functional status of all vital organs (Amarilla *et al*., 2025). In the critical care unit, 10 to 15% of patients are admitted with critically ill conditions and need continuous monitoring (Diamond *et al.*, 2024). Monitoring of haemodynamic parameters is an essential responsibility of nurses (Rali *et al*., 2022). The correct methods of monitoring provide actual information about the relationship between demands and fulfilments to avoid organ failure (Farah & Khleif, 2024).

Nurses who care for critically ill and vulnerable patients need continuous updated education. They should have optimal brain function in monitoring (Yang *et al.*, 2025). One study reported that nurses' knowledge and

Received: July 21, 2025; Received in revised form: September 23, 2025; Accepted: September 28, 2025

self-efficacy in the management of vascular access devices needs continuous training (Giusti *et al.*, 2024), as it was found that only 61.25% of nurses had a fair level of knowledge compared to 22.50% who had a good level (Mostafa *et al.*, 2023).

It was evident that monitoring of critically ill patients needs adequate knowledge and practice. One survey research was conducted among 100 ICU nurses in Tehran, which explored that ICU nurses had poor levels of skills (52.56%) towards assessment of vital monitoring and needed in-service training (Jeshvaghani *et al.*, 2021). Another study was conducted among CCU nurses in Turkey, and it reported that nurses had poor knowledge of CVP monitoring with a 30-degree head angle (Avcı & Yılmaz, 2024). Arterial blood pressure monitoring is an invasive monitoring which needs sophisticated skill (Gazerani *et al.*, 2024). Critical care nurses should have sophisticated knowledge and skills toward effective haemodynamic monitoring (McEvoy *et al.*, 2025). Many nurses are not familiar with handling the new devices in monitoring (Huang *et al.*, 2024). In this regard, technical and medical advancement, caregivers' roles and responsibilities through structured systems monitoring, as well as clinical guidelines for effective utilisation, are required (Teesdale, 2025).

This study aimed to explore nurses' knowledge and practice towards haemodynamic monitoring and evaluate the effectiveness of haemodynamic monitoring guidelines in terms of improvement of knowledge and practice among critical care nurses.

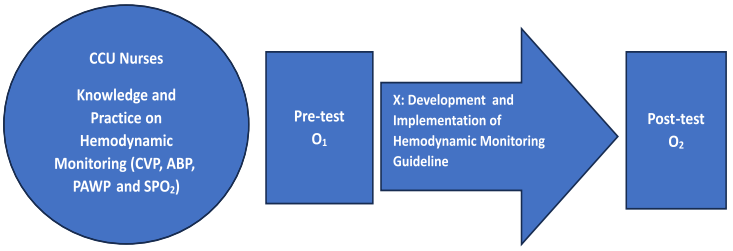
METHODOLOGY

Nursing research is a systematic investigation (Mori, 2024). It helps to explore the facts effectively (Thomas & Zubkov, 2023). Data was collected using convenience sampling techniques, the act of selecting the sample based on their accessibility (Makwana *et al.*, 2023).

Research Approach and Design: Quantitative Research Approach

1st Phase: The exploratory research design explored nurses' knowledge and practice on hemodynamic monitoring.

2nd Phase: A Quasi-Experimental One-Group Pre-test Post-test research design assessed, implemented and evaluated the effectiveness of haemodynamic guidelines among nurses working in CCU.



CVP: Central Venous Pressure, ABP (Arterial Blood Pressure), PAWP (Pulmonary Arterial Wedge Pressure), SPO2 (Peripheral Capillary Oxygen Saturation)

Figure 1: One Group Pre-test Post-test Research Design on Hemodynamic Monitoring Guideline

Figure 1 shows that O_1 and O_2 [O_1 = Pre-test Observation (CVP, ABP, PAWP, SPO_2) O_2 = Post-test Observation (CVP, ABP, PAWP, SPO_2)]: Pre-test and Post-test: Assessment of Knowledge and Practice of Hemodynamic Monitoring of Central Venous Pressure (CVP), Arterial Blood Pressure (ABP), Pulmonary artery wedge Pressure (PAWP) and Peripheral capillary oxygen saturation (SPO_2)

Development and Implementation of Hemodynamic Monitoring Guideline

Table 1: Validated Hemodynamic Monitoring Guideline

Sl. No.	Selected Hemodynamic Monitoring Parameters	Method of Educational Intervention
1.	CVP (Central Venous Pressure)	Power Point, Booklet and Handson training 1. Devices 2. Patient positioning 3. Measurement 4. Recording
2.	ABP (Arterial Blood Pressure)	
3.	PAWP (Pulmonary Arterial Wedge Pressure)	
4.	SPO_2 (Peripheral Capillary Oxygen Saturation)	

Table 1 primarily covers four major areas of haemodynamic monitoring: Central Venous Pressure (CVP), Arterial Blood Pressure (ABP), Pulmonary Artery Wedge Pressure (PAWP), and Peripheral Capillary Oxygen Saturation (SPO_2). The contents of this guideline include an introduction, types of monitoring, patient positioning, and essential requirements for monitoring, such as the phlebostatic axis, labelling, flushing, calibration, and zeroing of the transducer.

The CVP monitoring section outlines the indications and steps for measuring central venous pressure, the associated waveform, and the pressure measurement values. The arterial pressure monitoring section covers the indications for arterial pressure monitoring, the steps for measuring arterial blood pressure, mean pressure, the waveform, and the significance of the dicrotic notch. The pulmonary arterial pressure and pulmonary capillary wedge pressure sections include the indications, measurement steps, waveform interpretation, and pressure values. The non-invasive oxygen saturation section details the indications and steps for measurement, along with the plethysmograph. Additionally, the guideline includes a remarks column and a space for the nurse's signature. It also references conditions where pressure values may vary and provides clarification and descriptions of the waveforms to help in understanding the components of the waveforms.

The guidelines were reviewed by eight experts, selected for their expertise and experience in the field. The content validity index (CVI) criteria, as evaluated by the experts, scored 4.5 across four items, resulting in a calculated CVI score of 0.90, which is higher than the targeted reference index of 0.75. The reliability of the guidelines was established using two methods: the inter-rater test and Cohen's kappa reliability. In the first method, there was a 97.15% agreement between the two raters, and in the second method, the correlation coefficient was 0.92, indicating that the guidelines were reliable.

This validated and reliable guideline demonstrated its effectiveness by enhancing the knowledge and practice of CCU nurses in haemodynamic monitoring. This finding is supported by other studies, which suggest that effective training in haemodynamic monitoring can improve the knowledge and practice of CCU nurses (Hashmi, 2024; Li *et al.*, 2024; Lommi *et al*., 2025).

Population: Critical care nurses who were working in critical care units and assessing the vital parameters of the haemodynamic condition of patients.

Sample: 1st phase: 300 critical care nurses; 2nd phase: 60 nurses, who need training as they have average knowledge and practices.

Sample Size: Based on previous research study findings regarding CCU nurses' knowledge and skills on haemodynamic monitoring (52.56%) and availability of sample in the accessible areas of CCU, Kolkata, West Bengal, India, the size used here follows 2-tailed formulas (Kang, 2021).

$$A = n/(1+(n-1)/P) = 300 / (1+(299/50{,}000)$$ Here n = accessible sample, P = Population

$$= 300 / (1+ 0.00598)$$ Here A = adjusted sample CI= 95%, Margin error 5%

$$= (300/1.00598) = 298.216$$

In this study, 300 participants were selected based on their availability and accessibility on knowledge, and practice level in haemodynamic monitoring.

Data Collection Procedure

Data toward collection of hemodynamic monitoring parameters provides essential information (Baldetti *et al.,* 2025). In this study, data was collected in the following two phases.

1st phase

Self-reported data was collected from 300 critical care nurses working in two different hospitals at critical care units on knowledge and Observation Technique for practice of arterial blood pressure, central venous pressure, pulmonary artery wedge pressure and SPO_2 from June 2024 to August 2024.

2nd phase

Based on the 1st phase's assessment, guidelines on selected parameters of haemodynamic monitoring were developed and validated by 8 experts in the field of nursing, then implemented among those nurses who had

poor and average levels of knowledge and practice to evaluate the effectiveness of haemodynamic monitoring guidelines from September 2024 to February 2025.

Validity and Reliability of the Tool

The Tool 1, knowledge questionnaire and Tool 2, observation checklist, along with the haemodynamic monitoring guidelines, were validated by 8 experts from critical care nursing.

The reliability of the Knowledge questionnaire computed by the test-retest reliability technique, using Karl Pearson's Product Moment Correlation Coefficient Formula; it was found 0.95, indicating high reliability. And the reliability of the Structure observation checklist was done by interrater reliability test (% agreement) and rank difference method. Each item in the observation list was discussed, made clear and then re-tested after minor changes which indicated the tool is reliable.

Ethical Consideration

The present study received ethical approval from the ethics committees of two hospitals. Approval was obtained from Fortis Hospital Anandapur, Kolkata with Reg. No.: ECR/240/Inst/WB/2013 RR-19 (Letter No.: 267/EC/PhD/2023, on 27th April 2023 and from Ruby General Hospital Pvt. Ltd., Kolkata with reference number IEC-RGH/KOL/2021/002/CS, on 26th July 2023.

RESULTS

1st Phase:

Table 2: Frequency and Percentage Distribution of Demographic Profile n=300

Criteria	Range / Values	Frequency	Percentage
Age in year	21-24	49	16.33%
	25-28	173	57.67%
	29-32	63	21.00%
	33-36	14	4.67%
Sex	M	65	21.67%
	F	235	78.33%
Stream	Science	139	46.33%
	Arts	151	50.33%
	Commerce	10	3.33%
Qualification	M.Sc. Nursing	1	0.33%
	GNM	212	70.67%
	Post Basic B.Sc. nursing	9	3.00%
	B. Sc	77	25.67%
Critical care Specialization	No	155	51.67%
	Yes	145	48.33%
Designation	In-charge	8	2.67%
	Staff Nurse	246	82.00%
	Shift In-charge	46	15.33%
Working experience (in years)	1-4 years	26	8.67%
	5-8 years	192	64.00%
	9-13 years	62	20.67%
	13-16years	18	6.00%
	>17 years	2	0.67%
Critical Care Experience (in Years)	<1-3	222	74.0%
	4-6	52	17.3%
	7-9	24	8.0%
	10-12	2	0.7%%

Table 2 showed that the majority of the critical care nurses, 173 (57.67%), belonged to the age group of 25-28 years, and 235 (78.33%) were female nurses. As per educational value, out of 300 participants, 151 (50.33%) belonged to the arts group in higher secondary, and 139 (46.33%) were of a science background.

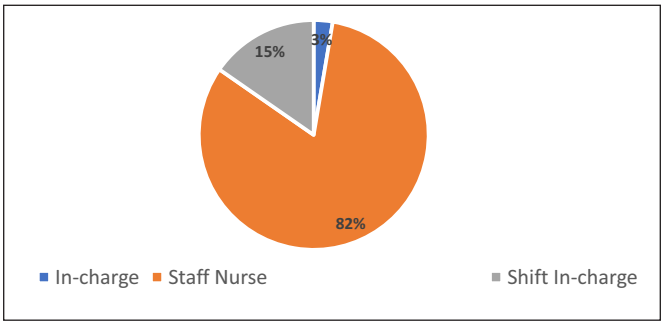


Figure 2: Designation Distribution n=300

Figure 2 shows that, out of 300 nurses, 246 (82%) were staff nurses, 46 (15.33%) were shift in-charges, and 8 (2.67%) were nurse in-charges from critical care areas.

Among the 300 nurses, 246 (82%) were staff nurses, of whom 222 (74%) had 1-3 years of critical care exposure. Shift in-charges accounted for 46 (15.33%), with critical care experience ranging from 4 to 9 years. Eight nursing in-charges (2.67%) participated, all belonging to the age group of >29 years, with more than 7 years of experience in critical care areas and a total working experience of over 10 years.

Table 3: Pretest Knowledge Score of the Critical Care Nurses n=300

Range	Pretest Knowledge Score	Frequency (*f*)	(%)	Mid-Point (*X*)	Cumulative Frequency
Poor	0-10	11	3.67%	5	11
Average	11-20	146	49%	15.5	157
Good	21-30	65	21.67%	25.5	222
Very good	31-40	78	26.00%	35.5	300

The questionnaire, focused on selected haemodynamic monitoring parameters, included sections on haemodynamic monitoring setup, arterial pressure, central venous pressure, pulmonary arterial pressure monitoring, and SPO_2. Each section contained 10 multiple-choice questions, resulting in a total of 40 questions.

The data presented in Table 3 show that 11 (3.67%) nurses had poor knowledge, while 146 (49%) nurses working in the critical care unit demonstrated average knowledge. Additionally, 65 (21.67%) nurses were categorised as having good knowledge, and 78 (26%) fell into the very good category.

Table 4: Pretest Practice Score of the Critical Care Nurses n=300

Range	Pre-Test Practice Scores		Frequency (*f*)	Percentage (%)	Mid-Point (*X*)	Cumulative Frequency
Poor	0	15	1	0.33%	7.5	1
Average	16	30	181	60.33%	23	182
Good	31	45	107	35.67%	38	289
Very Good	46	60	11	3.67%	53	300

Table 4 has shown that 1 (0.33%) and 181(60.33%) were having poor and average practice score on hemodynamic monitoring. 107(35.67%) and 11(3.67%) were having good and very good category of practice in critical care areas.

Table 5 revealed the chi-square value between the association of pretest knowledge scores with demographic profile. The result reported that the knowledge level of nurses has a significant association with the stream of school education – science, arts and commerce (χ^2=16.21), professional qualification (χ^2=17.19) and critical care specialisation (χ^2=77.47). The rest of the demographic profile doesn't establish any significant association with the knowledge score.

Table 5: Association with Pretest Knowledge and Demographic Profile of the Nurses n=300

Sl. No.	Variables	Poor	Average	Good	Very Good	*df*	Tabulated Chi-square	Observed Chi-square	Remarks
1	**Age in yrs.**								
	21-24	1	26	11	11	9	16.91	15.38	Not Significant
	25-28	9	71	43	51				
	29-32	1	42	7	13				
	33-36	0	7	4	3				
2	**Gender**								
	M	5	29	18	13	3	7.81	6.49	Not Significant
	F	6	117	47	65				
3	**Stream**								
	Science	6	57	35	41	6	12.59	16.21	Significant
	Arts	4	87	29	31				
	Commerce	1	2	1	6				
4	**Qualification**								
	M.Sc. Nursing	0	0	0	1	9	16.91	17.19	Significant
	GNM	6	111	41	54				
	Post Basic B.Sc. Nursing	0	2	1	6				
	B.Sc.	5	33	23	17				
5	**Critical Care Specialization**								
	Y	8	33	43	61	3	7.81	77.47	Significant
	N	3	113	22	17				
6	**Designation**								
	In-charge	0	2	2	4	6	12.59	10.11	Not Significant
	Staff Nurse	8	123	58	57				
	Shift In-charge	3	21	5	17				
7	**Work Experience**								
	0-4 years	7	72	44	51	9	16.91	12.69	Not Significant
	4-8 years	3	46	14	19				
	8-12 years	1	26	5	6				
	Above 12 years	0	2	2	2				
8	**Critical Care Experience**								
	0-3 years	6	71	44	39	9	16.91	11.15	Not Significant
	3-6 years	4	49	13	30				
	6-9 years	1	21	5	8				
	Above 9 years	0	5	3	1				

Table 6: Association with Pretest Practice Score and Demographic Profile n=300

Srl #	Variables	Poor	Average	Good	V Good	*df*	Tabulated Chi-Square	Observed Chi-square	Remarks
1	**Age in Years**								
	21-24	0	27	18	4	9	16.91	7.39	Not Significant
	25-28	1	104	66	3				
	29-32	0	41	19	3				
	33-36	0	9	4	1				
2	**Gender**								
	M	0	44	19	2	3	7.81	2.06	Not Significant
	F	1	137	88	9				
3	**Stream**								
	Science	1	83	52	3	6	12.59	3.92	Not Significant
	Arts	0	91	52	8				
	Commerce	0	7	3	0				
4	**Qualification**								
	M.Sc. Nursing	0	1	0	0	9	16.91	3.80	Not Significant
	GNM	1	128	73	10				
	Post Basic B.Sc. nursing	0	6	3	0				
	B.Sc	0	46	31	1				
5	**Critical Care specialization**								
	Y	1	85	53	6	3	7.81	1.44	Not Significant
	N	0	96	54	5				
6	**Designation**								
	In-charge	0	6	2	0	6	12.59	2.24	Not Significant
	Staff Nurse	1	148	89	8				
	Shift In-charge	0	27	16	3				
7	**Work Experience**								
	0-4 years	1	101	66	6	9	16.91	5.13	Not Significant
	4-8 years	0	51	28	3				
	8-12 years	0	26	11	1				
	Above 12 years	0	3	2	1				
8	**Critical Care Experience**								
	0-3 years	1	89	65	5	9	16.91	6.73	Not Significant
	3-6 years	0	62	30	4				
	6-9 years	0	25	9	1				
	Above 9 years	0	5	3	1				

P<0.05 level of significance

The values in Table 6 indicate that there was no significant association between the pre-test practice scores and the demographic variables.

2nd phase

Table 7: Demographic Profile of 2nd Phase of Sample

Demographic Profile		N=60	
Criteria	**Range / Values**	**Frequency**	**Percentage**
Age in years	21-24	5	8.33%
	25-28	25	41.67%
	29-32	13	21.67%
	33-36	17	28.33%
Working exp.	1-4 years	40	66.67%
	5-8 years	15	25.00%
	9-13 years	5	8.33%
Critical care experience	<1-3 years	43	71.67%
	4-6 years	10	16.67%
	7-9 years	7	11.67%
	10-12 years	0	0.00%

Table 7 reported that of 60 critical care nurses, 25 (41.67%) belonged to the age group of 25 to 28 years. 13 (21.67%) were 29 to 38 years old and 17 (28.33%) were 33 to 36 years of age, with only 5 nurses of 21 to 24 years, as at the initial phase of nursing, mostly posted at the ward level. Out of them, 40 (66.67%) had a total of 1-4 years of working experience, and 43 (71.67%) of the nurses had critical care experiences.

Table 8: Pretest, Post-test Mean, Median and SD of Knowledge & Practice Scores n=60

Pretest, Post-test Mean, Median and SD of Knowledge and Practice Scores				
	Pre-test Knowledge Score	**Post- test Knowledge score**	**Pre-test Practice Score**	**Post-test Practice-score**
Mean	14.53	33.47	26.40	53.35
Median	16.00	34.00	26.00	54.50
Standard Deviation	3.86	3.67	4.47	6.55

Table 8 showed the mean post-test knowledge score of 33.47 is higher than the mean pre-test knowledge score of 14.53, and the mean post-test practice score of 53.35 is higher than the mean pre-test practice score of 26.40 with a median value of 54.50 and a significant SD value. Thus, the intervention of haemodynamic monitoring guidelines is effective in the enhancement of knowledge and practice among nurses.

Table 9: Paired t-test

N=60									
Paired *t*-test		**Paired Differences**					***t***	***df***	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**S.E. Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Pre-test Knowledge Score Post-test Knowledge	18.93	5.24	0.68	-20.29	-17.58	27.99	59	0.000*
Pair 2	Pre-test Practice Score Post-test Practice score	26.95	7.88	1.02	-28.98	-24.92	26.50	59	0.000*

*** p value is significant at the 95% confidence level*

Table 9 reports that the mean and standard deviation (SD) of the pre-test knowledge scores were 18.93 (SD 5.24), which showed a significant difference with a *t*-value of 27.99. The mean and SD of the pre-test practice scores were 26.95 (SD 7.88), with a significant *t*-value of 26.50, both at a 95% confidence interval after the introduction of the haemodynamic monitoring guidelines among critical care nurses. These results establish the effectiveness of the haemodynamic monitoring guidelines in improving critical care nurses' knowledge and practice.

DISCUSSION

Critical care patients are always in high-risk situations (Kulkarni *et al.*, 2022). Several studies have reported that critical care nurses should possess adequate knowledge and skills in haemodynamic monitoring. Understanding and monitoring the arterial and venous systems positively impact the management of critically ill patients (Vincent *et al.*, 2021). Critical care nurses play a vital role (Norte *et al.*, 2024) and require evidence-based in-service training (Jafari *et al*., 2025). An experimental study revealed that 62.5% of nurses had an unsatisfactory level of knowledge regarding haemodynamic monitoring (Mohamed *et al.*, 2023). The present study also found that, out of 300 nurses, the majority—146 (49%) and 181 (60.33%)—had average knowledge and practice scores.

Different research studies reported that continuous training with structured guidelines helps to improve the assessment of haemodynamic parameters (Hashmi, 2024). Another study reported that those who received training had higher levels of knowledge and practice scores (Li *et al.*, 2024). In-service training and maintaining efficient teams are a growing trend in the world (Lommi *et al*., 2025). Study highlighted that in-service educational sessions on hemodynamic monitoring towards improvement of knowledge and practice of nurses are enhanced in comparison to pre-educational session (Mohamed *et al*., 2023).

To fill up the gap among nurses' practice, in the 2nd phase, the haemodynamic monitoring guideline was implemented, and the data revealed that the post-test mean and SD of knowledge scores were 18.93 and SD 5.24 with a significant *t*-value of 27.99, and the post-test mean practice scores were 26.95 and SD 7.88 with a significant *t*-value of 26.50 at a 95% confidence interval. The above findings established the effectiveness of haemodynamic monitoring guidelines in terms of improvement of knowledge and practice among nurses from a good to a very good level.

Limitations

The study is delimited to only four (4) selected parameters of haemodynamic monitoring. Sample size is delimited to 300 in the 1st phase and 60 in the 2nd phase with a lack of a control group as per the sampling formula. For better generalisation, a larger sample size with a control group is recommended to avoid limitations of the study in the future.

CONCLUSION

Critically ill patients need careful assessment and evaluation. Nurse leaders can implement educational strategies for enhancing nurses' knowledge and practice on haemodynamic monitoring, especially as that can have a significant impact on quality outcomes in critical care settings and many more nurses can become more competent towards critical care nursing. This study's findings revealed that CCU nurses had inadequate knowledge and practices on haemodynamic monitoring, especially regarding maintaining the phlebostatic axis, zeroing, flushing, calibration and different compositions of wave formations and the importance of understanding the accurate composition with pressure measurement, but after implementation of the guideline, there was an improvement of knowledge and practice among nurses towards haemodynamic monitoring. This study's findings and haemodynamic monitoring guidelines can be utilised in the future among critical care nurses for quality establishment. In the future it is assumed that nurses who will work in critical care units should continuously follow and utilise the guideline for effective management of critically unstable patients. The result of the study also could be considered as data-based towards nursing care of patients with haemodynamic monitoring in critical care units.

Conflict of Interest

The authors declared that they have no competing interests.

ACKNOWLEDGEMENT

The authors are grateful to their guide and participants for their continuous support.

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