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Development and Efficacy of the Code Blue Simulation (CBS) Program in improving the Code Blue Response Time among Nurses

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Abstract
Background: Managing cardiorespiratory arrest is both high-pressure and vital; therefore, a Code Blue Simulation (CBS) program was designed to enhance response performance. Significance: Structured CBS training strengthens clinical judgment and critical thinking skills. Objectives: To assess the effectiveness of the CBS program. Methods: A mixed-method sequential explanatory approach was employed at Gleneagles JPMC, Brunei Darussalam. Limitation: The study was limited to a single institution, Gleneagles JPMC. Findings: Results indicated a significant positive relationship between participation in the CBS program and improved performance outcomes ($p < 0.05$). Implication: The program enhances both clinical performance and participant confidence, potentially improving patient survival and outcomes.

Keywords: Code Blue Simulation (CBS) Program; Code Blue Response Time; Code Blue Drill; Cardiorespiratory Arrest.

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1.0 Introduction

Cardiovascular disease (CVDs) accounted for 26% of all deaths in Brunei Darussalam in the year 2021, as cited by Minister of Health, Brunei, Dato Seri Setia Dr Haji Mohd Isham bin Haji Jaafar, as noted by Lyna, Mohamad (2022), and this statistic brings CVDs as the number 1 killer of Bruneians. The age-standardized premature CVD mortality rate in the Sultanate was about 135 per 100,000 population in 2021. United States (US) at 130 per 100,000 population in 2019," statement by the Brunei Minister of Health as cited by Lyna Mohamad (2022) in the Borneo Bulletin.

1.1 Coronary Artery Disease (CAD)

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Patients with STEMI and left Main Coronary Artery Disease (CAD) were associated with a higher rate of incidence, 32.56% of sudden cardiac arrest (SCA), as mentioned by Chu, Shih, Yu, et al (2022). This statement is essential for the Gleneagles JPMC as a Cardiac Tertiary Hospital that caters to approximately 2000 cardiac procedure cases per year, to fully equip the staff with established code blue management because the incidence of SCA is more than 30% among coronary artery disease (CAD), as cited by Chu, Shih, Yu, et al (2022).

1.2 Resuscitation Guidelines

Panchal, Bartos, Cabana, et al. (2020) mentioned that even with breakthroughs in resuscitation science, about 25% of patients survived cardiac arrest while hospitalized. The American Heart Association (AHA) (2016) has issued recommendations that the first attempt at defibrillation should be made within two minutes of a cardiac arrest caused by a shockable rhythm, and the first assisted ventilation should begin within one minute. Early detection of a cardiac arrest episode, prompt action, and the activation of a “code blue” team. The hospital offers a blue code simulation program to assist the person in resolving this problem, particularly regarding unfamiliarity with the equipment, difficulty locating supplies, and the synergy of the blue code team.

1.3 Cardiac Arrest

According to the American Heart Association (AHA, 2022), 90% of patients who experience cardiac arrest die because of this incident. If CPR is performed immediately, it can double or triple a cardiac arrest victim's chance of survival. Penketh & Nolan (2022) have suggested that implementing resuscitation guidelines and a blue code team are key factors in cardiac arrest performance. It is essential to equip nurses with the roles and responsibilities they need when they encounter these situations. Healthcare personnel, especially nurses, must be prepared with the necessary ability, knowledge, and attitude to manage this situation. Therefore, this study aims to develop and evaluate a comprehensive Code Blue Simulation (CBS) program to improve code blue response time using Delphi techniques and a learning needs analysis.

2.0. Literature Review

2.1 Code Blue

Code blue events are highly stressful for healthcare providers, patients, and families. Understanding and effective management can significantly improve outcomes. Rapid responses by the first and second responders are essential. According to the American Heart Association (AHA, 2016), CPR should be initiated within 1 minute and defibrillation within 2 minutes to improve survival in cardiac arrest cases.

2.2 Simulation-based training

Simulation-based training is vital in equipping nurses with the skills, knowledge, and confidence. Matson (2023) emphasizes that simulation helps novice nurses recognize clinical deterioration and respond appropriately, thereby minimizing confusion and stress in real-world settings. It builds team coordination, promotes critical thinking, and enhances familiarity with emergency equipment, reducing complications. Despite technological and medical advances, survival rates for in-hospital cardiac arrests remain only 25%, and nearly 90% of cardiac arrest victims die without immediate intervention (Panchal et al., 2020; AHA, 2022).

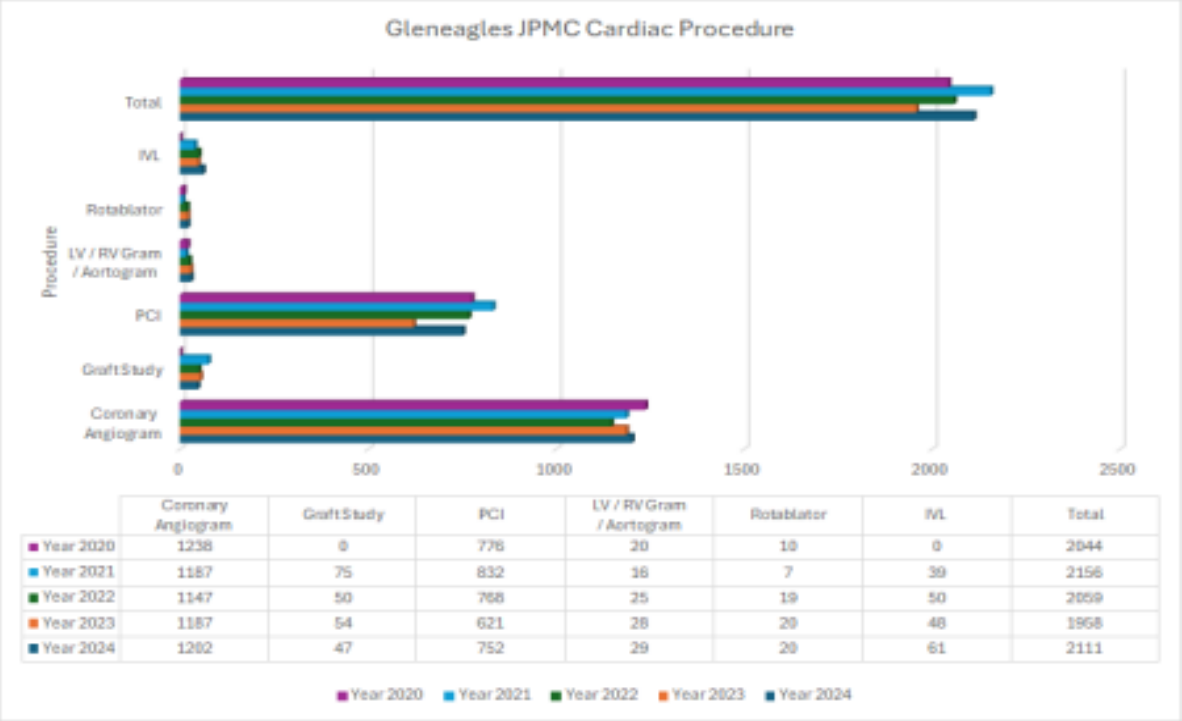
2.3 Sudden Cardiac Arrest

Simulation training helps prepare staff to respond effectively and improve system readiness (Penketh & Nolan, 2022). In Brunei Darussalam, cardiovascular disease (CVD) was the leading cause of death in 2021, accounting for 26% of all deaths, with a premature mortality rate of 135 per 100,000, higher than the US rate of 130 per 100,000 (Lyna, Mohamad, 2022). Conditions like STEMI and left primary coronary artery disease have been linked to a 32.56% incidence of sudden cardiac arrest (Chu et al., 2022). Hospitals need to ensure that staff are well-trained and ready to respond to code blue events at any time.

2.4 GJPMC Cardiac Procedure

The following table shows the number and types of procedures conducted at GJPMC from 2020 to 2024. With the high volume of cardiac procedures, it is vital to equip the staff with preparation in managing code blue because cardiac arrest can occur at any time, especially in STEMI patients.

Table 1. Gleneagles JPMC Cardiac Procedure



	Coronary Angiogram	Graft Study	PCI	LV / RV Gram / Aortogram	Rotablator	IVL	Total
Year 2020	1238	0	776	20	10	0	2044
Year 2021	1187	75	832	16	7	39	2156
Year 2022	1147	50	768	25	19	50	2059
Year 2023	1187	54	621	28	20	48	1958
Year 2024	1202	47	752	29	20	61	2111

Gleneagles JPMC Cardiac Procedure (GJPMC, 2025)

2.5 Root Cause Analysis

The diagram below shows the Code Blue root cause analysis.

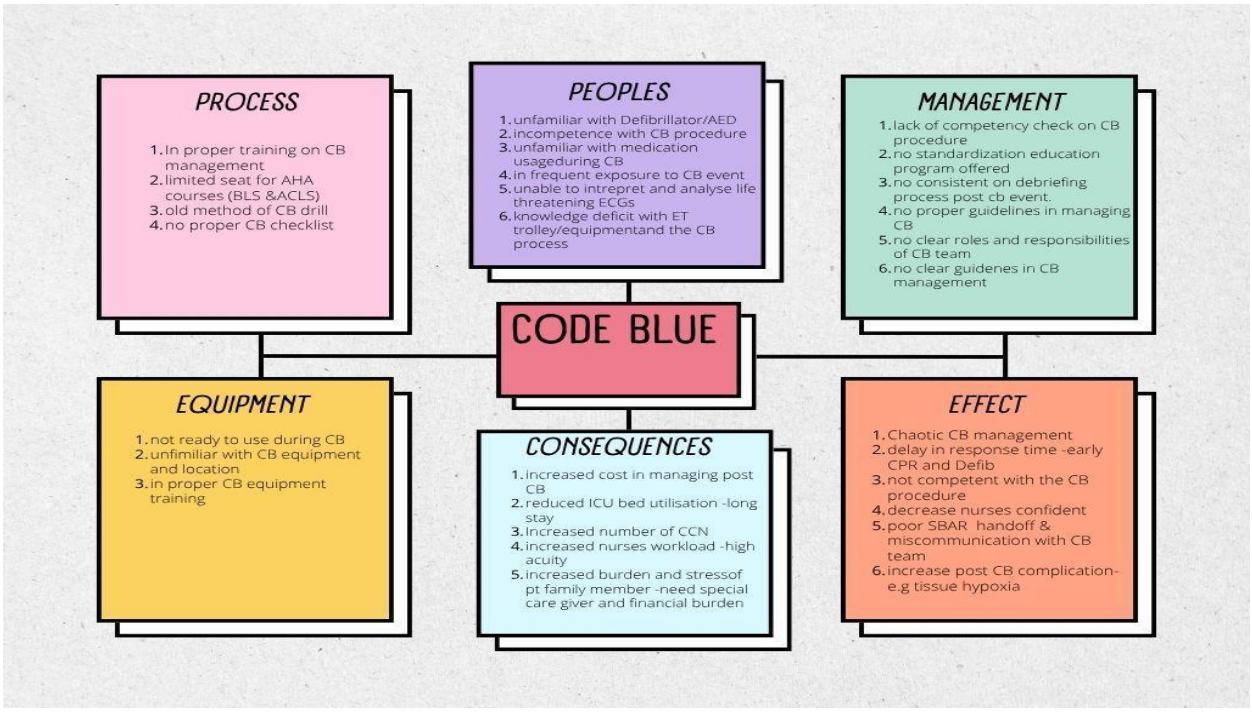


Figure 1. Code Blue Root Cause Analysis (GJPMC, 2022)

3.0 Methodology

3.1 Research Method

The researcher conducted the study using a mixed-methods sequential explanatory design, which entails gathering and analyzing data in two separate phases: first, quantitative, and then qualitative. The researcher observed and measured the impact of the code blue simulation (CBS) module. The methodological approach entails (1) developing a curriculum for the code blue simulation training using the Delphi techniques and the ADDIE model. (2) observed the code blue drill exercises; (3) conducted a code blue drill observation to see any difference in the intervention and non-intervention groups. This study was divided into a few phases. Phase One: Code Blue Simulation (CBS) development; Phase Two: Validation of the CBS Module, and Phases Three to Five are to evaluate the CBS program.

3.2 Research Process and the Phases.

The diagram below shows the research process and research phases.

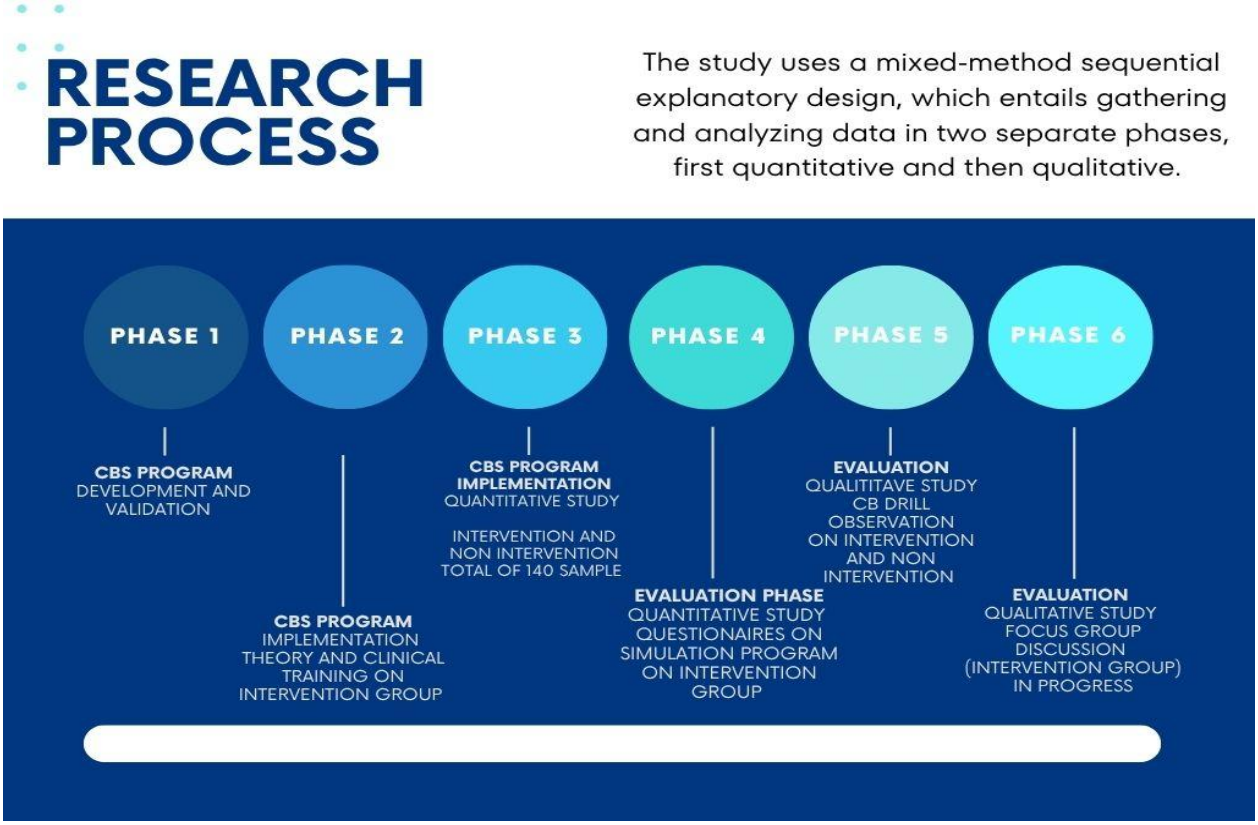


Figure 2. Research Process and Phases of the CBS Program,

3.3 Research Sample, Subject, and Ethical Approval.

The researcher chose the medium sample for this study. The sample calculation using the G Power application indicates that at least 128 measurements or surveys are required to reach a 95% actual confidence value within 5% of the measured or surveyed value. An extra 10% has been added to account for the unexpected number who will withdraw from the research. One hundred forty samples are needed for this study, which have been divided into 13 groups, each consisting of 5 to 6 members.

It is voluntary participation, and the researcher used a purposive sampling method. The intervention group (70 participants) underwent the CBS program and was assessed on clinical intervention, competency, and communication; the non-intervention group did not receive the CBS program. The intervention group was closely observed to determine the impact of the CBS program during the code blue drill. This study has been reviewed and approved by the UiTM Research Ethics Committee, which operates in accordance with the ICH Good Clinical Practice Guidelines, the Malaysian Good Clinical Practice Guidelines, and the Declaration of Helsinki. With reference to the number of REC/11/2023 (PG/MR/444).

3.4 Research Objectives

3.4.1 First phase:

The researcher develops a comprehensive Code Blue Simulation (CBS) program to improve Code Blue response time through Delphi techniques and learning need analysis. The researcher integrates expert panel feedback into the Delphi technique and uses the American Heart Association (2020) guidelines for Adult Cardiac Arrest in the Code Blue Simulation Development program.

3.4.1.1 Delphi Techniques for Code Blue Simulation Program

Table 2. Delphi Techniques Survey Result

Items/CBS procedures	Mean	SD	N
Chest compression more than 100/min	4.92	.289	12
Minimize interruptions during CPR and change the compressor every 2 minutes.	4.75	.452	12
Allow a complete chest recoil.	4.92	.289	12
Use a 30:2 compression-to-ventilation ratio if no advanced airway is present, and for an advanced airway in 5 seconds.	4.83	.389	12
Assist in advanced airway, i.e., LMA insertion and endotracheal intubation.	4.83	.389	12
Use the Automated External Defibrillator (AED) for Non-ACLS-trained personnel.	4.83	.389	12
Identify the rhythm suitable for Synchronised Cardioversion, then select the sync mode with the correct Joules.	4.67	.492	12
Identify the shockable rhythm and deliver the shock/defibrillation (Joules) within 2 minutes, i.e, Ventricular Fibrillation (VF) or Pulseless Ventricular Tachycardia (pVT).	4.75	.452	12
Identify the Complete Heart Block and administer Transcutaneous Pacing.	4.75	.452	12
Prepare and administer emergency medication during code blue events -Adrenaline, Noradrenaline, Amiodarone, and Lidocaine.	4.75	.452	12
Prepare and administer IV Epinephrine 1mg IV every 3 to 5 minutes	4.75	.452	12
Prepare and administer the IV Amiodarone 300mg, and repeat the second dose of 150mg	4.75	.452	12
Reversible causes- 5 H and 5 T.	4.75	.452	12

3.4.1.2 Learning Need Analysis

A survey adopted from Nusser (2021) assessed nurses' readiness and confidence in managing Code Blue events. One hundred questionnaires were distributed, and only 45 were returned, most from critical care units. While many felt prepared, some reported low confidence in using the defibrillator, SBAR communication, and scribing. The majority (68.8%) believed Code Blue drills would enhance their readiness, highlighting the need for ongoing simulation-based training.

The survey results below showed that nurses generally felt confident in managing Code Blue events, especially with physical tasks like using the crash cart and performing chest compressions. However, show lower confidence in using the defibrillator and scribing. Most agreed that simulations and debriefings help maintain their readiness, highlighting the importance of continued training.

Table 3. Code Blue Readiness Survey Result.

Descriptive Statistics	N	Range	Min	Max	Mean	SD	Var
I feel confident and prepared for a code blue.	45	2	3	5	4.09	.668	.446
I feel confident in recognizing and calling in a code blue	45	2	3	5	4.22	.670	.449
I feel confident providing and assessing high-quality chest compression during a code blue.	45	2	3	5	4.33	.674	.455
I feel confident administering ventilation with a bag-valve mask/manual respiratory code blue.	45	2	3	5	4.24	.679	.462
I feel confident bringing the crash cart/ ET trolley and applying a backboard under the patient during a code blue.	45	2	3	5	4.40	.618	.382
I feel confident monitoring vital signs and heart rhythm during a code blue.	45	2	3	5	4.11	.775	.601
I feel confident operating the defibrillator during a code blue.	45	3	2	5	4.02	.812	.659

I feel confident in providing SBAR handoff to the code blue team.	45	2	3	5	4.09	.701	.492
I feel confident scribing during a code blue until the code blue team arrives at the scene.	45	3	2	5	3.93	.809	.655
Participating in simulated crisis scenarios and team debriefing is beneficial to maintaining my code blue readiness	45	3	2	5	4.20	.757	.573

3.4.2 Second phase:
The validation of this CBS program using the expert panel in the Delphi techniques, with a Cronbach's Alpha of 0.915, which shows the reliability coefficient is excellent and the questionnaires are valid to use as a research instrument, as cited by Daud, Khidzir, Ismail, & Abdullah (2018).

3.4.3 Third phase:
The researcher evaluates the CBS program's impact on Code Blue response time for CPR within 1 minute and on early defibrillation within 2 minutes for shockable rhythms. GJPMC code blue observation form used during code blue drill.

3.5 The Code Blue Simulation Program.
The CBS program consists of four stations involved in the code blue management 1. Cardiopulmonary resuscitation, 2. administering emergency drugs, 3. airway management, and 4. applying the defib pad and defibrillation procedure. The standard code blue drill scenario with involvement of the ECG rhythm interpretation. These simulations mimicked a real code blue to provide a hands-on learning experience and to engage critical thinking.

The debriefing session allows reflective thinking during the drill. The assessor provides constructive feedback on improvement. Participants need to recognize and respond to emergencies in accordance with the American Heart Association (AHA, 2013b) guidelines. The assessor, adopting a checklist from GJPMC, observed and evaluated the drills. Each session concluded with a structured, two-way debriefing. This approach, aligned with the ADDIE instructional model (Branch, 2009), aimed to enhance communication, teamwork, and clinical decision-making. The assessment is divided into three sections as follows.

3.5.1 Clinical Practice (CP)
1. Recognized the medical emergency, e.g., cardiac arrest, respiratory arrest
2. Determines unresponsiveness within 10 seconds
3. Anticipated the blue code -call for help/ press the code blue button
4. Performed CPR < 1 min
5. ET Trolley to the room
6. Proper hand bagging with the MRB/Ambu Bag.
7. Apply the backboard
8. Apply a defib pad and turn on the defibrillator.
9. Defibrillate patients with shockable rhythm (pVT/VF) < 2 mins.

3.5.2 Communication (CO)
1. Team Leader communicates effectively
2. Roles were assigned, and each team member could perform the task accordingly.
3. Team members collaborate well.
4. Clear message/using closed-loop communication.
5. Event recorded: event documentation completed.

3.5.3 Competency (CY)
1. MRB skill is good
2. CPR skills are good
3. Intubation/LMA was done on time.
4. Administer emergency medication accordingly.
5. The CB team is competent.

3.5.4 Other/any feedback

4.0. Finding

4.1 Code Blue Observation

This study evaluates nurse performance during a code blue drill using scenarios per the AHA (2020) guidelines. Interventions were rated, and success was determined by staff performance or patient return of spontaneous circulation. Debriefings enhance learning and procedure competence.

Simulation-based education, particularly debriefing, supports reflective thinking and improves skill retention by providing a safe, realistic training environment (Chamberlain, 2015; Al Sabei & Lasater, 2016; Matson, 2023). The debriefings offered two-way feedback to improve team performance, communication, and patient outcomes through reflective learning (AHA, 2013b).

4.2 Early Response Time.

This study found that the CBS program significantly improved nurses' response times, achieving 100% compliance with AHA guidelines for CPR within 1 minute and defibrillation within 2 minutes post-training. In contrast, in the Pre-CBS program, 7.7% of groups did not meet these targets.

4.3 Return of Spontaneous Circulation (ROSC)

The findings support simulation-based training as an effective means of translating theoretical knowledge into clinical practice. Regular drills are recommended to maintain skills and ensure timely intervention in improving patient outcomes (AHA, 2013b). The following finding from GJPMC shows that, in real code blue events, the percentage of return of spontaneous circulation (ROSC) ranges from 68 to 92% from 2020 to October 2025. In 2025, the total number of code blues was 49, and the number of ROSCs was 45. 92% ROSC patients were achieved with early defibrillation.

Table 4: GJPMC Code Blue Details

GJPMC Code Blue Details,(GJPMC *2025)*

4.4 Pre and post-CBS findings based on mean calculation.

Table 5: Pre and post CBS findings

Code Blue Simulation		Clinical Practice (CP)	Communication (CO)	Competency (CY)
Pre CBS Training	1	3.78	4.00	3.60
	2	3.78	3.00	3.20
	3	4.00	3.60	3.60
	4	3.78	2.50	3.40
	5	4.00	3.80	3.60
	6	3.67	2.80	3.20
	7	3.78	3.00	3.00
	8	3.78	2.40	3.20
	9	4.00	3.60	3.40
	10	3.67	3.60	3.60
	11	3.78	3.00	3.00
	12	3.78	2.40	3.20
	13	4.00	3.80	3.60
	Total N	13	13	13
	1	4.00	4.00	4.00

Post CBS Training	2	3.78	3.40	4.00
	3	4.00	4.00	4.00
	4	4.00	4.00	3.60
	5	4.00	3.80	3.60
	6	3.78	3.60	3.60
	7	4.00	4.00	4.00
	8	4.00	4.00	4.00
	9	3.67	3.60	3.60
	10	4.00	4.00	4.00
	11	4.00	4.00	4.00
	12	4.00	4.00	3.60
	13	4.00	4.00	4.00
	Total N	13	13	13

4.4.1 Result of pre-CBS and post-CBS Program

The case summaries suggest that all three variables (CP, CO, CY) increase from the "pre-CBS" to the "post-CBS" groups. Indicates a positive change or improvement in these measurements after the intervention or change represented by CBS.

It aligns with the significant correlations observed in the previous data, reinforcing the relationships between these variables. Overall, the data suggest that the CBS intervention has improved performance or outcomes across the measured variables.

4.4.2 Correlation Coefficients:

The significant positive correlations are shown in the table below, including clinical practice, communication, competency, and the Code Blue Simulation (CBS) program, indicating that improvements in one area relate to improvements in others. Post-intervention data showed increases in all three variables, with the strongest correlation between communication and competency (r = 0.777) and the weakest between clinical practice and competency (r = 0.574), all significant at the 0.01 level.

This value indicates a strong positive correlation between the predictors (CP, CY, CO) and the dependent variable. A value closer to one signifies a strong positive relationship**.** These findings support that simulation-based training enhances nurses' confidence, knowledge, and overall Code Blue performance (AHA, 2013b; Chamberlain, 2015).

Table 6: Pearson Correlation Result.

Correlations

		CP	CO	CY	CBS
CP	Pearson Correlation	1	.671**	.574**	.431*
	Sig. (2-tailed)		<.001	.002	.028
	N	26	26	26	26
CO	Pearson Correlation	.671**	1	.777**	.639**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	26	26	26	26
CY	Pearson Correlation	.574**	.777**	1	.761**
	Sig. (2-tailed)	.002	<.001		<.001
	N	26	26	26	26
CBS	Pearson Correlation	.431*	.639**	.761**	1
	Sig. (2-tailed)	.028	<.001	<.001	
	N	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

4.5 Student Satisfaction and Self-Confidence

The Code Blue Simulation (CBS) program effectively enhanced nurses' satisfaction and confidence, with most participants agreeing that the teaching methods were helpful and supportive of skill development. The simulation also promoted self-reflection on clinical performance and encouraged active learner engagement. These findings across all satisfaction categories with current learning include five questions with p-values < 0.01; self-confidence also showed a p-value < 0.01, and the simulation design scale, consisting of 10 questions, also achieved a p-value < 0.01.

This finding highlights the CBS program's role in fostering critical thinking and clinical judgment within a safe learning environment, although opportunities exist to build confidence further (Jeffries, 2005; Matson, 2023; Nusser, 2021; National League for Nursing, 2005). This finding shows that the simulation program helps participants feel satisfied and boosts their confidence.

5.0 Discussion

5.1 Code Blue Simulation (CBS) Program

This study demonstrated that the program effectively improved nurses' response times and competency during code blue drills through realistic, standardized scenarios that foster critical thinking and confidence (O'Brien, 2015). The CBS program is an effective educational intervention that improves nurses' response times and competency in emergency procedures.

The CBS program supports safer, more efficient acute care responses by reinforcing rapid, coordinated actions in a controlled environment (National League for Nursing, 2005; O'Brien, 2015). These significant improvements highlight the critical role of simulation-based training in optimizing emergency care outcomes (O'Brien, 2015; National League for Nursing, 2005).

5.1. Limitation

Despite limitations such as its single-site design and simulated setting, the program showed particular benefits for junior nurses and overall enhanced emergency preparedness. Still, it was limited by being conducted with nurses at only one centre.

Further research across multiple centres and countries is recommended to assess the program outcomes. The researcher also cannot solely evaluate the impact of the CBS program because most of the nurses had experience in attending code blues or in training.

6.0 Conclusion & Recommendations

The study demonstrated that the CBS program significantly improved nurses' response times, confidence, and preparedness in Code Blue events. 7.7% of groups failed to meet the recommended CPR and defibrillation times in pre-CBS, but post-training, all groups achieved all these targets.

The simulation effectively bridges theory into practice, enhances clinical skills, reduces errors, and encourages reflective practice in a safe setting. These improvements contribute to better patient outcomes and reduce complications such as brain hypoxia (O'Brien, 2015; National League for Nursing, 2005).

Acknowledgement

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Article Contribution to Related Field of Study:

The CBS Program significantly enhances nurses' response times, preparedness, communication, clinical judgment, and teamwork during emergencies. Cycled CBS training is essential to maintaining high competency.

This program improved patient safety and clinical outcomes by fostering technical and non-technical skills. The findings advocate standardized protocols and continuous training as part of hospital quality improvement efforts, and recommend simulation as a practical, evidence-based approach to strengthen emergency readiness across healthcare teams (O'Brien, 2015; National League for Nursing, 2005).

The standardized protocols and continuous training initiatives are essential components of hospital-wide quality improvement strategies because they encourage healthcare institutions to adopt simulation as a sustainable, evidence-based approach to strengthening clinical performance and emergency readiness across nursing and other healthcare teams.

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