Research Article

A Study of Routine Electrocardiogram Requests for Patients Admitted to Acute Medical Wards

Mark Muscat[1*], Darren Borg Azzopardi[2] and Daniela Cassar DeMarco[2]

[1]Researcher, Malta

[2]Mater Dei Hospital, Triq Dun Karm, L-Imsida, Malta

*Corresponding Author
Mark Muscat, Researcher, Malta.

Abstract

Background: *Patients admitted to acute medical wards often undergo routine Electrocardiograms (ECGs), though not always with clear justification. While ACCF/AHA guidelines recommend ECGs for patients with hypertension or diabetes for cardiovascular risk assessment, there are no guidelines for ECG use in patients without cardiac risk factors.*

Aim: *To evaluate the justification for ECGs in patients admitted to Acute medical wards, assessing the need for repeat 12-lead ECGs.*

Methods: *A retrospective cohort study analysed a random sample of acute medical admissions over two months. Data from the first two days of admission included patient diagnosis, bed type, ECG frequency, presenting complaints, clinical findings, and relevant factors such as troponin tests or electrolyte imbalances.*

Results: *Among 50 patients, 257 ECGs were performed in the first two days, with all patients receiving an ECG on admission. However, 70% of ECGs were ordered without specified reasons. ECG frequencies varied, with the most common being every six hours. Troponin tests and electrolyte imbalances were noted in some patients, but only a small percentage required ECG monitoring due to medications or specific diagnoses.*

Conclusions and Relevance: *Frequent, unjustified ECGs increase hospital costs, misdiagnosis risks, and unnecessary follow-ups. Standardized guidelines with risk stratification could optimize ECG use, improving patient care and resource allocation.*

Abbreviations
ECG: Electrocardiogram
ACCF: American College of Cardiology Foundation
AHA: American Heart Association
CXR: Chest X-Ray
ACS: Acute Coronary Syndrome
ACC: American College of Cardiology
CVD: Cardiovascular Disease
LIJMC: Northwell Health Long Island Jewish Medical Centre

1. Introduction
Patients admitted to the acute medical wards undergo several routine investigations upon admission, some of which may lack clear justification. According to the American College of Cardiology Foundation/American Heart Association (ACCF/AHA) guidelines for cardiovascular risk assessment in asymptomatic adults, an Electrocardiogram (ECG) is recommended for patients with hypertension or diabetes when evaluating cardiovascular risk

(Level of Evidence C, Class IIA). However, there is no current guideline that identifies when an ECG is appropriate for patients without specified cardiac risk.

2. Materials and Methods
A retrospective cohort study was conducted using the administrative healthcare database. Admissions to acute medical wards over a two-month period were randomly sampled. Data was collected from the first two days of admission and stored securely, with access limited to authorized personnel. The data collected included:
• Patient diagnosis on admission
• Type of bed (monitor/telemetry or normal)
• ECG frequency (baseline, or regular intervals)
• Presence of specific presenting complaints (e.g., chest pain, shortness of breath, dizziness, palpitations, pre-syncope and/or syncope)
• Clinical examination findings (e.g., cyanosis, tachycardia, brady-

cardia, hyperthermia/hypothermia, blood pressure abnormalities)
• Other relevant factors (e.g., electrolyte disturbances, troponin tests)

2.1. Statistical Analysis

The dataset included categorical variables (e.g., type of bed, presenting complaints, clinical examination findings) and continuous variables (e.g., ECG frequency). Data on comorbidities, medication use, and other relevant medical conditions were also collected. The study focused on both justified and unjustified ECG orders based on specified clinical indications (e.g., chest pain, arrhythmia, acute coronary syndrome, electrolyte imbalance, etc.). Chi-square (χ^2) tests were used to analyse the relationship between categorical variables, such as clinical indications for ECGs and the frequency of ECG monitoring. For example, the proportion of patients with chest pain receiving more frequent ECG monitoring was compared to those without chest pain. All statistical analyses were performed using SPSS (version 25.0) or R (version 4.0.2) for more complex modelling. For data visualization and interpretation, graphical summaries (e.g., histograms, boxplots) were generated where appropriate. Statistical significance was defined as $p<0.05$.

3. Results

A total of 50 patients were randomly selected from the Medical Admission Units. During their initial two days of admission, 257 ECGs were performed. All patients (100%) had an admission ECG booked on admission. Of these, 7 patients (14%) had an ECG due to 'chest pain', 4 (8%) due to 'arrhythmia', 3 (6%) due to 'acute coronary syndrome', and 1 (2%) due to 'electrolyte imbalance'. However, the majority of ECGs (70%) were booked for unspecified reasons. There were several frequencies at which the ECGs were ordered. The most common ECG frequency was every 6 hours (62%). 8 patients (16%) had ECGs booked three hours, 4 (8%) had 2 hourly, 3 patients (6%) had ECGs booked 4 hours, 2 (4%) had ECGs 9 hourly and ONCE respectively, whereas 1 patient (2%) had ECGs booked 12 hours and 24 hours. Among the 50 patients, 27 (54%) had an admission troponin ordered, and 11 (22%) had an associated electrolyte imbalance. Only 2 patients (4%) were on medications that required ECG monitoring. Additionally, 3 patients (6%) were diagnosed with a pulmonary embolism during their stay, and 1 patient (2%) had a pacemaker in situ. N. B. In order for an ECG to be ordered, an 'indication' must be specified. Such indications include, 'chest pain', 'arrhythmia', 'acute coronary syndrome', 'electrolyte imbalance' and 'other'.

4. Discussion

The majority of patients in are initially admitted through the Emergency Department (ED). These patients are subject to several investigations, guided by their medical history, physical examination findings and results from previous investigations. These investigations are often ordered in line with hospital policy or based on the clinical judgment of the ED senior physician. Before being transferred to the acute medical wards, patients typically have a set of routine admission tests, including blood tests, a chest X-ray (CXR), and an electrocardiogram (ECG). The ED senior would thus assign a frequency of the ECG being ordered

for each patient, based on the senior's judgement of suitability. The frequency of ECGs ordered for each patient is determined by the ED senior, based on their assessment of the patient's needs. However, in some cases, patients undergo multiple ECGs without clear justification, often only being reassessed when seen by the consultant the next day. Therefore, this audit aims to evaluate whether the indications for baseline and serial ECG monitoring are justified.

ECG monitoring plays a crucial role in hospitalized patients, ranging from simple assessments like heart rate and rhythm monitoring to more complex applications such as diagnosing myocardial ischemia, arrhythmias, and electrolyte imbalances. In many cases, the ECG remains the gold standard for diagnosing cardiac arrhythmias, acute coronary syndromes (ACS), conduction disturbances, and chronic myocardial infarction. Given its non-invasive nature, ease of use, and reproducibility, the ECG is one of the most commonly utilized diagnostic tests for inpatients. Patients with a history of cardiovascular disease, renal disease, electrolyte imbalances, or altered consciousness are 17 times more likely to receive frequent serial ECGs on admission compared to those without such histories, even when their presenting complaint does not necessarily warrant it. This trend may be further driven by an aging population that often presents with complex medical histories and ambiguous symptoms, prompting more frequent ECG monitoring [1].

The American College of Cardiology (ACC) and the American Heart Association (AHA) have developed a clinical practice guideline classification system to categorize patients based on their need for cardiac monitoring [2]. This system uses both class of recommendation and level of evidence to guide clinical strategies, interventions, treatments, and diagnostic testing in inpatient care. By applying this system, patients can be stratified into specific populations with appropriate recommendations for cardiac monitoring [3]. Cardiovascular risk assessment is a vital tool in evaluating inpatient management options. Identifying high-risk patients can help prevent cardiovascular events, while recognizing low-risk patients can reduce unnecessary interventions. Key factors associated with an increased risk of cardiovascular events include:
• Age >65 years
• Male gender
• Obesity
• Smoking
• Sedentary lifestyle
• Hypertension
• Abnormal lipid profile
• Diabetes Mellitus

These risk factors can be used to estimate an individual's 10-year risk of developing cardiovascular disease (CVD) using the Framingham Risk Score [4]. Patients with a 10-year CVD event risk of less than 10% are classified as low risk, those with a risk of 10-20% are considered intermediate risk, and those with a risk greater than 20% are deemed high risk. Cardiovascular disease

(CVD) remains the leading cause of mortality and morbidity in Europe, accounting for approximately 45% of all deaths. Screening asymptomatic patients can be a valuable tool for identifying those at risk of CVD who may benefit from early interventions, such as lifestyle modifications or preventive treatments. First-line management typically involves lifestyle changes, including a balanced diet, physical activity, reduced alcohol consumption, and smoking cessation. Second-line management includes pharmacological interventions, such as antihypertensives, cardioprotective medications, and lipid-lowering agents [5]. However, while screening may benefit some individuals, it can be detrimental to others. A 2019 US population-based study assessed the consequences of incidental findings on screening and diagnostic ECGs in asymptomatic patients [6]. The study found that 99.4% of respondents experienced cascades of care, with 68.4% experiencing physiological harm, 15.6% suffering physical harm, 57.5% facing financial burdens, and 45.4% enduring anxiety. These findings indicate that incidental discoveries often led to harm without yielding clinically significant diagnoses.

Another study conducted by the ED, cardiology, and internal medicine hospitalist services at Northwell Health Long Island Jewish Medical Center (LIJMC) implemented evidence-based ECG ordering guidelines to reduce unnecessary ECGs if the history, examination and diagnosis do not specify a clear indication [7]. Their results showed a decrease in unnecessary ECGs on admission from 44.1% to 27.5%. Patients at low risk for CVD who underwent ECGs were five times more likely to be referred for further cardiac consultations and additional testing compared to those who did not have an ECG. A similar guideline could be adopted following the assessment of this audit's results. Furthermore, recommendations devised by the US Preventive Services Task Force (USPSTF) on ECG screening in low-risk patients at risk of CVD events advises against screening of such individuals (Recommendation D) [8]. Clinical correlation, however, should be context-dependent, considering the patient's specific situation rather than relying solely on evidence. One key reason why evidence-based guidelines like those mentioned above may not always be followed is due to medico-legal concerns. Balancing the need for accurate diagnosis against the risks of misdiagnosis or missing significant cardiac conditions is critical. While most diagnoses are based on thorough history-taking and physical examination, objective tests such as ECGs and blood tests are valuable in confirming or refuting clinical hypotheses. Therefore, these investigations should be used judiciously to complement clinical assessments, rather than as routine measures without clear indications.

4.1. Summary
Known findings
• ECGs are recommended for cardiovascular risk assessment in patients with hypertension or diabetes (ACCF/AHA guidelines).
• Guidelines are lacking for ECG use in asymptomatic patients without specific cardiac risks.
• Routine ECGs are often ordered in hospitals, sometimes without clear justification.
• Overuse of ECGs can lead to unnecessary costs, misdiagnoses,

and excessive resource allocation.

New Findings
• 70% of ECGs in the study were ordered for unspecified reasons, indicating potential overuse.
• The majority of ECGs were ordered at frequent intervals (e.g., every 6 hours) without a clear clinical indication.
• Only 4% of patients were on medications that required ECG monitoring, despite frequent ECG orders.
• Implementation of risk stratification guidelines could reduce unnecessary ECG use and improve resource allocation.

4.2. Limitations
Several limitations were encountered during the course of this study. First, the retrospective nature of the study meant reliance on pre-existing data and convenience sampling, which may have introduced biases. Additionally, the study was limited by the number of available cardiac monitor beds, which led to the inappropriate substitution of serial ECGs in place of continuous monitoring. The wards selected for this audit were those with the highest number of monitor beds in the hospital. In wards with fewer or no monitor beds, the frequency of ECGs ordered was notably higher. The study's time frame also imposed constraints. Conducted during a particularly busy period for the hospital, there was an increased demand for monitor beds, which further contributed to the higher volume of ECGs ordered for regular cardiac assessments. Compounding this issue, the study was carried out during the COVID-19 pandemic, necessitating the admission of patients to isolation wards that were not equipped with cardiac monitor beds. Consequently, patients who might otherwise have been admitted to Medical Admission Unit wards were transferred to isolation wards instead. Moreover, many patients had a pre-set frequency of ECGs established by the emergency physician before admission to inpatient wards. This frequency was often left unchanged for extended periods due to factors such as delays in physician reviews, pending investigation results, or a lack of confidence from the on-call physician to adjust the frequency. As a result, patients often underwent unnecessary repeated ECGs with minimal diagnostic value.

5. Conclusions and Relevance
Cardiac monitoring is essential in hospitals for diagnosing certain conditions, assessing the risk of atherosclerotic cardiovascular disease, and monitoring disease progression and response to medical or interventional therapy. While many patients admitted to the hospital have pre-existing comorbidities that may benefit from cardiac monitoring, others are admitted specifically for this purpose. However, many 'low-risk' patients, whose conditions do not meet the criteria for repeated cardiac monitoring, continue to undergo frequent ECGs without valid justification. This practice results in several negative consequences, including:
• Increased hospital costs and resource allocation for redundant investigations
• Risk of misdiagnosis due to inexperience or ECG artifacts
• Unnecessary cardiac follow-ups and consultations
• More invasive investigations (e.g., coronary angiography,

echocardiography, cardiac stress tests)
• Psychological harm and anxiety for the patient
• Added burden on ECG technicians to meet the increased demand
• Additional strain on House Officers, who must order, track, and follow up on ECG results, particularly when on duty

The absence of clear hospital guidelines for cardiac monitoring means that patients are not systematically categorized according to their risk levels. The decision to initiate or determine the frequency of ECG monitoring typically falls to the first medical contact either the Emergency Department physician or the Basic Specialist Trainee (BST) doctor in the inpatient ward. It is not until such patients would be seen during the ward round, either the following day or later on in the morning, would the need for cardiac monitoring be adequately assessed. The implementation of standardized guidelines in both the ED and inpatient settings, with clear risk stratification (low, medium, or high risk), could greatly enhance the hospital's approach to cardiac monitoring. This would improve the quality of patient care both during hospital stays and on an outpatient basis, ensuring that resources are appropriately allocated and that monitoring is tailored to the needs of each patient.

References

1. Greenland, P., Alpert, J. S., Beller, G. A., Benjamin, E. J., Budoff, M. J., Fayad, Z. A., ... & Wenger, N. K. (2010). 2010 ACCF/AHA guideline for assessment of cardiovascular risk in asymptomatic adults: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation, 122*(25), 2748-2764.
2. Halperin, J. L., Levine, G. N., Al-Khatib, S. M., Birtcher, K. K., Bozkurt, B., Brindis, R. G., ... & Wijeysundera, D. N. (2016). Further evolution of the ACC/AHA clinical practice guideline recommendation classification system: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation, 133*(14), 1426-1428.
3. Sandau, K. E., Funk, M., Auerbach, A., Barsness, G. W., Blum, K., Cvach, M., ... & Wang, P. J. (2017). Update to practice standards for electrocardiographic monitoring in hospital settings: a scientific statement from the American Heart Association. *Circulation, 136*(19), e273-e344.
4. Bosomworth, N. J. (2011). Practical use of the Framingham risk score in primary prevention: Canadian perspective. *Canadian Family Physician, 57*(4), 417-423.
5. Drew, B. J., Califf, R. M., Funk, M., Kaufman, E. S., Krucoff, M. W., Laks, M. M., ... & Van Hare, G. F. (2004). Practice standards for electrocardiographic monitoring in hospital settings: an American Heart Association scientific statement from the Councils on Cardiovascular Nursing, Clinical Cardiology, and Cardiovascular Disease in the Young: endorsed by the International Society of Computerized Electrocardiology and the American Association of Critical-Care Nurses. *Circulation, 110*(17), 2721-2746.
6. Ganguli, I., Simpkin, A. L., Lupo, C., Weissman, A., Mainor, A. J., Orav, E. J., ... & Sequist, T. D. (2019). Cascades of care after incidental findings in a US national survey of physicians. *JAMA network open, 2*(10), e1913325-e1913325.
7. Appold, B., Soniega-Sherwood, J., Persaud, R., Moss, R., Ramnarine, M., LaVine, S. P., ... & Richman, M. (2021). Reining in unnecessary admission EKGs: a successful interdepartmental high-value care initiative. *Cureus, 13*(9), e18351.
8. Curry, S. J., Krist, A. H., Owens, D. K., Barry, M. J., Caughey, A. B., Davidson, K. W., ... & US Preventive Services Task Force. (2018). Screening for cardiovascular disease risk with electrocardiography: US preventive services task force recommendation statement. *Jama, 319*(22), 2308-2314.

Appendix

Guideline for Appropriate Ordering of Emergency ECGs (adapted from the Northwell Health Long Island Jewish Medical Center (LIJMC) hospital guidelines)

1. Patients with a cardiopulmonary complaint (or a complaint related to a cardio-pulmonary condition (e.g., weakness, dizziness, abdominal pain in diabetic or elderly patients)) should have an ECG as part of the admission evaluation.

2. Patients expected to have procedures in which a cardiac evaluation prior to the procedure is required should have an ECG as part of the admission evaluation.

3. Patients without a cardio-pulmonary complaint (as specified in point 1), and who are not expected to have procedures in which a pre-procedure cardiac evaluation is standard (as specified in point 2), do not require an ECG upon admission.

4. Patients without a cardio-pulmonary complaint (as specified in point 1), and who are not expected to have procedures in which a pre-procedure cardiac evaluation is standard, can be requested or performed on a case-by-case basis at the provider's discretion. Said patient can be assigned a level of inpatient care, called up to, and accepted by a medical team prior to the ECG being performed.