Original Article

Enhancing Healthcare Quality through Connected Care Monitoring: A Survey on Nurses' Knowledge, Attitude, and Practice in Wards

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Abstract

Background: Enhanced Connected Care (ECC) monitoring, which fuses medical devices with continuous monitoring of patient vitals captured by a nursing dashboard, offers a better way to address patient safety and improve clinical outcomes. Nurses are the key players involved in the implementation of ECC, while their KAP towards the technology in place decides the success and efficacy of this innovation. The purpose of this study is to determine the level of knowledge among nurses regarding ECC, perceptions regarding its benefits/challenges, and drivers/inhibitors of its implementation in a hospital environment.

Methods: A two-month cross-sectional study was conducted at Apollo Hospital – Jubilee Hills. Nurses with a minimum of six months of practice experience were invited to complete a structured questionnaire via Survey Monkey. A total of 125 Nurses participated voluntarily in the survey. Descriptive statistics using SPSS and thematic analysis for qualitative answers were used. The significant variables were nurses' knowledge of ECC, confidence level, time saving per shift and the perceived barriers for implementation of ECC.

Results: Sixty-one percent of nurses expressed high confidence in ECC usage, with increased comfort in ECC evident among younger (18–34 years) than older nurses. Time saved was substantial, with 47.2% saving 5–10 min per shift. There was a strong correlation between levels of knowledge and confidence ($p = 0.009$). The main cited benefits were enhanced patient safety (24%) and increased early deterioration detection (22.4%), although alarm burden and technical integration challenges constrained uptake.

Conclusion: ECC monitoring can improve our patients and workflow but to be successful we need better training, tailored mid-career nurse support, and the right systems in place to drive alarm fatigue down. The solution to these challenges will enable wider adoption and better clinical outcomes.

Keywords: Enhanced Connected Care (ECC), Continuous Patient Monitoring, Healthcare Technology Adoption, Nursing Workflow Efficiency, Patient Safety

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Introduction

With advancements in health tech, connected care[1]— or the integration of patient care through more coordinated communication and technology — is reshaping healthcare. Apollo Hospital, being a leading healthcare provider, is poised to adopt these advancements. Enhanced Connected Care monitoring (ECC) in wards provides continuous monitoring of patients in wards using medical devices.[2,3] They record the vital signs of patients like Heart rate, Blood Pressure, Oxygen saturation, Temperature and Respiratory rate. Captured vitals are transmitted to the nursing station dashboard, enabling immediate nurse response while being continuously monitored by a command center nurse. Continuous patient monitoring enhances patient safety and clinical outcomes in hospital wards.[4–6] This practice mainly involves the nurse's role and responsibility for establishing the connection as it provides ongoing assessment of patients' vital signs and other clinical parameters to detect early signs of deterioration and to facilitate timely intervention[7]. The successful implementation of these systems largely depends on the knowledge, attitudes, and practices (KAP) of nursing staff who are at the forefront of patient care.[8,9] The extent to which nurses are willing and able to incorporate ECC into their daily practice is influenced by several factors, including their familiarity with ECC, their perceived benefits and challenges associated with ECC and the training to support nurses to deliver ECC in practice.

The primary objective of this prospective observational study is to understand to what extent Apollo Hospital nurses understand, perceive and use enhanced connected care in professional settings. The secondary objective includes exploring nurses' attitudes toward connected care, identifying barriers to implementation, assessing training and resource needs, analyzing the relationship between knowledge and practice, and collecting feedback for system improvement.

This study explores barriers to ECC implementation, identifies training and resource needs, and gathers feedback for system improvements. Understanding the dynamics between physicians and nurses is crucial to optimizing ECC use, enhancing patient care, and addressing nursing challenges.

This study examines how nurses' confidence and experience impact ECC adoption, providing insights into training efficacy and areas for intervention. Similar to research on alarm burden, workflow integration, and ECC's impact on patient outcomes, these findings will help refine training, improve system usability, and support nurses in adapting to digital healthcare.

Material and Methods

This prospective observational study was conducted in the Apollo Hospital – Jubilee Hills for a period of 2 months.The study was done after getting clearance from Institutional Ethics Committee with IEC Application No: AHJ-C-S-015/08-24 on 30th August 2024.Nurses in wards working with Enhanced Connected Care monitoring in wards were enrolled in the study. Volunteer sampling was taken and 125 Nurses participated in the study. A structured questionnaire was designed using Google Forms. The Google forms Questionnaire was share with all study participants.

The inclusion and exclusion criteria of the study is mentioned below.

Inclusion Criteria

1. *Employment Status:* Nurses currently employed at Apollo Hospital at the time of the study.
2. *Experience:* Nurses with a minimum of 6 months of experience in Apollo Hospital to ensure they have had some exposure to the hospital's systems and protocols.

Exclusion Criteria

1. *New Recruits:* Nurses with less than 6 months of experience at Apollo Hospital to eliminate the learning curve bias.

Data Analysis

Quantitative data from the questionnaires will be analysed using statistical software like SPSS or

R. Qualitative data from open-ended questions or interviews will be analysed thematically.

The questionnaire was designed to assess the following parameters from all the staff working with ECC.

1. *Knowledge:* Identify the percentage of nurses familiar with the principles and protocols of enhanced connected care.
2. *Attitude*: Highlight areas of enthusiasm, resistance, or indifference toward connected care practices.
3. *Practice*: Evaluate how many nurses actively integrate enhanced connected care in their daily routines and the efficacy of their practices.
4. *Recommendations*: Based on the feedback from the front line workers, suggest actionable steps so that Apollo Hospital can take to improve its connected care training and implementation.

Results

Confidence in Using ECC Technologies

Sixty-one percent of participants expressed high confidence (rated 10 on a 10-point scale) in using ECC technologies.Confidence levels were associated with experience, even though the relationship was not statistically significant (Chi-square = 62.575, p = 0.491).The data showed higher confidence levels among younger participants (18–34 years) compared to older groups (35–44 years). Participants in the 35–44 age group exhibited lower confidence levels, suggesting the need for additional training or targeted support. Although a visible trend was identified between age and confidence, the Pearson Chi-square value indicated no statistically significant correlation between age and confidence levels (Chi-square = 6.061, p = 0.640).

The younger workforce (18–34 years) appears more confident in using ECC tools, while participants aged 35–44 age group show lower confidence levels. Older employees may need tailored support through workshops or additional training to enhance their comfort with technology. This insight can help healthcare facilities design age-specific interventions to boost user confidence across all age groups (Fig. 1).

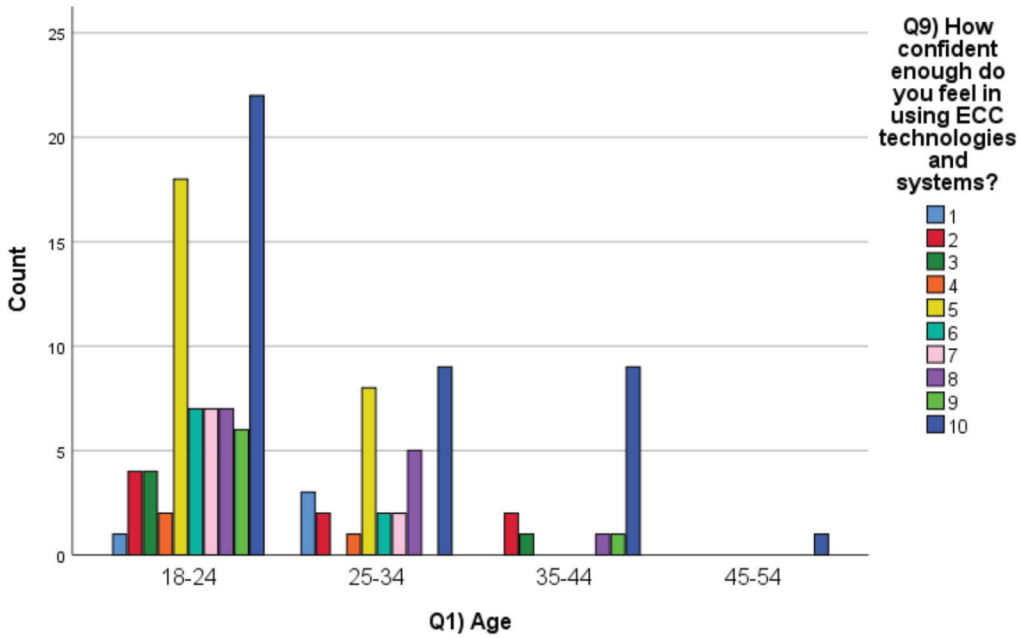

Figure 1: Age group wise distribution of Confidence in Using ECC Technologies

Time Savings per Shift

As presented in Table 1, 59 (47.2%) respondents reported saving 5–10 minutes per shift due to continuous patient monit oring. Moreover, 13.6% (17), 26.4%(33) of respondents reported of saving time >10 min and <5 min respectively.However, 12.8% (16) stated no time was saved during their shifts.

Table 1. Time saved per shift due to the use of technology of continuous patient monitoring

Time Saved per Shift	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 5 minutes per shift	33	26.4%	26.4%	26.4%
More than 10 minutes per shift	17	13.6%	13.6%	40.0%
5–10 minutes per shift	59	47.2%	47.2%	87.2%
No time saved during any shift	16	12.8%	12.8%	100.0%
Total	**125**	**100.0%**	**100.0%**	**100.0%**

Correlation between Confidence Level with Experience

This result shows a significant association, suggesting that there may be a linear relationship between confidence level and experience when considering them as ordinal variables. Where 1 (0–24), 2(24–48), 3(48–72), 4(72–96), 5(96–120), 6(120–144), 7(144–168), 8(168–192) experience in months has been grouped. (p-value: 0.024) (Fig. 2)

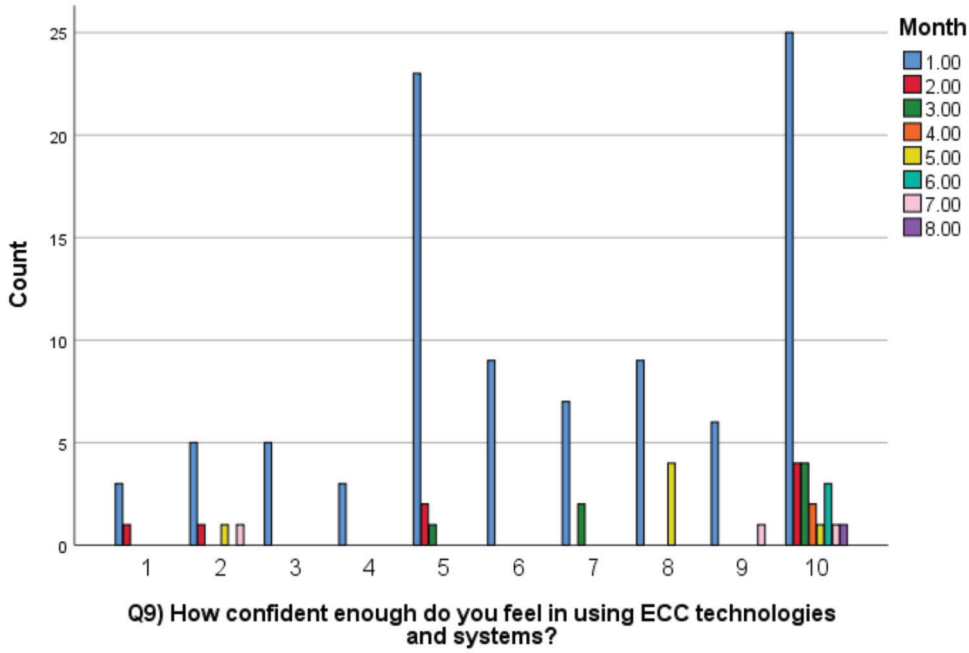

Figure 2: Association of Confidence Level and Experience

Correlation between Time Saved and Shifts

As shownin Fig. 3, 56.8% of participants who saved 5–10 minutes per shift reported savings during the morning shift.No time saved cases were also higher in the morning shift

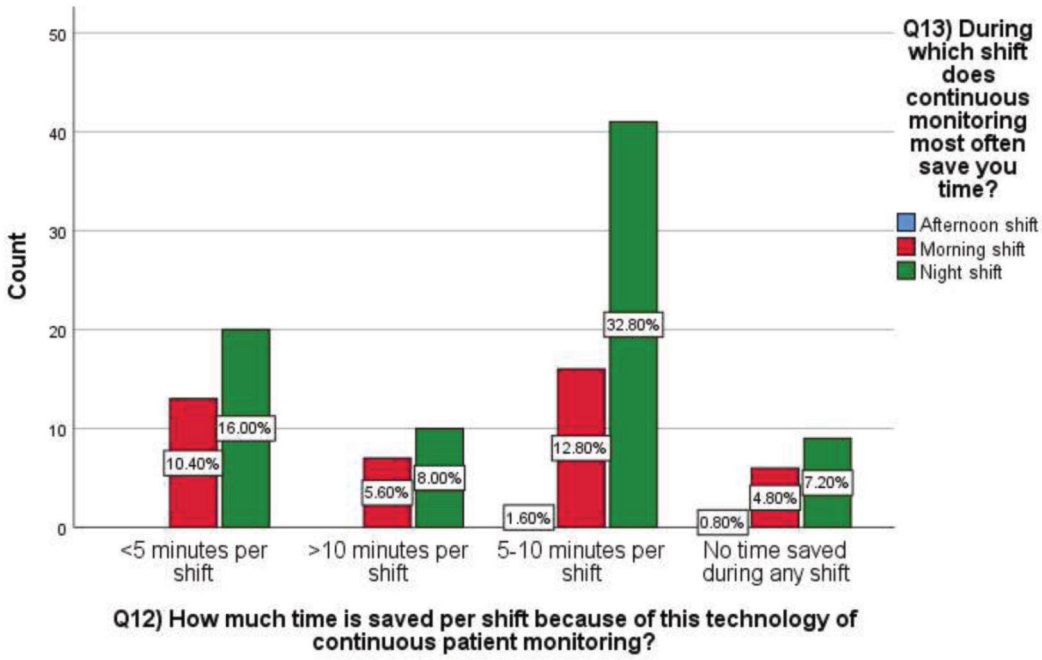

Figure 3: Association between Time saved and shifts of the duty

(6.3%).Time savings during the afternoon shift were less frequent, with only 2.4% of participants reporting any benefit. Most participants who reported >10 minutes saved per shift (around 13.6%) indicated these savings occurred during the night shift.This aligns with the increased need for continuous patient monitoring during non-peak hours. Chi-square Test: Pearson Chi-square Value = 12.272, p = 0.092. This indicates a marginal relationship between the amount of time saved and the shift, though the correlation was not statistically significant at a 5% level.There is a slight association suggesting that greater time savings (>10 minutes) are more likely during night shifts, possibly due to reduced workload and increased reliance on ECC tools. In conclusion, Morning shifts demonstrated moderate time savings, while afternoon shifts saw the least benefit from ECC technologies.

Training and Usage Frequency

As reported in Table 2, 66.4% of participants reported receiving training on ECC tools weekly, ensuring frequent reinforcement of skills. ECC tools were used daily by 56.8% of participants, and 37.6% used them multiple times a day. Fig. 4 reports how often ECC tools or systems were used in day-to-day work and responses fell into four main domains: a system for patient billing, an integrated system that allows for better connectivity within the patient experience through technology and communication, the burden on nurses to answer calls, and confusion over the new technology.

The survey results reveal a heavy dependence on an integrated system to tie patient care together, with most respondents reporting using it daily or more than once a day. The figure also showed differences in the frequency of use for systems related to patient billing and nurse response burdens, and the segment of respondents who were unsure about the new technology. Be it real-time patient data or analytics, these are all part of integrated systems that are crucial in augmenting the connected care and minimizing the load on healthcare professionals.

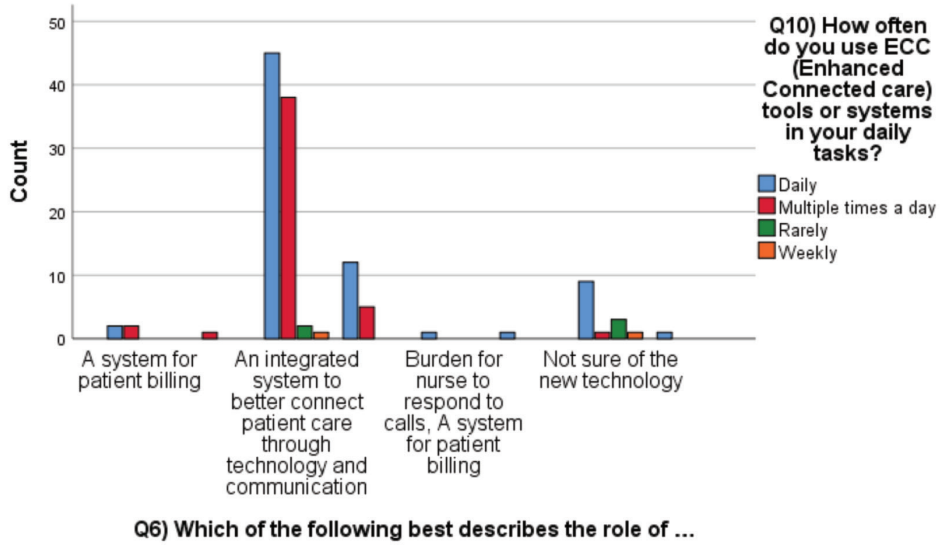

Figure 4: Tasks performed in ECC monitoring tool and their frequency

Table 2. Training and usage frequency of ECC tool

Frequency	Number of Responses	Percent	Valid Percent	Cumulative Percent
Fortnightly	3	2.4%	2.4%	2.4%
Monthly	21	16.8%	16.8%	19.2%
Quarterly	9	7.2%	7.2%	26.4%
Rarely	9	7.2%	7.2%	33.6%
Weekly	83	66.4%	66.4%	100.0%
Total	**125**	**100.0%**	**100.0%**	**100.0%**

Benefits of ECC Monitoring

The top benefits cited wereimproved patient care quality (32.80%), improved Patient Safety (24.00%), early detection of patient deterioration (22.40%), reduction in nurses' time spent on recording vitals (4.00%) (Fig. 5).

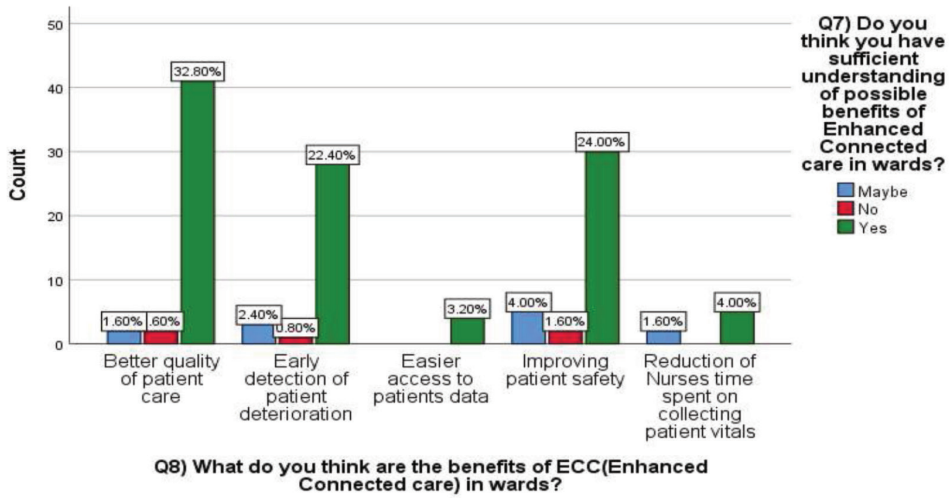

Figure 5: Benefits of ECC monitoring

Ease of use of ECC

According to Fig. 6, 17 nurses reported a score of 10 suggesting that ECC strongly benefits them for early detection of deterioration and 20 nurses reported a score of 10 suggesting ECC strongly helps them capture vitals easily.

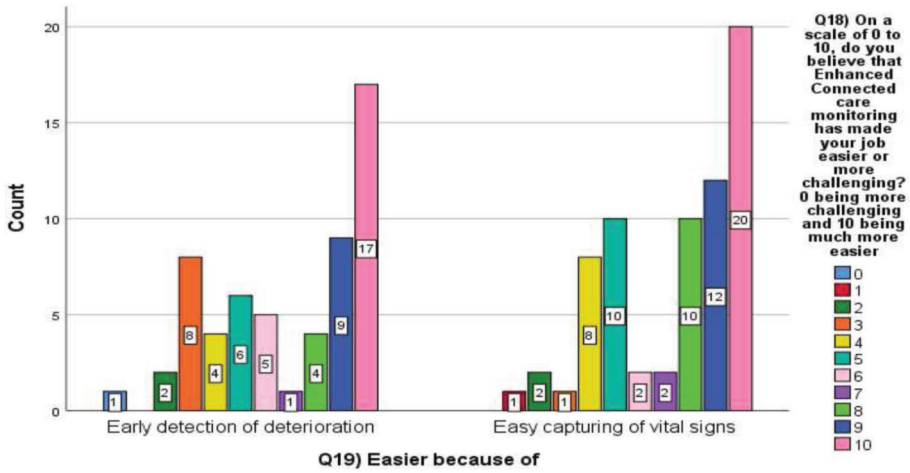

Figure 6: Ease of use of ECC monitoring as reported by nurses

Challenges in ECC Implementation

As Fig. 7 shows, 67.2% of participants encountered challenges using ECC tools. Primary difficulties included frequent alert calls, device installation and patient on boarding issues.

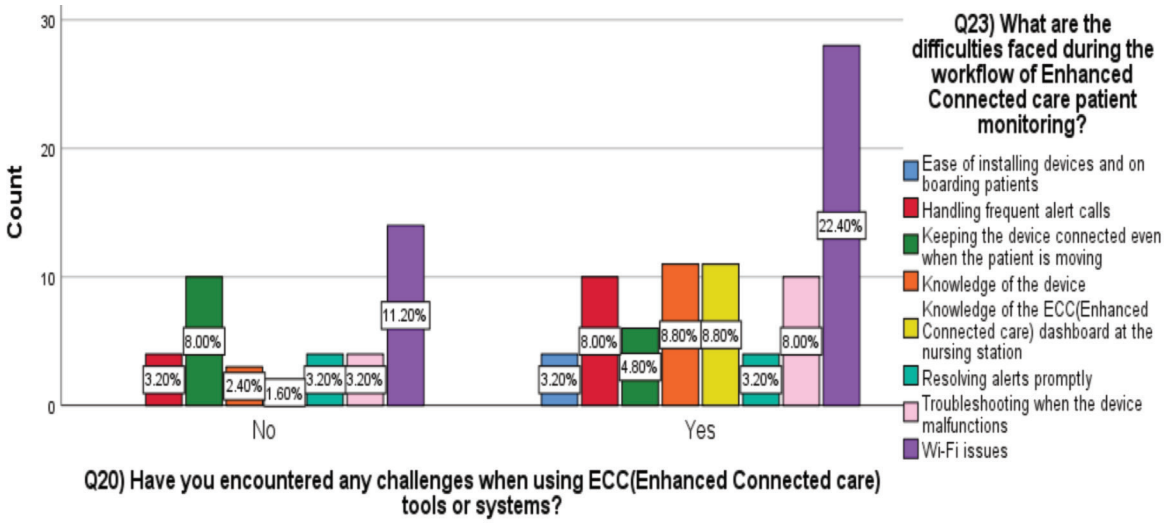

Figure 7: Challenges encountered while using ECC tools

The assessment of impact on patient outcomes and staff workflow was performed on a scale of 0 to 10. The average rating for ECC's impact on patient outcomes was 7.02.ECC monitoring was perceived as improving job efficiency, with participants assigning it a mean score of 7.26 for making tasks easier. The Pearson Chi-square suggest that there is no significant correlation between knowledge and practice frequency among the respondents.

Co-relation between Confidence level and Knowledge.

There is a statistically significant association between knowledge and confidence level.

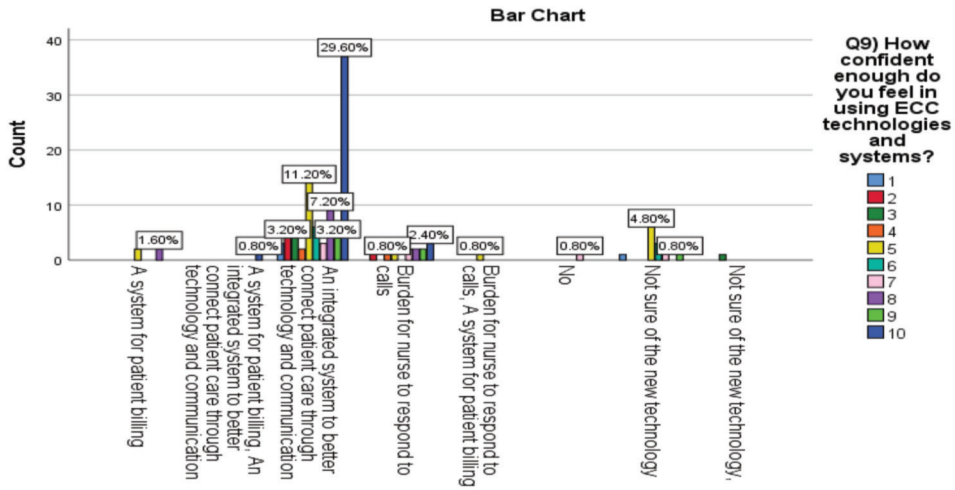

Figure 8: Association between confidence level and knowledge in performing different tasks

Impact of Alarm Burden on Daily Workflow

Table 3 presents the distribution of responses regarding the impact of alarm burden from the monitoring system on work. The results show 43.2% of nurses agreed that the alarm burden impacts their daily workflow. Where 16% of suggests maybe the alarm burden impacts their daily workflow.

Table 3. Impact of alarm burden

Response			Frequency	Percent	Valid Percent	Cumulative Percent
Maybe			20	16.0%	16.0%	16.0%
No			51	40.8%	40.8%	56.8%
Yes	54	43.2%	43.2%	100.0%		
Total	**125**	**100.0%**	**100.0%**	**100.0%**		

Additional Resource Needs

Respondents reported various needs on how to better implement ECC in their clinical practice when asked what supplementary resources would be beneficial. (Fig. 9)

Largest numbers of respondents thought Hands-on training sessions, chosen by 37.60%, is the most beneficial additional resource for proper implementation ECC monitoring. The second preference was updated manuals or guides chosen by 22.40% of participants. The need for access to a dedicated support team was recognized by 14.40% of respondents, as it facilitates fast and specialized assistance in troubleshooting and optimizing how the system is used. Other preferences were online tutorials and webinars, group led workshops as well as newer, digital-focused offerings that can aid in continuous learning and development.

These findings highlight the importance of diverse and broad educational materials in improving the uptake and efficacy of ECC technologies for use in clinical environments.

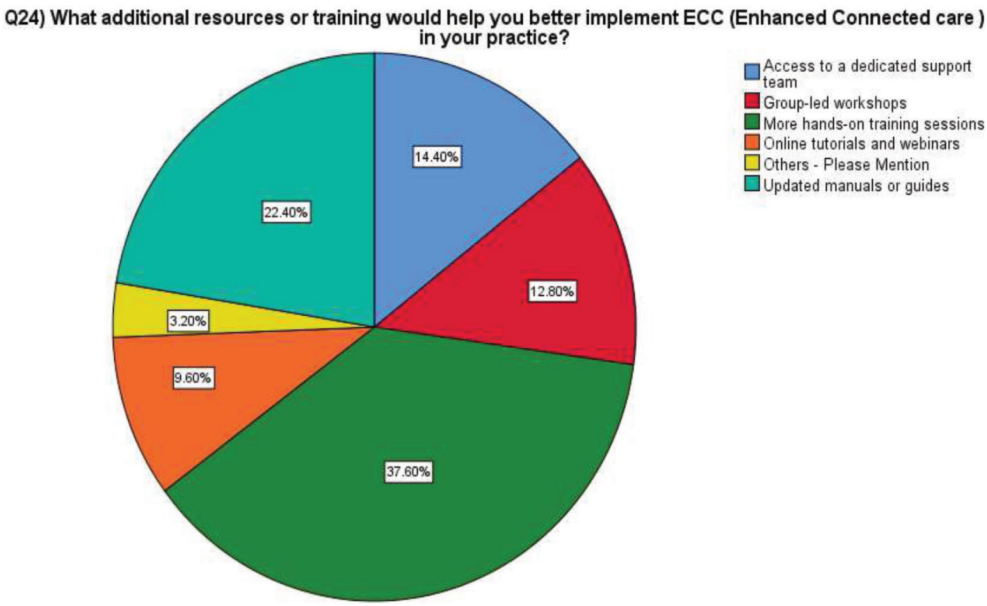

Figure 9: Need for additional resources to implement ECC

Discussion

The present cross-sectional study provides valuable insights into the knowledge, attitudes, and practices of nursing staff regarding Enhanced Connected Care (ECC) monitoring systems. Our findings reveal several key patterns in technology adoption, workflow integration, and perceived benefits, while also highlighting important challenges that need to be addressed for optimal implementation.

The study found that 61% of participants reported high confidence in using ECC technologies, with younger staff members (18–34 years) demonstrating greater comfort with the technology compared to their older colleagues (35–44 years). This age-related digital divide, though not statistically significant ($p = 0.640$) was reported before[10]. This finding suggests the need for age-specific training approaches, particularly for mid-career nurses who may require additional training and support in adapting to new monitoring technologies.

In another study by Kooij et al (2022) it was reported that Nurses' personal characteristics may also affect the uptake of technology in clinical practice. eHealth literacy, "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" requires skills[11] and access to digital tools[12].

A notable finding in our study was the significant correlation between knowledge levels and confidence levels among the study participants (Chi-square = 92.846, $p = 0.009$), indicating that increased understanding of ECC systems directly contributes to higher confidence level in their use of ECC. Previous studies have shown that with increase experience also affects the digital competencies among nurses[10].

The time-saving benefits of ECC monitoring emerged as a significant advantage in our study, with 47.2% of respondents reporting 5-10 minutes saved per shift. On a similar note, Femke L. Becking-Verhaar et al (2023) reported that automated monitoring reduced the time spent on manual vital sign measurements, freeing up nurses for other tasks[13].

However, this finding contrasts with previous research where the majority of nurses (74%) did not perceive continuous monitoring as time-saving[14]. This discrepancy might be attributed to differences

in system implementation and integration with existing workflows, highlighting the importance of proper infrastructure and training in realizing efficiency benefits.

The benefits of ECC monitoring in our study emphasized that ECC improved patient care quality (32.80%) and enhanced patient safety (24.00%), followed by early detection of patient deterioration (22.04%). These results align with previous research that identified early detection of clinical deterioration and increased feelings of safety as positive outcomes of continuous monitoring implementation[15].

Continuous monitoring for the early detection of deterioration and prevention of adverse events at general wards was also considered by Khanna et al (2019). They have also recognized the limitations of the current monitoring protocols, which only involve intermittent recording of vital sign leading to delayed detection of life-threatening events[16]. According to Downey et al., 2022 the recognition of deterioration in patients on surgical unit can be improved by using continuous monitoring. While they did indicate that the technology itself is a fixed resource, and the results depend on how staff respond to this resource in specific contexts. An example of this would include the presence of active senior colleagues engaging with nurses in using continuous devices effectively and improved recognition of deteriorating patients[17]. Kooij et al. (2022) also resonate with present study finding[15]. The specific reported benefits of improved monitoring of patients, safer procedures, efficient handling of patient loads, and increased comfort resonate with previous studies such as Becking-Verhaar et al. (2023)[13]. These consistent findings underscore the transformative potential of continuous monitoring in enhancing patient care through the timely identification of deterioration and alleviating nursing workload.

However, the literature also suggests that these benefits come with potential trade-offs, particularly in terms of patient contact and clinical assessment. Becking-Verhaar et al (2023) identified that potential challenges such as occasional device malfunction and connectivity problems can disrupt the workflow and required troubleshooting. They have also identified concerns about the visibility of the monitoring devices and potential privacy implications by the patients[13].

A significant challenge identified in our study was the impact of alarm burden, with 43.2% of nurses reporting that alarms affected their daily workflow. This finding resonates with previous research that identified technical integration and workflow compatibility as crucial factors for successful implementation[13,14]. The literature emphasizes that the complexity of continuous monitoring systems, including procedural steps and technical requirements, can significantly impact their effectiveness and adoption.

The high frequency of training (66.4% receiving weekly sessions) and regular usage (56.8% daily use) observed in our study appears to be a positive implementation factor. Previous research has highlighted the importance of proper integration with work processes and the need for clear role definitions when implementing new monitoring technologies[18]. This is particularly relevant given the concerns raised in the literature about changes in traditional nursing roles and the potential impact on patient-nurse relationships[19].

Our study identified the need for additional resources, particularly hands-on training sessions (37.6%) and updated manuals (22.4%). This aligns with previous findings emphasizing the importance of robust infrastructure support, including reliable Wi-Fi networks and proper integration with existing hospital information technology systems. The literature specifically notes that technical issues, such as Wi-Fi reliability and data accuracy, can significantly impact the successful implementation of continuous monitoring systems[15]. Pavithra et al (2024) also pointed out that the large volume of data generated by monitoring systems required efficient management and analysis[20].

Existing studies have focused on nurses impressions of continuous monitoring; however Kooij et al., (2022) provided more of a qualitative

auxiliary to the circumstantial challenges to implementation of wireless wearable sensors specifically[15]. This focus on the practical aspects of using wearable technology offers valuable insights for optimizing the implementation and adoption of RCM systems.

A limitation of our study was the lack of significant correlation between knowledge and practice frequency ($p = 0.243$). The literature suggests that successful implementation requires not only technical proficiency but also careful consideration of how new monitoring systems integrate with existing clinical practices and nurse-patient relationships.

The present study findings collectively suggest that while ECC monitoring systems show promise in improving patient care and workflow efficiency, their successful implementation requires careful attention to several key factors: technical infrastructure, workflow integration, training support, and preservation of essential nurse-patient interactions. In addition to that acceptance of technology and costs also represents additional crucial factors for any successful implementation and consequently are important findings.

However, the study also noted a number of challenges to ECC adoption. A notable proportion of mid-career nurses (35-44 years) reported lower confidence in using ECC tools than younger nurses. It also indicates that there is a gap in digital literacy among experienced nurses that requires specific training programs. The study indicated also the need for more resources to support ECC implementation.

Additionally, although ECC technologies bring many benefits, their successful implementation requires a comprehensive approach that takes into account both technological infrastructure as well as human aspects. The integration of ECC tools in clinical workflows should not come at the expense of patients-nurses interactions and must be accessible and easy to use via the hospital administrators.

Conclusion

To summarize, this study is a step forward in providing an important overview of the current state of play in ECC monitoring at Apollo Hospital.These clear results show an awareness of the improvements in patient care that ECCs can facilitate, but also expose essential areas for improvement. Future research should explore ECC technology advancements, cost-effectiveness, and long-term impact. Addressing challenges and enhancing training can improve patient-centered monitoring, care quality, and clinical outcomes while maintaining nursing standards.

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