

# **ASSOCIATION BETWEEN NURSES' CHARACTERISTICS AND NURSES' RESPONSE TO CLINICAL ALARMS IN THE CRITICAL CARE UNITS AT A PRIVATE HOSPITAL IN KENYA**

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## **ABSTRACT**

Clinical alarms are triggers that alert healthcare providers to changes in physiological status. However, excessive false alarms, inappropriate alarm settings, and inadequate clinical alarm management may contribute to alarm fatigue and compromise patient safety. Globally, alarm-related adverse events remain a significant concern in critical care units. This study aimed to determine the association between nurses' characteristics and nurses' response to clinical alarms in the Critical Care Units of a private tertiary hospital in Kenya. An analytical cross-sectional study was carried out among nurses working in critical care units at a private tertiary hospital in Nairobi County, Kenya. Participants were selected proportionately using stratified random sampling from the Intensive Care Unit (ICU), High Dependency Unit (HDU), Coronary Care Unit (CorCU), and Cardiothoracic Intensive Care Unit (CT ICU). A structured self-administered questionnaire was utilized for data collection. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics were used to summarize data, while chi-square tests were used to determine associations between

variables. Statistical significance was set at  $p < 0.05$ . A total of 94 nurses participated in the study, yielding a response rate of 86%. Female nurses constituted 64.9% of participants, while 48.9% were aged between 30 and 40 years. Significant associations were found between nurses' response to clinical alarms and gender ( $p = 0.027$ ), years worked in critical care units ( $p = 0.014$ ), recent clinical alarm management training ( $p = 0.006$ ), and knowledge adequacy ( $p = 0.037$ ). Nurses who had received alarm management training within the previous year demonstrated more appropriate alarm responses compared to those trained earlier. Nurses' response to clinical alarms was significantly influenced by gender, recent clinical alarm management training, critical care experience, and knowledge adequacy. Regular refresher training and structured orientation programs are essential to strengthen clinical alarm management in critical care units.

**Key Words:** Nurses' Response, Clinical Alarms, Critical Care Units, Aga Khan University Hospital, Alarm Fatigue, Nurse Characteristics

## **INTRODUCTION**

Clinical alarms are visual or audio alert systems implanted in medical equipment like physiological monitors to notify healthcare providers of changes in patient conditions. They are classified into two major categories, namely false and true alarms, depending on the patient and machine trigger (Ergezen & Kol, 2020; Koomen et al., 2021).

False alarms are non-actionable alerts caused by patient movement, poor connections, or equipment malfunctions, accounting for more than 90% of all alarms that occur in the CCU. True alarms, on the other hand, indicate a genuine physiological change and may require immediate attention, and account for 13% of the alarms in CCU. Inattention to these alarms may result in safety events to include mortality. (Hravnak et al., 2018).

Critical Care Units (CCU) are specialized units where critically ill patients require continuous monitoring. Physiological monitors are among the most used equipment and contribute the significantly in high volume of clinical alarms. (Johnson, Hagadorn, & Sink, 2017).

Globally, adverse events have been reported due to clinical alarms. The Joint Commission of International Accreditation (JCIA) picked clinical alarm management as a national patient safety goal and indicated that health institutions should develop policies, train staff, and implement strategies to reduce alarm fatigue. (JCIA 2022).

In Africa, an increase in technology adoption in patient monitoring has resulted in rising clinical alarm fatigue among nurses. However, from evidence, most nurses are undertrained, and in Kenya, limited studies exist (Ramlaul, Chironda, & Brysiewicz, 2021). Locally, Meng'anyi (2017) did a study involving 87 nurses in one of the major public hospitals in Kenya. It was noted that nurses working in the CCU need more training to manage the clinical alarms. In addition, the hospital needed to develop policies and protocols governing the management of clinical alarms. Due to high nurse turnover in CCUs ensuring there is continuous training on clinical alarm management is key (Meng'anyi, Omondi, & Muiva, 2017). The study sought to determine the nurses' responses to clinical alarms in the CCU at Aga Khan University Hospital, to enable and promote the appropriate response to clinical alarms.

## **RESEARCH SUBJECTS AND METHODS**

### **Study setting, design, and population**

The study was conducted in the critical care units of a private tertiary hospital in Nairobi, Kenya. Critical Care Units involved included the Intensive Care Unit (ICU), High Dependency Unit (HDU), Coronary Care Unit (CorCU), and Cardiothoracic Intensive Unit CT ICU). The target population consisted of 111 nurses working in the critical care units. An analytical cross-sectional

design was utilized to determine the association between nurse characteristics and nurses' response to clinical alarms.

### **Sample Size and Sampling Procedure**

Sample size was calculated through Fisher's formula, and stratified random sampling was applied for proportional representation for each critical care unit.

*Table:1 Stratified Sample Size per unit*

<b>UNIT</b>	<b>population</b>	<b>Proportion</b>	<b>Strata</b>
ICU	40	40/111*89	32
HDU	40	40/111*89	32
CT ICU	16	16/111*89	13
CCU	15	15/111*89	12
<b>Total</b>	<b>111</b>		<b>89</b>

A total of 109 questionnaires were distributed to account for probable nonresponse; 94 fully completed questionnaires were returned.

### **Data Collection**

A structured self-administered questionnaire was used for data collection, developed from an extensive literature review. The questionnaires assessed demographic characteristics, training history, knowledge adequacy, and nurses' responses to clinical alarms.

Participants completed the questionnaires voluntarily during work breaks in designated areas. Confidentiality and anonymity were maintained throughout the study.

### **Data Analysis.**

Data collected was input into Microsoft Excel, cleaned, and imported into SPSS version 26 for analysis. Participant characteristics data were presented using descriptive statistics, and Chi-square was utilized to assess associations between nurses' characteristics and responses. Statistical significance was set at  $p < 0.05$ .

### Ethical Considerations

Ethical approval was obtained from the Kenyatta University Ethics Review Committee, and authorization to conduct the study was granted by the National Commission for Science, Technology and Innovation (NACOSTI). Permission was also obtained from the study setting hospital administration. Written informed consent was obtained from all participants before data collection. Participation was voluntary, and confidentiality was maintained throughout the study.

## RESEARCH RESULTS

### Response Rate

Out of the total of 109 questionnaires distributed, 94 were fully completed and returned, indicating an 86% response rate.

*Response Rate Table:2*

Questionnaire	Frequency	Percentage
Returned	94	86%
Not Returned	15	14%
Total	109	100%

### Demographic Characteristics of Participants

Female participants accounted for 64.9%, aged between 30 and 40 years (48.9%). Nursing experience between 6 and 10 years was (35.1%), with those between 3 and 6 at (33%). Half of the participants had a Bachelor of Science in nursing degree.

Most participants had received training in managing physiological monitor clinical alarms at 95.7%, with more than half done in the previous year.

*Table :3 Demographics Characteristics*

Variable	Categories	Frequency	Percentage
Age	20-30 years	22	23.4
	<b>30-40 years</b>	<b>46</b>	<b>48.9</b>
	Above 40 years	26	27.7
Gender	<b>Female</b>	<b>61</b>	<b>64.9</b>
	Male	33	35.1

Years of Experience as a Nurse	3-6 years	17	18.1
	<b>6-10 years</b>	<b>33</b>	<b>35.1</b>
	10- 15 years	18	19.1
	More than 15	26	27.7
Years worked in the Critical Care unit	1-3 years	13	13.8
	<b>3 -6years</b>	<b>31</b>	<b>33</b>
	6-10 years	27	28.7
	Above 10 years	23	24.5
Highest Level of Education (Academic Qualification)	Diploma in Nursing	19	20.2
	<b>Bachelor of Science in Nursing</b>	<b>47</b>	<b>50</b>
	H. Dip in Critical Care Nursing	26	27.7
	Postgraduate Degree	2	2.1
Clinical alarms management training (How long ago)	<b>1 year ago,</b>	<b>48</b>	<b>51.1</b>
	2 years ago,	20	21.3
	More than 2 years ago	19	20.2
	Not applicable	<b>7</b>	<b>7.4</b>

### **Association Between Nurses' Characteristics and Nurses' Response to Clinical Alarms**

A significant association was found between clinical alarm response and female nurses compared with male nurses ( $p=0.027$ ). Compared to those who had stayed longer, those with between one and three years of critical care displayed a significant association ( $p=0.014$ ). Clinical alarm management training timing indicated a significant association at ( $p=0.0060$  if done recently within one year).

Table:4 Association Between Nurses' Characteristics and Nurses' Response

Variable	Categories	Nurses Actions		X <sup>2</sup>	P-value
		Appropriate	Not Appropriate		
Age	20-30 years	15(68.2)	7(31.8)	1.028	0.598
	30-40 years	28(60.9)	18(39.1)		
	Above 40 years	14(53.8)	12(46.2)		
Gender	<b>Female</b>	<b>42(68.9)</b>	<b>19(31.1)</b>	<b>4.912</b>	<b>0.027</b>
	Male	15(45.5)	18(54.5)		
Years of Experience as a nurse	3-6 years	12(70.6)	5(29.4)	6.796	0.079
	6-10 years	24(72.7)	9(27.3)		
	10- 15 years	7(38.9)	11(61.1)		
	More than 15	14(53.8)	12(46.2)		
Years worked in the Critical Care unit	<b>1-3 years</b>	<b>11(84.6)</b>	<b>2(15.4)</b>	<b>10.65</b>	<b>0.014</b>
	3 -6years	19(61.3)	12(38.7)		
	6-10 years	19(70.4)	8(29.6)		
	Above 10 years	8(34.8)	15(65.2)		
Highest Level of Education (Academic Qualification)	Diploma in Nursing	11(57.9)	8(42.1)	1.983	0.371
	Bachelor of Science in Nursing	26(55.3)	21(44.7)		
	Postgraduate Degree/	20(71.4)	8(28.6)		
Clinical alarms management training (How long ago)	<b>1 year ago</b>	<b>36(75.0)</b>	<b>12(25.0)</b>	<b>10.158</b>	<b>0.006</b>
	2 years ago	7(35.0)	13(65.0)		
	More than 2 years ago	14(53.8)	12(46.2)		
	Agree	7(35.0)	13(65.0)		
	<b>Strongly Agree</b>	<b>49(73.1)</b>	<b>18(26.9)</b>		
	Open set up	32(65.3)	17(34.7)		
	Not sure	1(9.1)	10(90.9)		

Which nurse-patient ratio makes it easy to respond to physiological clinical alarms?	1:1	46(63.0)	27(37.0)	3.314	0.191
	1:2	11(57.9)	8(42.1)		
	Inadequate	31(72.1)	12(27.9)		

## **RESEARCH DISCUSSION**

This study investigated the association between nurses' characteristics and nurses' responses to clinical alarms in critical care units at a private hospital in Kenya. The association between age and nurses' response to clinical alarms was not statistically significant; however, younger nurses demonstrated a better alarm response than older nurses. These findings differ from studies conducted in China and Europe, which reported that older nurses respond more effectively due to experience and familiarity with monitoring equipment (Liao et al. 2020),. Such variation may be explained by differences in institutional culture, training practices, and alarm exposure. Heightened vigilance may be seen in young nurses due to more recent training and closer adherence to policies.

A significant association was seen between gender and nurses' response to clinical alarm, with female nurses indicating a more appropriate response than male nurses. Similar findings were reported in previous studies done in Korea (Lee et al., (2021), However, across the literature, inconsistencies were seen in the association between gender and clinical alarm response, indicating that training and organizational structure may play a larger role than gender alone (Mirhafez, (2019). The study indicated that recent alarm management training significantly improved nurses' response to clinical alarms. Previous year training showed improved response than more those trained more than two years earlier. This finding indicates the importance of continuous training in maintaining competency in clinical alarm management. (Meng'anyi et al. 2017, Jeong & Kim 2022) and Leape ,2021). Interestingly, nurses with fewer years in critical care showed better clinical alarm response than those with longer experience. This may reflect alarm fatigue and desensitization among highly experienced nurses. Knowledge indicated a significant association, whereby nurses with adequate knowledge demonstrated appropriate clinical alarm response, highlighting the connection between theoretical knowledge and competency-based training.

Overall, the study findings highlighted the importance of structured education, continuous training, institutional policies, and effective management in enhancing patient safety within critical care settings.

### **Limitations**

The study was conducted in a single private tertiary hospital, which may limit the generalizability of findings to other healthcare settings in Kenya. Additionally, the cross-sectional design limits

the ability to establish causal relationships between variables. Data was collected using a self-administered questionnaire, which may have introduced recall bias. Despite the limitations, the study provides the baseline evidence regarding alarm management practices among critical care nurses in Kenya.

### **Conclusions**

The study showed that nurses' responses to clinical alarms were significantly associated with gender, years worked in critical care units, recent clinical alarm management training, and knowledge adequacy. Recent training in clinical alarm management arose as one of the strongest indicators of appropriate alarm response. Nurses with fewer years of critical care experience indicated an appropriate response, suggesting possible effects of alarm fatigue and desensitization among highly experienced nurses. The findings indicate the importance of continuous education, regular refresher training, and orientation programs aimed at strengthening alarm management and improving patient care in critical care units.

### **Recommendations**

- i. Execute regular training programs on clinical alarm management for all critical care nurses
- ii. Develop uniform evidence-based clinical alarm management protocols and policies
- iii. Strengthen orientation for newly deployed critical care nurses
- iv. Regular spot checks and audits to check compliance and identify gaps for further training.

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