Role of nurses' electrocardiography competency in emergent situations

Radu-Alexandru Iacobescu1,2, Luiza-Elena Corneanu3,4, Alina-Mihaela Dimache3,4, Bogdan-Danut Florescu2, Adorata-Elena Coman3,4

1Department of Thoracic Surgery, Pneumophthiziology Hospital, Iasi, Romania
2Department of Thoracic Surgery, County Emergency Hospital, Suceava, Romania
3Department of Internal Medicine 2, “SF. Spiridon” County Emergency Hospital, Iasi, Romania
4Faculty of General Medicine, University of Pharmacy and Medical Science “Grigore T. Popa”, Iasi, Romania

ABSTRACT

Electrocardiography is an essential tool in emergency care and monitoring of patients with severe cardiovascular diseases. Nurses are at the center of this evaluation and play an important role in the outcome of therapy. Data shows that nurses are limited in their ability to record and interpret electrocardiography diagrams accurately. Little is known about the role nurses play in electrocardiographic evaluation in an emergency. This narrative literature review assesses the competency of nurses in electrocardiography in an emergency, the implications for medical practice, and tries to identify possible improvement solutions.

Keywords: electrocardiography, telemetry, nursing, ECG competency, ECG education, emergency care

Abbreviations:
ECG - Electrocardiography
AHA - American Heart Association
ED - Emergency department
ICU - Intensive Care Unit
BLS - Basic Life Support
ALS - Advanced Life Support
AMI - Acute Myocardial Infarction

INTRODUCTION

Electrocardiography (ECG) is a vital diagnostic tool in emergent situations, especially for patients suffering from acute coronary syndrome or other life-threatening arrhythmias [1]. Continuous monitoring of ECG through telemetry has become an indispensable tool in the management of critical care patients [2]. Correct placement of leads and usage of electrocardiographic devices ensures consistency and accuracy of interpretation. Nurses are in a favorable position to augment patient outcomes in an emergent situation by correctly performing the test and readily identifying patients in need of emergent intervention, decreasing waiting time [3]. Evidence showed that rapid and accurate interpretation skills of cardiac rhythm have an impact on patient outcomes [4]. Thus, nurses need to possess an elevated degree of knowledge and competency in the technical aspects of ECG assessment, interpretation of results, recognition of ECG patterns, and then report and respond appropriately. ECG recording and interpre-
tation of rhythm is a component of undergraduate training of nurses, and training is required at least every 5 years [5,6]. Yet, little is known about nurses' competency in ECG assessment and interpretation, and if training programs make a difference in their performance in emergent situations. In this narrative review, we explore relevant literature data about the role that nurses play in ECG assessment in emergency settings and ways to improve performance.

MATERIALS AND METHODS

An inquiry of PubMed database was performed using key terms such as nursing, ECG monitoring, telemetry, ECG competency, ECG education, knowledge, and emergency care. The articles were reviewed and appropriate data was extracted regarding nurses' capacity to perform ECG assessments.

Lead placement and standards

In 2004 a standard on ECG assessment and telemetry was issued by the American Heart Association (AHA) [2,7,8]. These standards improved resource use and patient outcomes if correctly implemented [9]. However, there seems to be a constant lack of implementation of these standards in the current medical practice by medical professionals [10]. Nurses are key players in improving patient outcomes as they can elevate the quality of surveillance for cardiac arrhythmias [9]. It has been long suggested that health providers including nurses face difficulty in the correct positioning of ECG leads [11]. Inaccuracy of results following telemetry also stems from other potential flaws in ECG assessment such as lack of site preparation through shaving, skin cleaning, and removal of dead tissue, improper attachment of leads, lack of aseptic measures such as protective covers for telemetry, improper feedback to attending physicians, and lack of relevant information delivery to patients such as electromagnetic interference of other electric devices [10,12]. Fålun et. al. performed a 6-year longitudinal study on AHA standards and found that nurses consistently fail in the above criteria and there is a persistent lack of implementation through protocols [10]. These findings are supported by previous research [9,11-13] (Table 1).

Time management is also a significant factor. Management of emergent situations and critical care involves a multidisciplinary team and good cooperation between health providers, and nurses are usually the first responders [10]. AHA recommends a maximum of 10 minutes of elapsed time between the onset of symptoms and ECG (dor-to-ECG) [14]. A randomized clinical study has shown that the average door-to-ECG time can be reduced to 4 or 5 minutes with educational interventions and effective cooperation between nurses and cardiologists [15].

**TABLE 1. Nurses adherence to AHA standards**

<table>
<thead>
<tr>
<th>Author</th>
<th>Study type</th>
<th>Cohort</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fålun [10]</td>
<td>Prospective</td>
<td>Two hospitals: 185 and 178 nurses each</td>
<td>Mispositioned electrode placement (38%);</td>
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<tr>
<td></td>
<td>observational</td>
<td></td>
<td>Shaving improved (90% to 98%);</td>
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<tr>
<td></td>
<td>6-year study</td>
<td></td>
<td>Skin cleaning is often neglected (performed by 27%);</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Protective telemetry cover in only 65% ;</td>
</tr>
<tr>
<td>Funk [9]</td>
<td>6 years multisite</td>
<td>17 hospitals with a total of 65 cardiac units;</td>
<td>Mispositioning of electrodes 22.6%;</td>
</tr>
<tr>
<td></td>
<td>clinical trial</td>
<td>3013 nurses; 4587 patients</td>
<td>Educational intervention improved the quality of care and electrode placement correctness;</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Implementation of AHA standards improved patient outcomes</td>
</tr>
<tr>
<td>Pettersen [12]</td>
<td>Prospective</td>
<td>366 ICU patients: 201 pre-educational</td>
<td>Misplacement of electrodes 26% (23% post-intervention);</td>
</tr>
<tr>
<td></td>
<td>interventional</td>
<td>intervention; 165 post-educational</td>
<td>Shaving in 44% of cases (52% post-intervention);</td>
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<tr>
<td></td>
<td>study</td>
<td></td>
<td>Skin cleaning in 3% (1% post-intervention);</td>
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<td></td>
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<td>Poor electrode attachment 6% (10% post-intervention);</td>
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<td></td>
<td></td>
<td></td>
<td>Protective telemetry cover 71% (94% post-intervention);</td>
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<td></td>
<td></td>
<td></td>
<td>Informed about the need for the procedure 70% (82% post-intervention);</td>
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<td></td>
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<td>Informed about telephone use 12% (23% post-intervention)</td>
</tr>
<tr>
<td>Saethre [13]</td>
<td>Prospective</td>
<td>55 ICU patients</td>
<td>Misplacement of electrodes 30%;</td>
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<tr>
<td></td>
<td>observational</td>
<td></td>
<td>Poor attachment 22%;</td>
</tr>
<tr>
<td></td>
<td>study</td>
<td></td>
<td>Protective telemetry cover 71%;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Informed about the need for the procedure 76%</td>
</tr>
<tr>
<td>Rajaganeshan [11]</td>
<td>Prospective</td>
<td>72 Physicians; 37 Nurses; 10 cardiac technicians</td>
<td>Misplacement by 51% of nurses</td>
</tr>
<tr>
<td></td>
<td>observational</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AHA – American Heart Association; ICU – Intensive Care Unit
was 43 minutes on average, and just 59% were evaluated in the recommended 10-minute time that guidelines support [15]. Gender was an independent predictor of time as females had higher delays (53 min vs. 34 min for males; p = 0.001). Although reasons for the delay exist in the emergency room (such as overcrowding) the study also suggests that the level of education and experience of staff could play a major role as some might not be aware of ACC/AHA standards of care. Lack of awareness regarding standards has been suggested as a culprit by other studies as well [9,10].

**Monitoring**

Telemetry has become an essential tool for ECG monitoring of patients with cardiovascular disease [16]. It is within nurses’ duty to observe and monitor telemetry devices and respond to device alarms in intensive care units [10]. A degree of over-monitoring of cardiac patients has been reported, which puts a strain on nurse staff, does not contribute to the overall improvement of cardiac patient outcomes, and leads to fatigue and increased costs [9]. A study has shown that 20.2% of telemetry were performed for noncardiac reasons [16]. There are concerns about alarm fatigue and desensitization of nurses related to prolonged monitoring of patients which leads to failure in recognition of real life-threatening conditions [17]. It is unclear what the involvement of nurses could be in the augmentation of the relevance of telemetry or the duration of it but the PULSE clinical trial revealed a significant decrease in unnecessary monitoring after a training intervention for nurses [9]. It has been stated that much of the in-hospital training of hospital staff is done by observing nurses in their activities which might explain the above effect [11].

**Interpretation of ECG data**

Myocardial ischemia and arrhythmia are facilely recognizable through ECG and telemetry, as such identification of symptomatic patients and proper recording and interpretation of ECG in a timely manner is detrimental in any clinical or surgical department [1]. A recent meta-analysis of 43 scientific papers that evaluated nurses’ competency in ECG interpretation has shown that knowledge levels vary significantly and that there is a scarcity of training and exposure to adequate interpretation of electrocardiographic recordings [18]. Ho and colleagues performed a cross-sectional study on 96 emergency department (ED) nurses and found their knowledge and skills in the identification of heart rhythms to be fair, and that these are heavily dependent on formal education, exposure, and years of experience [19]. ED nurses have good skills in interpreting ECG regardless of professional level, another study shows [6]. However, a recent study shows poor performance of intensive care nurses and ED nurses in ECG interpretation [4]. Ambulance nurses have been shown to lack the necessary competency in ECG interpretation [20]. Lack of skill is a reoccurring conclusion of many studies [19-21] (Table 2). A concerning aspect is the consistent misdiagnosis of acute myocardial infarction (AMI) on ECG by both ED and ambulance nurses [6,20]. However, this assessment is dependent on competency evaluation which was different in all the above studies, and so far a standard assessment of competency is lacking [18]. There are current efforts to redefine competency and reach a consensus [22]. All the above studies assess different demographic populations which vary in their undergraduate teaching programs for nurses. This might explain the variation in nurses’ skills between studies. Most studies report on ED nurses’ competency, thus there is a lack of representation of ward and surgical nurses which warrants further research.

**Implications for medical practice**

The human factor remains significant in electrocardiographic assessment and is subjected to various potential pitfalls. Improper placement of leads has consequences on ECG waveform morphology, which increases the risk of misdiagnosis and consequently clinical error and mistreatment [9,12]. A noisy signal increases the frequency of false alarms which negatively impacts nurses’ performance [23,24]. Doctors recognize potential faults in ECG recordings and thus there is a degree of mistrust between health providers which is detrimental in an emergent situation [11]. Patient outcomes in an emergency are dependent on nurses’ level of knowledge and skill in the interpretation of ECG recordings [9]. Studies show a consistent lack thereof with dire consequences on patient safety (Table 2).

**Training for nurses**

Training at all levels of experience seems to be the appropriate solution but that has proved to be difficult and limited for nurses. A recent survey of final-year medical students reveals that 80% received less than 6h hours of training in rhythm interpretation during undergraduate education [5]. This had an effect on their confidence level regarding ECG interpretation and impacted their willingness to seek assistance in patient care. Moreover, in hospitals, the training of other staff members in ECG lead placement is usually limited to the observation of nurses’ activity which puts the weight of teaching on practicing nurses and undesirably perpetuates the mistakes [11]. Fålun et al. show that despite governmental-influenced educational efforts, nurses’ performance and accuracy in monitoring improved minimally, and was suboptimal as nurses failed consistently in lead placement, proper hygiene and site preparation, epidemiologic precautions, and interpretation.
of emergent cardiac arrhythmias [10]. An intervention-
al study showed minimal improvement in the perfor-
mance of nurses after attending a specially designed
course, regarding mainly epidemiologic measures such
as protective covers for telemetry monitors and informa-
tion delivery [12]. Arguably this is due to staff mem-
bers' inherent resistance to change suggesting the need
for long-term measures and education plans. Others
have provided teaching plans that improve nurses’ per-
formance in ECG interpretation [25]. Simulation-based
methods are emerging as superior teaching methods
[26,27]. Dedicated courses are needed to target and
improve areas of vulnerability such as alarm fatigue
[19,24]. As well, skill decay is an important issue and
must be addressed through continuous education and
consistent evaluation [5,6]. To date, no teaching stand-
ard has been established [28].

**CONCLUSION**

Electrocardiography and telemetry are important
assessments in emergent situations that are highly de-
pendent on nurses’ skills. Though of significant impor-
tance, nurses’ level of knowledge is limited in ECG inter-
pretation in emergent situations. There is a current
need for raising awareness and local implementation of
AHA standards of practice. Training is a significant fac-
tor for patient outcome improvement but has been
proven difficult as there is a lack of standardization and
no teaching method has emerged superior. Relevant
in-service training, skill sharing, and simulation-based
learning are potential strategies for future improve-
ment.

**Conflict of interest:** The authors declare no conflict of interest.

**Financial support:** none declared

**Author’s contributions**

Conceptualization, I.R.A. and C.A.E.; writing-original
draft preparation, I.R.A. and F.B.D; writing-review and
editing, F.B.D., D.A.M., and C.L.E.; supervision C.A.E.

All authors have read and agreed to the published
version of the manuscript.

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**TABLE 2. Nurses’ competency in ECG interpretation at different levels of experience and training**

<table>
<thead>
<tr>
<th>Author</th>
<th>Cohort</th>
<th>Level of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alijohani [4]</td>
<td>255 ICU and ED nurses</td>
<td>Nurses performed poorly in ECG interpretation; Almost half failed to identify ventricular fibrillation, atrial flutter and fibrillation, and heart block</td>
</tr>
<tr>
<td>Rahimpour [21]</td>
<td>105 ED nurses, 65 ED staff</td>
<td>Nurses performed poorly in ECG interpretation; Females performed better; Competency was dependent on experience, training, and type of training, and feedback from doctors</td>
</tr>
<tr>
<td>Ho [19]</td>
<td>96 ED nurses</td>
<td>Nurses performed fairly in rhythm recognition; Most were not able to identify heart block types; Males performed better; Competency was dependent on years of experience and training level; Completion of BLS or ALS did not improve skills</td>
</tr>
<tr>
<td>Chen [5]</td>
<td>114 final year nursing students</td>
<td>Student nurses performed poorly in rhythm recognition; Most failed to identify ventricular fibrillation and tachycardia</td>
</tr>
<tr>
<td>Coll-Badell [6]</td>
<td>57 ED nurses</td>
<td>Nurses performed fairly in ECG interpretation; Nurses performed poorly in the identification of AMI; Those with training courses in the past 5 years performed slightly better; Competency was not associated with professional level</td>
</tr>
<tr>
<td>Funk [9]</td>
<td>3013 nurses of cardiac unit</td>
<td>Nurses performed poorly in ECG interpretation; Educational intervention improved knowledge and decreased mortality but was not sustained after 15 months</td>
</tr>
<tr>
<td>Werner [20]</td>
<td>132 ambulance nurses</td>
<td>Nurses performed poorly in ECG interpretation; Nurses poorly identified AMI; No correlation with experience and years of practice</td>
</tr>
</tbody>
</table>

ICU – Intensive Care Unit; ED – Emergency Department; ECG – Electrocardiography; BLS – basic life support; ALS – advanced life support; AMI – acute myocardial infarction
REFERENCES


