

Enhancing Emergency ECG Interpretation: A Practical Checklist Developed from a Study Assessing Young Physicians' Diagnostic Abilities

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Abstract

Effective interpretation of electrocardiograms (ECGs) is a critical skill for healthcare professionals, especially in emergency settings. This study assessed the diagnostic abilities of 200 final-year medical students and young doctors in ECG interpretation. Subsequently, based on the study findings, a practical checklist was developed, and a comprehensive book entitled “Critical ECG in Emergencies” was authored by the researchers. The checklist provides cognitive aids and serves as a systematic guide to enhance ECG interpretation in urgent situations. The study revealed a need for improved confidence in interpreting critical ECGs among the participants. The checklist offers promise for reducing diagnostic errors and improving patient outcomes. Further research is required to evaluate its impact on daily practice and patient care, while the book provides valuable resources for healthcare professionals in emergency medicine.

Keywords

Electrocardiogram, Checklist, Emergency, Interpretation, Education

1. Introduction

The accurate interpretation of electrocardiograms (ECGs) plays a pivotal role in diagnosing and managing cardiac conditions, particularly in the demanding environment of the emergency department [1]. However, studies have revealed knowledge gaps among medical students and young doctors when it comes to ECG interpretation. To address this issue, we conducted a comprehensive study

that aimed to assess the knowledge of medical students and young doctors in this field. The findings of this study served as the foundation for our subsequent work, which involved the development of a practical cognitive aid designed to improve ECG interpretation.

Building upon the insights gained from our knowledge assessment study, we wrote the book titled “*Critical ECG in Emergencies*” (Figure 1). This book encapsulates our research findings and provides in-depth guidance on ECG interpretation, with a focus on identifying and managing urgent cardiac conditions. By distilling our study’s outcomes into a comprehensive resource, we aimed to bridge the gap between theoretical knowledge and practical application in ECG interpretation. We made it downloadable as a free eBook online.

Based on the principles and recommendations outlined in “*Critical ECG in Emergencies*”, we subsequently developed a cognitive aid entitled “My Emergency ECG Checklist” (Figure 2). This checklist was designed to serve as a user-friendly and easily accessible tool that could be utilized in emergency departments. It provides a systematic approach to ECG analysis, ensuring that critical aspects are considered and potential anomalies are identified promptly.

The checklist’s format consists of a column on the left, where healthcare professionals can unroll and tick boxes corresponding to specific ECG criteria. A complete checklist, with all boxes checked, indicates the absence of anomalies; however, it is crucial to emphasize that this does not guarantee the patient’s overall well-being. If any boxes remain unchecked, the cognitive aid provides diagnostic ideas and serves as an electrical reminder of key ECG emergencies that require immediate attention.

In this scientific paper, we aim to present our cognitive aid, “My Emergency

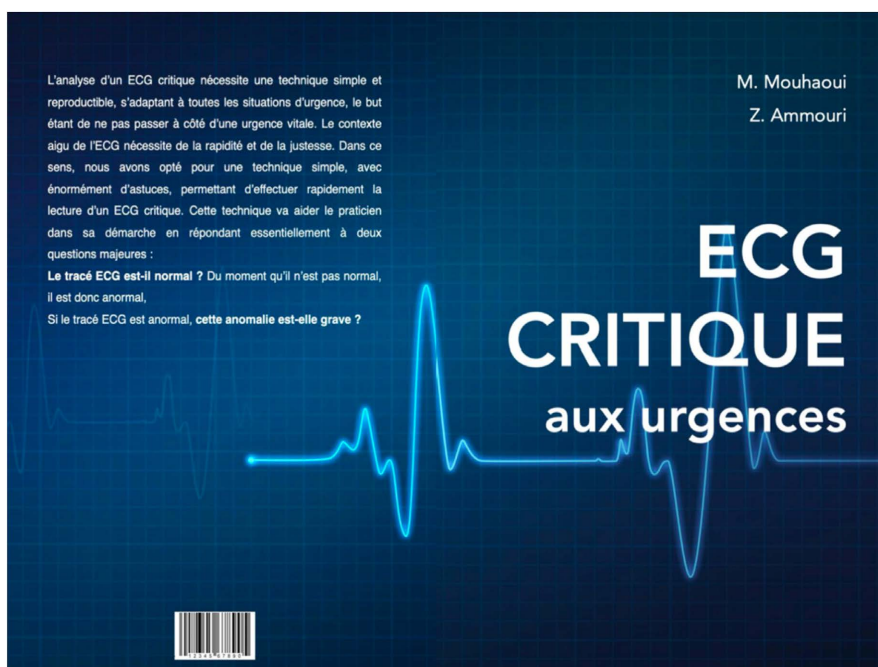


Figure 1. Cover of the book “*Critical ECG in Emergencies*”.




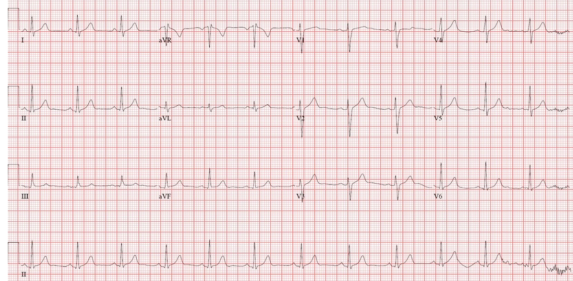

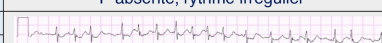





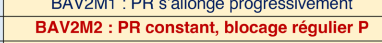
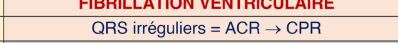

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Figure 2. ECG checklist “My Emergency ECG Checklist”.

ECG Checklist,” as the result of our comprehensive knowledge assessment study and subsequent book development. We will outline the process of transforming research findings into practical guidance, highlighting the collaboration with Professor Mouhaoui and the incorporation of insights from “Critical ECG in emergencies.” Additionally, we will discuss the implementation of the cognitive aid and its potential impact on improving ECG interpretation in the emergency department.

By translating our research outcomes into a tangible and user-friendly tool, we aim to enhance the proficiency and confidence of medical students and young doctors in interpreting ECGs during critical situations. We anticipate that the utilization of our cognitive aid will lead to more accurate diagnoses, improved patient outcomes, and increased efficiency in emergency settings.

Through this paper, we aim to contribute to the growing body of literature on ECG interpretation and underscore the importance of cognitive aids in optimizing patient care in emergency departments. By combining our research findings, practical recommendations, and the development of the “My Emergency ECG Checklist”, we strive to empower healthcare professionals with the necessary tools to enhance their ECG interpretation skills and ultimately improve patient outcomes.

2. Methods

In our preliminary study, we conducted an observational, cross-sectional study

to assess the knowledge of medical students and young doctors in ECG interpretation. The study was conducted over a period of six months, gathered 200 responses from our target population.

The target population included medical students in their final year from different medical faculties in Morocco, including Casablanca, Rabat, Fes, Oujda, and Marrakech. We also included interns from peripheral hospitals and university hospitals, as well as young doctors who completed their thesis between January 2018 and July 2020.

For data collection, we designed a survey using the “Google Forms” platform. The survey was divided into two parts. The first part focused on assessing the current state of ECG interpretation and included questions about participants’ demographics, previous training in ECG interpretation, accessibility to ECG equipment, average number of ECGs reviewed per day, and self-assessment of ECG interpretation skills.

The second part of the form evaluated participants’ interpretation of ten selected critical ECGs. Each ECG was accompanied by multiple-choice questions to assess their understanding and interpretation.

Data analysis was descriptive in nature, with quantitative data presented as means with standard deviations and qualitative data expressed as percentages.

The findings of this preliminary study served as the basis for the development of our book “Critical ECG in Emergencies” meant to be didactic and a useful guide to understand the basics of ECGs interpretation. This book helped and led to the elaboration of a cognitive aid, the “My Emergency ECG Checklist”.

3. Results

3.1. Preliminary Study

Our study included 200 final-year medical students and young doctors. The participants were predominantly female, accounting for 61% of the total, while males represented 39%. The age range of the participants was from 21 to 30 years, with a median age of 25 years (**Figure 3**).

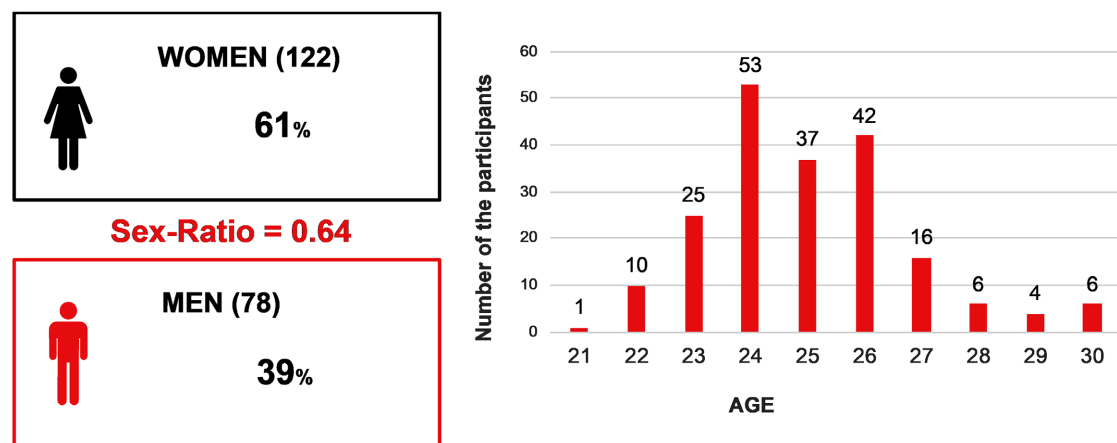


Figure 3. Sex ratio and age repartition.

Regarding their previous training in ECG interpretation, 168 of the participants reported having received some form of training. The types of training varied, with 63.5% attending lectures, 53% engaging in self-study, and 61 participants using online videos for learning. Additionally, 122 participants had attended workshops (Figure 4).

Participants' confidence levels in interpreting critical ECGs varied. While 9% rated their ability at 1 out of 10, 20% rated it at 6 out of 10. When asked about their overall confidence in ECG interpretation, only 0.5% rated their confidence at 10 out of 10, while 58% rated it below 5 out of 10 (Figure 5).

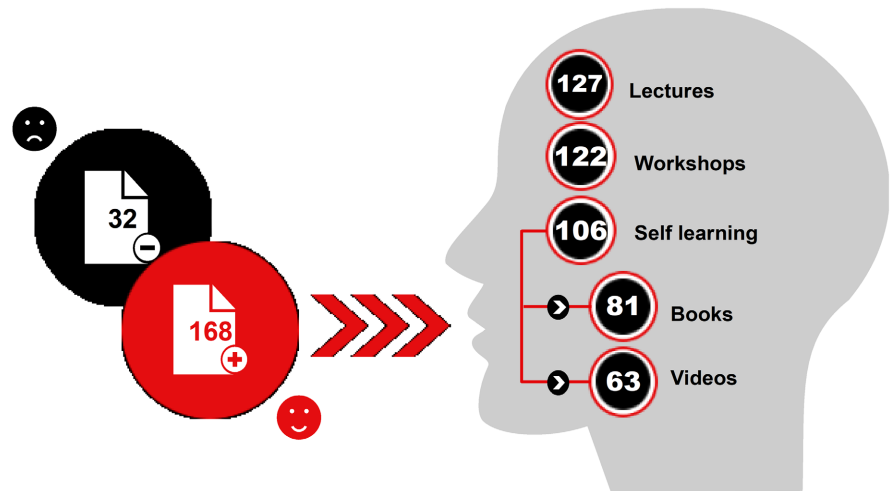


Figure 4. ECG interpretation training types.

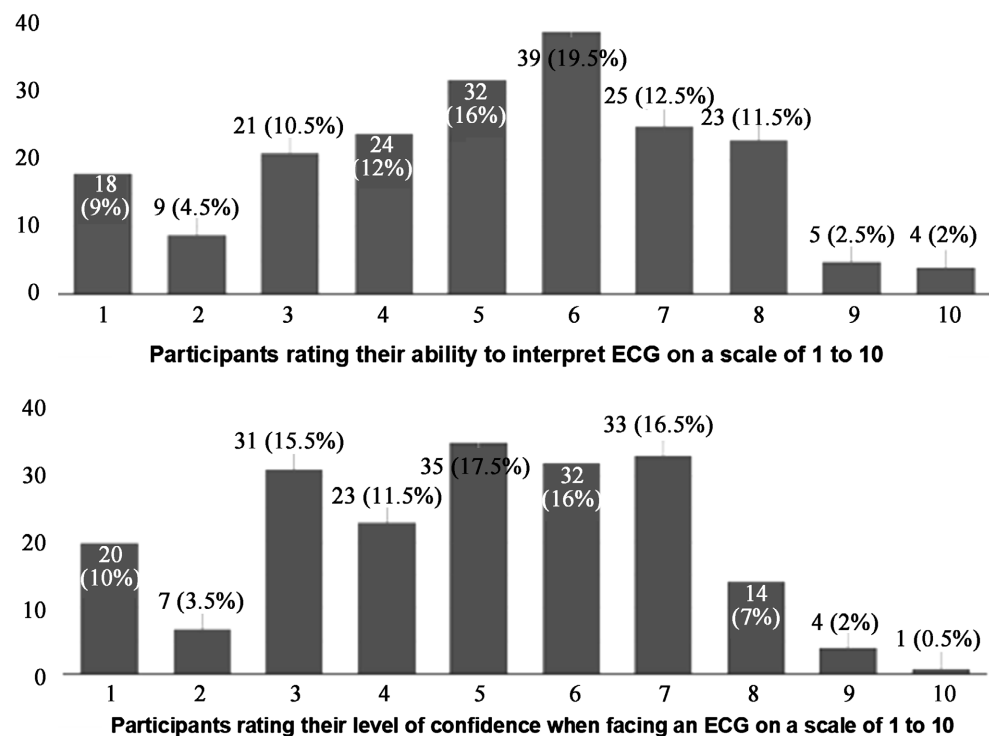


Figure 5. Ratings of interpretation ability and level of confidence among the participants.

Fear of missing a diagnostic emergency was reported by 75% of participants, and 41% felt a sense of incompetence in ECG interpretation. Two-thirds of the participants had read ECG books, but 65% felt that these books did not meet their expectations, primarily citing their theoretical nature and lack of practicality.

Importantly, 90% of the participants emphasized the significance of ECG interpretation skills in a physician's daily practice, rating it as more than 8 out of 10 in terms of importance.

In the ECG interpretation section, 83.5% of the participants correctly identified a normal ECG, while 86.5% accurately diagnosed T-wave amplitude related to hyperkalemia. However, only 11% correctly identified type 2 Mobitz II atrioventricular block.

These findings highlight a big variation in previous training methods, the importance of ECG interpretation skills, and the need for improved confidence and level of competence in interpreting critical ECGs.

3.2. The Book and the Checklist

Taking into account the participants' feedback and the main findings of our study, our initial approach involved creating a practical book for ECG interpretation. This book was designed to provide comprehensive guidance and in-depth explanations to aid in understanding the complexities of ECG patterns.

However, based on the participants' overwhelming preference for practicality and ease of use, we recognized the need for a more condensed and user-friendly format. As a result, we condensed the key concepts and essential information from the book into a checklist.

3.3. The Checklist

The checklist serves as a practical tool that can be easily referenced and utilized in real-time, particularly in emergency room settings where quick decisions are often required. By distilling the essential elements from the book into a concise checklist, we aimed to provide healthcare professionals with a practical resource that can be readily accessed during critical situations.

The checklist includes clear and straightforward instructions, step-by-step guidelines, and visual aids to facilitate efficient ECG interpretation. It emphasizes the key concepts identified through our study, focusing on the most relevant diagnostic criteria and potential abnormalities that require immediate attention.

By transitioning from the comprehensive book to the streamlined checklist, we aimed to meet the participants' needs for a practical, easy-to-use resource that enhances their confidence and competence in ECG interpretation. This approach allows healthcare professionals to quickly and accurately analyze ECGs, leading to timely diagnoses and appropriate patient management in emergency room settings.

The checklist we have developed for ECG interpretation is a user-friendly tool

designed to assist healthcare professionals in accurately analyzing electrocardiograms. It provides a systematic and structured approach to ensure comprehensive evaluation and interpretation of ECG patterns.

The checklist is divided into different sections, each focusing on a specific aspect of ECG interpretation. It begins with a brief introduction and instructions on how to use the checklist effectively. The checklist is then organized into the following key components:

Three big sections, on the left the interpretation checklist, in the top middle a normal ECG to keep in mind what a normal ECG look like, and finally in the bottom middle an right side some of the main ECG emergencies with focused keynotes.

You can find in the end of the paper a detailed appendix explaining every section of the checklist and the interpretation process.

4. Discussion

The electrocardiogram (ECG) is one of the most commonly applied technical procedures in clinical medicine; physicians of all specialties should be familiar with the basic principles of ECG interpretation and diagnoses requiring emergency treatment [2] [3]. However, many studies suggest the need to improve ECG training during postgraduate medical training [4].

We must highlight the importance of acquiring the skill of interpreting critical ECGs during medical training. The study revealed that participants recognized the significance of this skill, with 90% rating it as highly important. This finding aligns with previous research indicating the widespread recognition of ECG interpretation as a crucial competency among healthcare professionals.

Interestingly, despite acknowledging the importance of ECG interpretation, participants expressed low levels of confidence in their ability to interpret critical ECGs. More than half of the participants rated their confidence as low, with a score of five or below on the Likert scale. This lack of confidence was consistent with findings from other studies, where a significant percentage of participants reported limited or moderate confidence in ECG interpretation [5].

The origin of this lack of confidence is a noteworthy concern. The study found that three-quarters of participants expressed fear of missing a diagnostic emergency, while 41% felt a sense of incompetence. These factors likely contribute to the overall lack of confidence and highlight the importance of addressing these psychological barriers to enhance healthcare professionals' confidence in interpreting critical ECGs.

To make the interpretation of critical ECGs more attractive and effective, interventions should focus on addressing these confidence issues. Providing targeted training programs, incorporating practical and hands-on experiences, and offering continuous support and feedback can help build competence and boost confidence in ECG interpretation.

Additionally, the checklist developed in this study serves as a valuable tool in

guiding healthcare professionals through the interpretation process. By providing cognitive reminders and presenting diagnostic ideas, the checklist helps identify and prioritize the main ECG findings, including critical emergencies. The inclusion of a reference to a normal ECG pattern further enhances practitioners' ability to recognize abnormal findings.

Three hundred million ECGs are done annually, even a small percentage of misinterpretation would have a considerable negative impact on the management of a significant number of patients [5]. The "American College of Cardiology" (ACC) and the "American Heart Association" (AHA), aware of this issue, set up a Task Force in 1998 with the aim of reviewing and establishing the prerequisites for cardiology training interpretation and reading of ECGs. This same Task Force recommends the interpretation of one hundred and fifty ECGs in the company of trainers in order to ensure the acquisition of this skill. However, despite this, how to train in the interpretation of the ECG remains an unresolved problem. The AHA also recommends and emphasizes the importance of maintaining and maintaining this knowledge of ECG interpretation, thus recommending a minimum of twenty-five ECGs annually for this [6].

In our study, ten different types of training were identified, ranging from traditional lectures to online videos and books. Note that in Poland, Kopec, *et al.* demonstrated that self-training in young physicians significantly improved their ability to correctly interpret an ECG [1]. DeJager, *et al.* highlighted the fact that out of ninety-six emergency medicine residents, self-study was the most frequently used method [7]. However, contrary to these findings, a prospective study conducted by Mahler, *et al.* had shown a lesser effectiveness of self-training compared to formal teaching [2].

However, in the literature, no method of teaching the interpretation of ECGs has been proven superior to another [2] [8].

Checklists have long been used to reduce error in fields such as airline travel. More recently, medicine has adopted checklists in an effort to improve safety [9] [10]. However, the majority of studies have evaluated the use of checklists in procedural skills rather than cognitive skills [11].

Research has shown that checklists can play a crucial role in reducing diagnostic errors in medicine. Specifically, diagnostic checklists serve as valuable tools in broadening the range of possible diagnoses that physicians consider. By providing a systematic reminder of all potential options, checklists prevent clinicians from relying solely on memory and pattern recognition, which can be prone to errors [11].

Furthermore, studies have found that checklists are particularly beneficial for less experienced clinicians who have not yet developed robust schemas for pattern recognition. In the fast-paced environment of the emergency department (ED), where ECG interpretation is often based on pattern recognition, checklists can significantly improve accuracy [12].

Given the potential consequences of missed diagnoses, enhancing accuracy in

ECG interpretation is of utmost importance. By incorporating checklists into the process, healthcare professionals are prompted to consider a comprehensive list of potential diagnoses, reducing the risk of overlooking critical information and improving patient outcomes.

The next crucial step for the checklist will be to evaluate its impact on daily medical practice once it becomes widely implemented. Conducting studies to assess the checklist's effectiveness in real-world settings is essential in understanding its practical implications and benefits.

Future research will focus on conducting observational studies to compare the outcomes of healthcare providers who use the checklist versus those who do not. By measuring key metrics such as diagnostic accuracy, patient outcomes, and workflow efficiency, researchers can gain insights into the checklist's impact on clinical decision-making and patient care.

Additionally, qualitative research methods like surveys, interviews, or focus groups will be employed to gather feedback from healthcare professionals regarding their experience using the checklist. This feedback can help identify any potential challenges or areas for improvement, allowing for iterative refinements of the checklist to better align with the needs and workflows of healthcare providers.

Overall, assessing the impact of the checklist in actual clinical practice will provide valuable evidence on its efficacy, potential barriers to implementation, and opportunities for optimization. This information will guide future iterations of the checklist and contribute to the ongoing improvement of patient care in emergency settings.

5. Conclusion

Our study has shed light on a critical aspect of medical education and practice—the interpretation of electrocardiograms (ECGs). Despite prior training, it's evident that there exists a substantial gap in the confidence of young physicians when it comes to interpreting critical ECGs. This observation prompts a broader reflection on the challenges inherent in translating theoretical knowledge into practical application.

The development of a practical checklist serves as a response to this challenge. Such tools have demonstrated their efficacy in other industries, offering a structured and methodical approach that can instill confidence and reduce errors. This approach, we believe, could significantly impact the landscape of ECG interpretation, allowing medical practitioners to navigate the complexities of this task with greater assurance.

In a field where accurate and timely diagnoses are paramount, addressing the confidence gap in ECG interpretation becomes an imperative. While our study may not have provided all the answers, it sparks a conversation that could reshape the training and support provided to young physicians, ultimately leading to improved patient care and outcomes. This journey from study to practical

implementation symbolizes the constant evolution of medical practice, reminding us that each piece of research has the potential to refine and redefine how healthcare is delivered.

Further research is needed to evaluate its impact on daily practice and patient outcomes, but its implementation holds promise for improving ECG interpretation skills and enhancing patient care.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Kopeć, G., Magoń, W., Hołda, M., *et al.* (2015) Competency in ECG Interpretation among Medical Students. *Medical Science Monitor*, **21**, 3386-3394. <https://doi.org/10.12659/MSM.895129>
- [2] Mahler, S.A., Wolcott, C.J., Swoboda, T.K., *et al.* (2011) Techniques for Teaching Electrocardiogram Interpretation: Self-Directed Learning is Less Effective Than a Workshop or Lecture: Techniques for Teaching ECG Interpretation. *Medical Education*, **45**, 347-353. <https://doi.org/10.1111/j.1365-2923.2010.03891.x>
- [3] Crocetti, M. and Thompson, R. (2010) Electrocardiogram Interpretation Skills in Pediatric Residents. *Annals of Pediatric Cardiology*, **3**, 3-7. <https://doi.org/10.4103/0974-2069.64356>
- [4] Mele, P.F. (2008) The ECG Dilemma: Guidelines on Improving Interpretation. *Journal of Healthcare Risk Management*, **28**, 27-31. <https://doi.org/10.1002/jhrm.5600280205>
- [5] Eslava, D., Dhillon, S., Berger, J., *et al.* (2009) Interpretation of Electrocardiograms by First-Year Residents: The Need for Change. *Journal of Electrocardiology*, **42**, 693-697. <https://doi.org/10.1016/j.jelectrocard.2009.07.020>
- [6] Kadish, A.H., Buxton, A.E., Kennedy, H.L., Knight, B.P., *et al.* (2001) ACC/AHA Clinical Competence Statement on Electrocardiography and Ambulatory Electrocardiography. *Circulation*, **104**, 3169-3178. <https://doi.org/10.1161/circ.104.25.3169>
- [7] Jager, J., Wallis, L. and Maritz, D. (2010) ECG Interpretation Skills of South African Emergency Medicine Residents. *International Journal of Emergency Medicine*, **3**, 309-314. <https://doi.org/10.1007/s12245-010-0227-3>
- [8] Rubinstein, J., Dhoble, A. and Ferenchick, G. (2009) Puzzle Based Teaching versus Traditional Instruction in Electrocardiogram Interpretation for Medical Students—A Pilot Study. *BMC Medical Education*, **9**, Article No. 4. <https://doi.org/10.1186/1472-6920-9-4>
- [9] Thomassen, Ø., Storesund, A., Søfteland, E., *et al.* (2014) The Effects of Safety Checklists in Medicine: A Systematic Review. *Acta Anaesthesiologica Scandinavica*, **58**, 5-18. <https://doi.org/10.1111/aas.12207>
- [10] Nöthiger, C.B. and Tscholl, D.W. (2022) The Use of Checklists in Medicine. *Praxis*, **111**, 749-753. <https://doi.org/10.1024/1661-8157/a003911>
- [11] Koca, A., Abraham, P., Cejka, J.-C., *et al.* (2021) Cognitive Aids: What Are We Talking about? *Journal of Clinical Anesthesia*, **74**, Article 110433. <https://doi.org/10.1016/j.jclinane.2021.110433>

- [12] Nickerson, J., Taub, E.S. and Shah, K. (2020) A Checklist Manifesto: Can a Checklist of Common Diagnoses Improve Accuracy in ECG Interpretation? *The American Journal of Emergency Medicine*, **38**, 18-22.
<https://doi.org/10.1016/j.ajem.2019.03.048>

Appendix

The Book and the Checklist

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The Blue Column: Interpretation Checklist

It is organized in a chronological order to ensure a systematic and thorough evaluation of each ECG. We decided to divide it into four sections: First data collection, secondly validity of the ECG, third general interpretation and finally specific approach.

Data Collection

Before diving into the ECG interpretation, itself, the checklist begins with a section dedicated to reviewing and verifying the personal data of the patient.

In this initial step, healthcare professionals are prompted to cross-check the patient's identity, ensuring that the personal information provided on the ECG report matches the patient's actual details. This includes confirming the patient's name, date of birth, and any other relevant identifiers.

Verifying the accuracy of personal data is crucial as it helps prevent potential errors or mix-ups in patient identification, ensuring that the ECG results are correctly attributed to the appropriate individual. This step promotes patient safety and minimizes the risk of misinterpretation or mismanagement based on incorrect patient information.

In addition to verifying the personal data of the patient, the first step of the checklist also includes the verification of the date and time associated with the ECG recording. This ensures the accuracy and relevance of the ECG results within the context of the patient's medical condition.

Healthcare professionals are prompted to confirm that the date and time recorded on the ECG report correspond to the actual date and time of the ECG recording. This step is crucial in maintaining the integrity of the ECG interpretation, as it helps ensure that the findings reflect the patient's cardiac status at the specific moment the ECG was performed.

By including date and time verification as part of the initial step, the checklist emphasizes the importance of capturing and documenting this information accurately. Discrepancies or inaccuracies in the recording date and time could lead to misinterpretation or the application of inappropriate clinical interventions.

By addressing personal data, including patient identity, and verifying the date and time of the ECG recording, healthcare professionals establish a strong foundation for reliable and precise ECG interpretation. These steps contribute to patient safety, data integrity, and the overall effectiveness of clinical decision-making in emergency room settings.

Validity

After confirming the personal data and verifying the date and time, the next step in the checklist is the validity check of the ECG. This step ensures that the ECG recording is valid and appropriate for interpretation.

During the validity check, healthcare professionals assess the quality of the ECG signal to determine if it meets the necessary criteria for accurate interpretation. They examine various factors such as the presence of artifacts, proper electrode placement, and adequate signal amplitude and paper speed.

Artifacts, such as muscle tremors or electrode movement, can interfere with the accuracy of the ECG interpretation. If significant artifacts are observed, healthcare professionals may need to reposition the electrodes or take measures to minimize their impact.

Proper electrode placement is crucial for obtaining an accurate ECG. The

checklist prompts healthcare professionals to ensure that the electrodes are correctly positioned on the patient's chest and limbs according to established guidelines. This step helps prevent misinterpretation resulting from electrode misplacement.

The paper speed refers to the rate at which the ECG waveform is displayed on the ECG paper. It is typically measured in millimeters per second (mm/s). The standard paper speed is 25 mm/s, although alternative speeds, such as 50 mm/s, may be used in certain situations.

Ensuring the correct paper speed is essential for accurate interpretation of the ECG. Different paper speeds can affect the visual representation of the ECG waveform, including the duration and spacing between individual waves and intervals. Therefore, it is crucial to verify that the paper speed setting on the ECG machine matches the speed at which the ECG was recorded.

The checklist prompts healthcare professionals to confirm the paper speed and verify that it aligns with the standard or intended speed for accurate interpretation. This step helps prevent misinterpretation due to errors or discrepancies in paper speed settings.

By including the paper speed verification in the checklist, healthcare professionals can ensure consistency and reliability in ECG interpretation. It helps maintain the integrity of the ECG waveform and facilitates accurate analysis of various waveform components, such as the P wave, QRS complex, and T wave, as well as the measurement of intervals and durations.

The validity check in the checklist serves as a crucial quality assurance step, ensuring that only reliable and appropriate ECG recordings are used for interpretation. This helps maintain the accuracy and clinical relevance of the subsequent analysis and decision-making processes. This step leads us to the general appreciation of the ECG before diving into the specific interpretation of its components.

General Interpretation

The third step in the checklist involves a general appreciation of the ECG, focusing on four key items: heart rate, sinus rhythm, regularity of the rhythm, and overall heart axis.

Heart Rate: The checklist prompts healthcare professionals to determine the heart rate based on the ECG recording. They calculate the number of QRS complexes occurring within a specified time interval (e.g., one minute) to assess the heart rate. This information helps evaluate the speed at which the heart is beating and provides important clinical insights.

Sinus Rhythm: Sinus rhythm refers to the normal electrical activity originating from the sinus node, the natural pacemaker of the heart. In this step, healthcare professionals assess whether the ECG demonstrates a sinus rhythm. They look for consistent P waves preceding each QRS complex, indicating that the electrical impulses are being initiated from the sinus node.

Regularity of the Rhythm: The regularity of the rhythm is assessed by eva-

luating the spacing between the R-R intervals on the ECG. Regular rhythm exhibits a consistent spacing between successive R waves, while irregular rhythm displays variations in the R-R intervals. Identifying the regularity of the rhythm helps in diagnosing various cardiac arrhythmias.

Heart Axis: The heart axis refers to the overall direction of the electrical activity within the heart. It is determined by analyzing the QRS complex in multiple leads of the ECG. The checklist guides healthcare professionals in assessing the heart axis to determine if it falls within the normal range or if there is a deviation, which may indicate underlying cardiac conditions.

By including these four items in the checklist, healthcare professionals can quickly evaluate essential aspects of the ECG. The heart rate provides insights into the speed of cardiac contractions, sinus rhythm confirms the integrity of the normal conduction pathway, regularity of the rhythm helps identify arrhythmias, and assessing the heart axis assists in detecting abnormalities.

This systematic approach ensures that no crucial aspects are overlooked during the interpretation process. We move then to the fourth step of the checklist which is the specific interpretation of the main components of the ECG.

Specific Interpretation

The fourth step of the checklist focuses on the specific interpretation of the main components of the ECG. It involves analyzing and evaluating the following components:

P Wave: The checklist prompts healthcare professionals to assess the characteristics of the P wave. They examine the shape, duration, and amplitude of the P wave, which provides information about atrial depolarization. Abnormalities in the P wave may indicate atrial enlargement or conduction abnormalities.

PR Interval: In this step, healthcare professionals measure and evaluate the PR interval. The PR interval represents the time it takes for the electrical impulse to travel from the atria to the ventricles. Deviations in the PR interval can indicate conduction abnormalities, such as atrioventricular block.

QRS Complex: The QRS complex is assessed for its duration, morphology, and amplitude. Healthcare professionals analyze the shape and duration of the QRS complex to identify abnormalities in ventricular depolarization. Deviations from the normal QRS complex can indicate ventricular hypertrophy, bundle branch blocks, intraventricular conduction delays, or specific patterns such as S1Q3T3 in pulmonary embolism or Q patterns in myocardial necrosis.

ST Segment: The checklist guides healthcare professionals to evaluate the ST segment. They examine the level and morphology of the ST segment in relation to the baseline. ST segment deviations, such as elevation or depression, can indicate myocardial ischemia, injury, or other cardiac conditions.

T Wave: Healthcare professionals assess the shape, symmetry, and amplitude of the T wave. Changes in the T wave morphology may suggest electrolyte imbalances, myocardial ischemia, or other cardiac abnormalities.

QT Interval: The checklist prompts the measurement and evaluation of the

QT interval. The QT interval represents the total duration of ventricular depolarization and repolarization. Prolongation of the QT interval can predispose individuals to life-threatening arrhythmias and requires careful monitoring and management.

By focusing on these specific components of the ECG, the checklist ensures a thorough analysis of the ECG findings. It helps healthcare professionals identify abnormalities or deviations from the normal pattern, providing crucial information for diagnosis and treatment decisions.

This systematic approach to interpreting the main components of the ECG enhances efficiency and accuracy in the emergency room setting. It helps healthcare professionals detect and manage cardiac conditions promptly, leading to improved patient outcomes.

Cognitive Reminders

Diagnostic ideas are displayed alongside each evaluated aspect, there are also cognitive reminders to help identify key ECG emergencies.

These cognitive reminders are specific notes or tips that assist medical personnel in remembering the characteristic signs of ECG emergencies and the actions to take when detecting these signs. They serve as practical guidance for a quick and accurate interpretation of the ECG in emergency situations.

Normal ECG Displayed

In the top middle part of the checklist, we included a representation of a normal ECG to serve as a reference for identifying what a normal ECG should look like. This serves as a visual guide for healthcare professionals to compare the ECG being evaluated with a standard normal pattern.

By displaying a normal ECG, it allows clinicians to quickly assess any deviations or abnormalities in the ECG they are interpreting. They can visually compare the waves, intervals, and segments of the patient's ECG with the normal reference to identify any potential abnormalities or differences.

This feature helps in improving accuracy and efficiency during ECG interpretation, as it provides a clear visual benchmark for recognizing normal patterns and distinguishing abnormal findings. It acts as a valuable aid in the diagnostic process, enabling healthcare professionals to make informed decisions based on a reliable reference point.