

**KAP STUDY****Interpretation of Electrocardiogram and Emergency Management of Myocardial Infarction: A Survey among Doctors**

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**ABSTRACT**

**Background:** A virtuous understanding of Electrocardiogram is an indispensable ability and essential skill required in doctors. This study assessed the understanding of the electrocardiogram and acute management of myocardial infarction among emergency doctors, general practitioners, medical officers, house officers and postgraduate students.

**Methods:** A cross sectional survey was conducted for 7 months on n=312 doctors working in tertiary care public and private hospitals and as General practitioners in Karachi, Pakistan. Convenience sampling technique was used. Participants were asked to interpret a 12 lead electrocardiogram attached to questionnaire and write down their findings and diagnoses. They were then asked about its acute management. ANOVA and Chi square was applied for making inferences from the acquired data. p value of less than 0.05 was taken as significant. Approval was taken from the Ethical Review board.

**Results:** Knowledge was assessed on basis of designation, 84.6% of the emergency doctors correctly interpreted the ECG while 75.4% of general physicians read it correctly. House officers and medical officers had the lowest scores in ECG interpretation. Years of experience demonstrated inverse results with >5 years experience at the lowest scores for interpretation of ECG and MI management. Interpretation scores of ECG were significantly high (p value 0.03) in participants who attended workshops compared to those who did not.

**Conclusion:** Emergency doctors had better scores when it comes to ECG interpretation and management of MI. Frequent workshops and cardiology rotations should be mandatory for health care professionals to improve essential skill and knowledge of acute management of myocardial infarction.

**Keywords:** Electrocardiography; Doctors; Emergency; Myocardial Infarction.

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**INTRODUCTION**

The electrocardiogram is one of the most common, useful and cost-effective test that is regularly been advised by the physician<sup>1,2</sup> and it is a commonly used test for diagnoses of common cardiac diseases including myocardial infarction (MI) and life-threatening arrhythmia<sup>3-6</sup>. A good understanding of ECG is an essential skill that is required in doctors<sup>7,8</sup>. Therefore, it is extremely important that doctors are competent in reading and interpreting ECGs when they complete their training<sup>3</sup>. In addition,

12 lead electrocardiogram is a common diagnostic test advised by general physicians in primary care for evaluating and confirming diagnoses in patients with cardiac complaints<sup>9-11</sup> and studies have shown that physicians working in all specialties frequently make errors while interpreting it<sup>12</sup>. Most of the medical conditions that require an ECG arise in acute and urgent care settings and also primary care settings where doctor on duty initially reviews it before deciding whether to refer it to a cardiologist<sup>3,13</sup>. In tertiary care hospitals, final decision regarding patient management based on his/her,

ECG interpretation depends on resident on duty<sup>3</sup>.

A study conducted in Germany revealed that approximately 66% of the doctors felt unprepared for their job after completing medical school, while 23.6% always had difficulty in ECG interpretation<sup>14</sup>. Another study in South Africa revealed that average score of interpretation of ECG among doctors was 46.4%<sup>3</sup>. Participants felt that there should be more emphasis on the needs to be given to formal ECG training during training sessions<sup>3</sup>. A study in USA in 2010 raised the concern that possibly 13% to 39% ECGs in emergency department are misinterpreted causing the physician to make incorrect diagnoses leading to adverse outcomes<sup>15</sup>. Around 56% of residents rated low when asked about their ability to interpret ECG<sup>13</sup>. Another study in US revealed that senior residents and house officers correctly diagnosed 66% and 55% of common ECGs respectively<sup>16</sup>. A study conducted in Paris revealed 51% errors in interpretation of ECGs<sup>1</sup>. Other studies found significant difference in interpretation of ECGs between physicians working in emergency department, cardiologists and primary care physicians<sup>1,17</sup>. In addition, a study conducted on graduating medical students in USA indicated that they need further training in ECG interpretation<sup>18</sup>. Very few international studies have been conducted on this topic and no such studies could be found that have been conducted in Pakistan.

The main purpose of this study was to assess the understanding of the electrocardiogram and acute management of myocardial infarction among emergency doctors, general practitioners, medical officers, house officers and postgraduate students and to compare it between these groups of doctors and also to compare the knowledge of ECG interpretation among residents of different specialties.

## METHODS

A cross sectional study was conducted on doctors working in tertiary care hospitals and general practitioners in Karachi. All together six tertiary care hospitals from both private and public sectors were selected as setting for the research study and general practitioners were selected from the list provided by the Pakistan Medical Association. The hospitals were teaching hospitals involved in training of post graduate and medical students. The hospitals that were approached for data collection were Ziauddin Hospital Clifton, Ziauddin Hospital North Nazimabad, Civil Hospital Karachi, Abbasi Shaheed Hospital, Jinnah Postgraduate Medical Center and National Institute of Cardiovascular Diseases. These hospitals were selected because authors had easy access to these hospitals and they have large number of doctors working in these hospitals. Also around sixty private GP clinics were approached. Our target populations

were doctors working in these hospitals or undergoing postgraduate training.

A sample size of n=384 was calculated at 50% proportion and 95% confidence level as it was a knowledge based survey. The final sample came out to be n=312 as non-response was high from the target population. Around 700 doctors were approached and were asked to fill the questionnaire. Only 312 doctors agreed to become a part of study. Non-response was high due to two main reasons. The major reason was that many of the doctors became anxious on finding out that the questionnaire included an ECG and they choose to not to fill it. The other reason was that some of the doctors especially in emergency department were extremely busy and could not take out time to fill the questionnaire. Health care professionals excluded from the study were consultants, medical students, non-practicing doctors, those not willing to consent, having language barrier and those absent at the time of data collection. Sampling technique employed was convenience-sampling technique. This study was conducted for a period of 7 months from March 2015 until September 2015.

Data was collected through self-administered questionnaire. Informed oral consent was taken from participants before administration of the questionnaire. The researchers were present at the time of data collection. Attached to the questionnaire was an ECG which had to be interpreted by the doctors and they were asked to give their diagnoses regarding it. They were also asked the details of ECG including rate, rhythm, axis, P-R interval, S-T segment and wall of heart involved. No time constraint was placed on them. In addition, they were also asked about the symptoms that indicated that ECG of patients must be done. They were given a list of symptoms, including both correct and incorrect symptoms and they were asked to choose the correct ones. In addition, they were asked to choose the correct acute management options for this patient whose ECG was attached.

A consultant from Cardiology and Internal Medicine already interpreted the ECG attached with the questionnaire independently. Kappa Statistics was calculated to evaluate the inter-observer variation. Substantial agreement was observed as Kappa statistic was 0.8. In addition, permission from administration of each hospital was taken before conducting the study in their hospital. The Ethical Review Board of Ziauddin Medical University approved this study.

Data was analyzed on SPSS version 20. All qualitative variables are presented as frequency and percentages and all quantitative variables are presented as mean and standard deviation. Chi-square test was used to find association between categorical variables and ANOVA was

applied to see the difference in the mean scores of interpretation among different categories of doctors. p-value less than 0.05 is considered as significant.

**RESULTS**

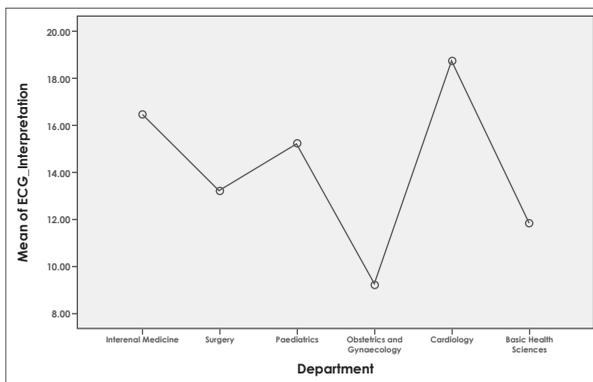
A total of n=312 participants were included with 34% residents, 26% medical officers, 18% were general physicians and rests were house officers and emergency doctors. Around 700 doctors were approached of which only 312 agreed to become a part of the study. Around 40% participants had 2 years experience. When knowledge was assessed on basis of designation, emergency doctors were found to have the highest mean scores for interpretation of ECG and acute management of myocardial infarction (Table 1).

**Table 1: Correct ECG interpretation and designation of participants.**

| Individuals        | ECG Interpretation |      |           |      | p-value |
|--------------------|--------------------|------|-----------|------|---------|
|                    | Correct            |      | Incorrect |      |         |
|                    | N                  | %    | N         | %    |         |
| House Officers     | 30                 | 54.5 | 25        | 45.5 | 0.001   |
| Medical Officers   | 34                 | 41.5 | 48        | 58.5 |         |
| Residents          | 67                 | 63.8 | 38        | 36.2 |         |
| Emergency Doctors  | 11                 | 84.6 | 2         | 15.4 |         |
| General Physicians | 43                 | 75.4 | 14        | 24.6 |         |

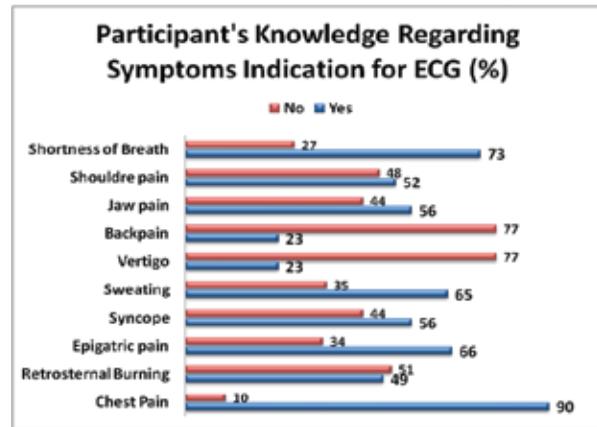
Years of experience working as a doctor demonstrated inverse results with >5 years experience at the lowest scores for interpretation of ECG and MI management. Participants were also asked whether they had taken any workshops regarding ECG interpretation. When interpretation scores of ECG were compared among those who had taken workshops significant difference was found (p value 0.03). Out of 312 participants, 107 participants (34.3%) had taken at least one workshop relating to ECG.

Then residents were further asked about the department in which they were doing their post-graduate training and mean scores of ECG interpretation between different departments were compared as shown in Graph 1.



**Graph 1: Mean Scores of ECG Interpretation of residents from different disciplines.**

Each of the participants was also asked regarding the symptoms for which ECG should be done. They were given a list of symptoms from which they had to choose and the results are shown in Graph 2.



**Graph 2: Participant knowledge regarding symptoms indication for ECG.**

The participants were also asked that according to them what would be the best way for improving the knowledge of ECG in doctors and the results are shown in Table 2.

**Table 2: Best method of improving ECG according to doctors.**

| Methods of improving ECG knowledge | Percentages |
|------------------------------------|-------------|
| Workshops                          | 34.9%       |
| Continuous Medical Education       | 12.5%       |
| Internet                           | 5.8%        |
| Cardiology Rotation                | 46.8%       |

The participants were asked about the correct management of acute myocardial infarction in relation to this ECG and they were given a list of options from which they had to choose the correct ones (Table 3). Since, 77.9% of doctors were found to be unaware of the fact that nitro-glycerine is contraindicated in right ventricular infarction. The participants in the end were asked about the appropriate duration in which streptokinase should be given and only 26.9% of doctors correctly identified that it should be given with in 1 hour.

**Table 3: Management options of Acute MI given to participants and percentage of participants who choose each option.**

| Management options of Acute MI | Percentage of participants who selected it (%) |
|--------------------------------|--|
| Aspirin / Clopidogrel          | 81.7   |
| Primary Angioplasty            | 56.4   |
| Streptokinase                  | 56.4   |
| Oxygen Inhalation              | 19.2   |
| Nitroglycerin                  | 77.9   |
| Heparin                        | 21.2   |
| Morphine                       | 15.1   |

## DISCUSSION

An emergency department physician must be able to interpret ECG quickly, in critical situations and without help from other doctors or cardiologists, making it an essential skill to acquire during the course of training<sup>1,19</sup>. A study conducted in South Africa found that the correct interpretation of ECG among emergency medicine residents was only 46.4%<sup>3</sup>. While in another study performed in Baltimore, USA showed that about 13% to 39% ECGs were incorrectly interpreted leading to life-threatening outcomes<sup>15</sup>. Another study conducted in Paris, France revealed that 51% of ECGs had errors in interpretation by emergency department physicians<sup>1</sup>. While the results displayed by our study were comparatively better with 86% emergency doctors correctly diagnosing the ECG.

The 12-lead ECG is a very common test that is routinely advised by General Practitioners for patients who come with cardiac complaints<sup>9</sup>. A study conducted in Denmark on ECG interpretation skills of General Practitioners found that the sensitivity of abnormal diagnosis made by the GPs was 69.8% and the specificity of abnormal diagnosis was 85.7%<sup>9</sup>. In our study, we found that the abnormal diagnosis made by GPs was 25%. We also included medical officers working in hospitals in our study and we found out that only 42% were able to correctly identify ECG. This shows that a large number of doctors were unable to correctly read ECGs and can therefore lead to misdiagnosis and can endanger patient's life<sup>19-21</sup>.

A study conducted in Germany found that 23.6%<sup>14</sup> of junior doctors reported have experienced deficiency in ECG interpretation. Other studies that have looked at the ability of junior doctors to interpret ECGs found from 56%<sup>8</sup> to 60%<sup>22</sup> overall accuracy. In our study, we found that out of the 55 house officers (junior doctors that have less than 1-year experience) only 54.5% were able to correctly interpret the ECG findings.

A study conducted in USA found that 56% of residents rated their ability to interpret ECGs as low and 54% residents had received little training in reading ECGs. It also found that senior residents were able to correctly identify more ECGs than junior residents<sup>15</sup>. A recent study conducted in a teaching hospital in New York, USA on internal medicine residents only found that they had low scores in ECG interpretation overall with senior residents scoring less points than junior residents<sup>23</sup>. While in our study, we found that 36.8% (38) of the residents were able to correctly identify ECG and amongst them, the cardiology residents had the highest scores. This is probably because they read and interpret ECGs more frequently than any other department on daily basis. After cardiology residents, internal medicine residents were found to

have highest scores in ECG interpretation. These results are consistent with another study that determined the being a non-cardiology resident reduced the probability of correct ECG interpretation by 42%<sup>24</sup>.

Doctors were also asked about the method of teaching that will improve the knowledge of ECG among doctors. Further, 47.4% doctors felt that workshops (34.9%) and continuous medical education (12.5%) would be the best way to improve the knowledge while 46.8% of doctors felt that undergoing a cardiology rotation would be the best way. Only 5.8% of doctors felt that internet-based teaching would be helpful. Compared to this, the doctors working in South Africa 43.5% of them felt that formal lectures would be helpful, while 17.4% doctors felt that ECG workshops would be more helpful. Only 11.6% of doctors felt that cardiology rotation will improve the knowledge of ECGs and only 5.8% were of the opinion that internet based teaching would be more helpful<sup>3</sup>. Contrary to this, a study conducted by Pourmand et al. showed that online training module significantly improved the skill of medical students and emergency medicine residents in recognizing acute myocardial infarction<sup>25</sup>.

While a study conducted in USA found out that those residents, who had completed a cardiology rotation correctly interpreted more number of ECGs than residents who had not<sup>15</sup>. In addition, residents who had undergone a cardiology rotation will be able to identify situations more accurately in where ECG should be advised and conditions that require a cardiology consultation<sup>15</sup>. Another study found out that students who had done a cardiology elective performed significantly better than those students who had not done a cardiology elective<sup>18</sup>. Therefore, a cardiology rotation, besides helping doctors in improving their ECG interpretation will also help them to improve their knowledge regarding other emergency cardiac conditions and their management. Also workshops and CMEs need to be conducted on regular basis as the study has shown that doctors who have more than 5 years of experience had the least scores of ECG interpretation. This is because significant difference in ECG interpretation ( $p$  value = 0.03) was found among those who had taken workshops.

The limitation of this study was that only one ECG was given to interpret and assess the knowledge of participants. This was done because most of the doctors were very busy and most would not have the time to read and interpret multiple ECGs. Therefore the ECG selected, was the common type of MI with which patients present to emergency department. The other limitation was that no appropriate clinical scenario was given with ECG. Another limitation of this study was that the calculated

sample size was 384, which could not be achieved as only 312 participants agreed to become a part of this study.

However, the strengths are that no such study has been conducted in our country. Doctors from various specialization fields were included in the study. Two consultants for accuracy of answers already interpreted our ECG while the primary investigators collected data. Our study emphasizes the need for ECG training during medical school and postgraduate training programs and how important it is for doctors to continually review their ECG reading skills with the help of workshops and CMEs.

### CONCLUSION

Emergency doctors had better scores when it comes to ECG interpretation and management of MI. The knowledge of symptoms and signs that require an ECG to be advised needs much improvement as well as knowledge of acute management of myocardial infarction. Therefore frequent workshops and CMEs need to be continually organized and a cardiology rotation be inculcated in the post-graduation curriculum can help improve overall knowledge of ECG to diagnose common cardiac conditions and its management.

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### CONFLICT OF INTEREST

There was no conflict of interest among the authors.

### ETHICAL APPROVAL

The permission for the study was sort from the ethical review committee of the Ziauddin University.

### PATIENTS CONSENT

Verbal and written informed consent was taken from all the participants.

### AUTHORS' CONTRIBUTIONS

FA supervised the work, critically reviewed it and did the analysis. AA conceived the idea, did the data collection and literature search, wrote and drafted the entire manuscript. SA also did the data collection, literature search and helped in writing the manuscript and data entry. HM did the data

collection, data entry, literature search and helped in writing the manuscript. MR did the literature search, data collection and data entry and helped in drafting and writing the manuscript. DH critically reviewed the manuscript, and did the analysis and supervised the entire work.

### REFERENCES

1. Snoey ER, Housset B, Guyon P, Elhaddad S, Valty J, Hericord P. Analysis of emergency department interpretation of electrocardiograms. *J Accid Emerg Med.* 1994; 11; 149-53.
2. Kölbl F. Electrocardiography of yesterday and today. *Cas Lek Cesk.* 2009;148:358-60.
3. De Jager J, Wallis L, Martiz D. ECG interpretation skills of South African Emergency Medicine residents. *Int J Emerg Med.* 2010; 3;309-14.
4. Isiguzo GC, Iroezindu MO, Muoneme AS, Okeahialam BN. Knowledge and utilization of electrocardiogram among resident doctors in family medicine in Nigeria. *Niger J Clin Pract.* 2017;20(9):1133-8.
5. Kopeć G, Magoń W, Hołda M, Podolec P. Competency in ECG interpretation among medical students. *Med Sci Monit.* 2015;21:3386.
6. Salerno SM, Alguire PC, Waxman HS. Training and competency evaluation for interpretation of 12-lead electrocardiograms: recommendations from the American College of Physicians. *Ann Intern Med.* 2003; 138(9): 747-50.
7. Raupach T, Harendza S, Anders S, Schuelper N, Brown J. How can we improve teaching of ECG interpretation skills? Findings from a prospective randomised trial. *J Electrocardiol.* 2016;49(1):7-12.
8. Hoyle RJ, Walker KJ, Thompson G. Accuracy of electrocardiogram interpretation improves with emergency medicine training. *Emerg Med Australas.* 2007; 19; 143-50.
9. Jensen MS, Thomsen JL, Jensen SE, Lauritzen T, Engberg M. Electrocardiogram interpretation in general practice. *Fam Pract.* 2005; 22; 109-13.
10. Richley D. Understanding how to interpret ECGs in primary care. *Pract Nurs.* 2016;27(3):136-9.
11. Isiguzo GC, Iroezindu MO, Muoneme AS, Okeahialam BN. Knowledge and utilization of electrocardiogram among resident doctors in family medicine in Nigeria. *Niger J Clin Pract.* 2017;20(9):1133-8.
12. Goy JJ, Schlaepfer J, Stauffer JC. Competency in interpretation of 12-lead electrocardiogram among Swiss doctors. *Swiss Med Wkly.* 2013;143.
13. Isiguzo GC, Iroezindu MO, Muoneme AS, Okeahialam BN. Knowledge and utilization of electrocardiogram among resident doctors in family medicine in Nigeria. *Niger J Clin Pract.* 2017;20(9):1133-8.
14. Ochsmann EB, Zier U, Drexler H, Schmid K. Well prepared for work? Junior doctors' self-assessment after medical education. *BMC Med Educ.* 2011; 11:99.
15. Crocetti M, Thompson R. Electrocardiogram interpretation skills in pediatric residents. *Ann Pediatr Cardiol.* 2010; 3; 3-7.
16. Snyder CS, Bricker JT, Fenrich AL, Friedman RA,

Rosenthal GL, Johnsrude CL, et al. Can pediatric residents interpret electrocardiograms? *Pediatr Cardiol.* 2005; 26; 396-9.

17. Begg G, Willan K, Tyndall K, Pepper C, Tayebjee M. Electrocardiogram interpretation and arrhythmia management: a primary and secondary care survey. *Br J Gen Pract.* 2016;66(646):e291-6.

18. Lundberg EL, Stagnaro-Green A, Zhang Y, LeLacheur S, Jablonover R. Assessment of competency in electrocardiogram interpretation of graduating physician assistant students. *J Physician Assist Educ.* 2013; 24; 15-8.

19. Barthelemy FX, Segard J, Fradin P, Hourdin N, Batard E, Pottier P, Potel G, Montassier E. ECG interpretation in Emergency Department residents: an update and e-learning as a resource to improve skills. *Eur J Emerg Med.* 2017;24(2):149-56.

20. Fent G, Gosai J, Purva M. Teaching the interpretation of electrocardiograms: which method is best? *J Electrocardiol.* 2015;48(2):190-3.

21. Antiperovitch P, Zareba W, Steinberg JS, Bacharova L, Tereshchenko LG, Farre J, Nikus K,

Ikeda T, Baranchuk A. Proposed In-Training Electrocardiogram Interpretation Competencies for Undergraduate and Postgraduate Trainees. *J Hosp Med.* 2017:E1-9.

22. Salerno SM, Alguire PC, Waxman HS. Competency in interpretation of 12-lead electrocardiograms: a summary and appraisal of published evidence. *Ann Intern Med.* 2003; 138; 751-60.

23. Kodra A, Rambhatla T, Patel S, Coplan N. Assessing the competency of internal medicine residents in electrocardiogram interpretation. *Int J Cardiol.* 2016;214:288-90.

24. Novotny T, Bond RR, Andrsova I, Koc L, Sisakova M, Finlay DD, Guldenring D, Spinar J, Malik M. Data analysis of diagnostic accuracies in 12-lead electrocardiogram interpretation by junior medical fellows. *J Electrocardiol.* 2015;48(6):988-94.

25. Pourmand A, Tanski M, Davis S, Shokoohi H, Lucas R, Zaver F. Educational technology improves ECG interpretation of acute myocardial infarction among medical students and emergency medicine residents. *West J Emerg Med.* 2015;16(1):133.

