The Impact of Two Hours of ECG Teaching on Knowledge and Confidence

Ailís Pollock[1], Jenna O'Sullivan[2], Bryan Traynor[2], and Carl Vaughan[3]

[1]Beaumont Hospital
[2]Mater Misericordiae University Hospital
[3]Mercy University Hospital

April 16, 2024

Abstract

Background Electrocardiogram (ECG) interpretation is a core skill required of all doctors. Despite this, ECG interpretation remains suboptimal among medical students and doctors in clinical practice. This study assessed the impact of a short period of ECG teaching provided to medical students on completion of their academic curriculum. The primary outcome was the impact on students' knowledge. The secondary outcome was the impact on confidence in ECG interpretation. Methods and Results Prospective cohort study of the impact of 2 hours of ECG teaching delivered by Cardiology trainees to final year medical students. Standardised 10 question examinations were given before and after the session. Questionnaires were given to assess confidence in ECG interpretation. Of 150 students who received teaching, 141 completed the pre-course examination and 139 completed the post-course examination (mean age 25.1 years; 55.5% female; 81.1% undergraduate). There was a statistically significant improvement in results after the course ($p < 0.001$). The improvement was most significant in the assessment of heart rate and STEMI identification. Thirty-nine students completed feedback questionnaires. There was a statistically significant improvement in confidence in ECG interpretation ($p < 0.001$). Conclusions This study showed an improvement in both ECG knowledge and confidence in ECG interpretation following 2 hours of teaching. The assessment of simple concepts such as heart rate improved more significantly than complex concepts such as conduction abnormalities. Our findings suggest a benefit from dedicated ECG revision programmes to enhance ECG knowledge and confidence in ECG interpretation.

The Impact of Two Hours of ECG Teaching on Knowledge and Confidence

Disclosures: None.

Funding: None.

Ethical approval statement: The study protocol was approved by the local ethics committee.

Authors:

Dr Ailís Pollock (corresponding author), Beaumont Hospital Cardiology department, Beaumont Road, Beaumont, Dublin 9, Ireland. ORCHID ID: 01-8834-426 Email: a.pollock@umail.ucc.ie

Dr Jenna O'Sullivan, Mater Misericordiae University Hospital Cardiology department, Eccles Street, Dublin 7.

Dr Bryan Traynor, Mater Misericordiae University Hospital Cardiology department, Eccles Street, Dublin 7.

Professor Carl Vaughan, Mercy University Hospital Cardiology department, Grenville Place, Cork.

Background

Electrocardiogram (ECG) interpretation is a core skill required of all doctors. Despite this, ECG interpretation remains suboptimal among medical students and doctors in clinical practice. This study assessed the impact of a short period of ECG teaching provided to medical students on completion of their academic curriculum. The primary outcome was the impact on students' knowledge. The secondary outcome was the impact on confidence in ECG interpretation.

Methods and Results

Prospective cohort study of the impact of 2 hours of ECG teaching delivered by Cardiology trainees to final year medical students. Standardised 10 question examinations were given before and after the session. Questionnaires were given to assess confidence in ECG interpretation. Of 150 students who received teaching, 141 completed the pre-course examination and 139 completed the post-course examination (mean age 25.1 years; 55.5% female; 81.1% undergraduate). There was a statistically significant improvement in results after the course ($p < 0.001$). The improvement was most significant in the assessment of heart rate and STEMI identification. Thirty-nine students completed feedback questionnaires. There was a statistically significant improvement in confidence in ECG interpretation ($p < 0.001$).

Conclusions

This study showed an improvement in both ECG knowledge and confidence in ECG interpretation following 2 hours of teaching. The assessment of simple concepts such as heart rate improved more significantly than complex concepts such as conduction abnormalities. Our findings suggest a benefit from dedicated ECG revision programmes to enhance ECG knowledge and confidence in ECG interpretation.

Keywords

ECG, teaching, interpretation, confidence, medical students

Manuscript

Background

ECG interpretation is a core skill required of all doctors. The inability to correctly identify abnormal ECGs can delay potentially life-saving treatment (1,2). Despite the vital importance of this skill ECG knowledge remains suboptimal among medical students and doctors in clinical practice (1-4). The reputation of ECG interpretation as a difficult skill to learn has negative impacts on students' engagement with teaching, a principle that continues into clinical practice for doctors in training. Recent studies in the area of ECG teaching have focused on the optimum method of ECG teaching for novice learners (e.g medical students)(5-7). Although there is no clear consensus on the optimal method of ECG teaching, the importance of reinforced learning and continuous professional development is consistently reproduced (7).

In clinical training at a post-graduate level, there is a high emphasis on self-directed learning and bedside teaching from senior colleagues. This method of teaching assumes a basic knowledge of the principles of ECG interpretation and aims to reinforce and build on that knowledge. It is therefore not directly comparable to ECG teaching for medical students. The purpose of this study was to assess the impact of a short period of ECG revision teaching on ECG knowledge in students who had completed their ECG teaching curriculum. The secondary outcome of confidence in ECG interpretation was included as a lack of confidence with ECG interpretation can limit a doctor's ability to provide confident interpretation of ECGs and potentially delay patient treatment.

Methods

This prospective cohort study was performed in Cork University Hospital in conjunction with University College Cork in April 2021. The participants were final year medical students from both the undergraduate and postgraduate programmes who had completed their educational curriculum. Students were invited to participate and receive supplementary ECG teaching. The participants were divided into 4 teaching sessions

to comply with local public health guidelines which limited lecture theatre capacity at the time. The participants were allocated to their groups by university administrators and the investigators had no influence on this process. Ethical approval was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals.

The ECG interpretation teaching was delivered by 3 cardiology trainees. The trainees were doctors with >5 years of clinical experience and at least 1 year of specialty experience. The teaching was delivered as live presentations with an interactive component and ECG examples were shown to illustrate all principles covered. The topics covered included: heart rate, rhythm, cardiac axis, bundle branch blocks, bradyarrhythmias, AV node block, atrial fibrillation, atrial flutter, tachyarrhythmias, acute coronary syndromes and distinctive ECG changes seen in various clinical emergencies.

Standardised examinations were given to all students before and after attending the teaching sessions. The examinations consisted of 10 questions, each with an accompanying ECG to interpret. A short clinical case was provided if necessary for accurate ECG interpretation. The examination format required participants to provide a free hand answer. There were no multiple choice answers. This was designed to reflect ECG interpretation in clinical practice. Two examination versions were used. There were equal numbers of questions on each aspect of ECG interpretation in each version, for instance there were 4 questions on identifying the rhythm in each version. Both versions were judged to be of equal difficulty by the investigators. A different examination version was given before and after the teaching session. The order in which these versions were given was alternated between teaching sessions.

A questionnaire was given to all students on completion of the teaching sessions to assess their confidence in ECG interpretation. Demographic data was taken from the examination papers returned at the end of the teaching sessions.

Statistical analysis was performed by a single investigator with a p value of less than 0.05 considered significant. A paired t-test was used to compare the examination results from before and after the teaching sessions. The null hypothesis of no difference between results was assumed. The association between receiving teaching and answering a question correctly was assessed using the log odds ratio. Subcategory analysis was performed on 7 aspects of ECG interpretation examined. Further subcategory analysis was performed to assess the impact of ECG teaching depending on the participants' baseline knowledge (pre-course results). The secondary outcome of change in participants' confidence was assessed using a paired t-test. The null hypothesis of no difference between confidence levels was assumed.

Results

Of 150 students who received teaching, 141 completed the pre-course examination and 139 completed the post-course examination. The mean age was 25.1 years and 55.5% of students were female (table 1). The majority of students had completed the undergraduate programme (81.1%).

The mean examination score prior to attending teaching was 42% (range 0-90%). The mean score after attending the teaching was 50% (range 0-90%). The full breakdown of scores on the different aspects of ECG interpretation examined both before and after attending the teaching can be seen in table 1. There was a statistically significant improvement in examination scores after attending the teaching ($p < 0.001$). Within the different aspects of ECG knowledge assessed, there was a statistically significant improvement in the assessment of heart rate, rhythm, cardiac axis and STEMI territory identification. There was an improvement in the correct diagnosis of clinical cases but it was not statistically significant. There was a disimprovement in the identification of spot diagnosis ECGs. Students with a lower pre-course examination result had a more significant improvement in their post-course examination result when compared to students with a higher pre-course examination result (table 2).

	Before (n=141)	After (n=139)	Odds Ratio (95% CI)	P value	Paired T-test (P val
Female	55.5% (71/128)	57.5% (73/127)	-	-	

	Before (n=141)	After (n=139)	Odds Ratio (95% CI)	P value	Paired T-test (P val
Age (range)	25.1 (22-41)	25.1 (22-41)	-	-	
Undergraduate	81.1% (107/132)	78% (103/132)	-	-	
Overall score (range)	4.2/10 (0-9)	5.0/10 (0-9)	-	-	<0.001
Rate (1)	55.6 % (79/141)	84.9% (118/139)	4.4 (2.5-7.8)	<0.001	
Rhythm (2,3,4,9)	35.5% (200/564)	41.4% (230/556)	1.3 (1.0-1.6)	0.04	
Axis (5)	58.2% (82/141)	71.9% (100/139)	1.8 (1.1-3.0)	0.02	
Conduction abnormality (6)	29.8% (42/141)	29.5% (41/139)	0.99 (0.6-1.6)	0.96	
Clinical cases (7)	9.95 (14/141)	17.3% (24/139)	1.9 (0.9-3.8)	0.08	
Spot diagnosis (8)	51.1% (72/141)	36.7% (51/139)	0.56 (0.3-0.9)	0.02	
STEMI territories (10)	75.2% (106/141)	87.1% (121/139)	2.2 (1.2-4.1)	0.01	

Table 1. Impact of teaching on students' knowledge.

Score	N=	Age	Female	Undergraduate	Before	After
0-1	10	24 (22-28)	5/10 (50%)	9/10 (90%)	0.4 (0-1)	2.9 (0-6)
2-3	37	25.2 (22-29)	24/37 (65%)	26/36 (72%)	2.5 (2-3)	4.9 (2-8)
4-5	49	25.5 (21-41)	24/48 (50%)	39/49 (73%)	4.5 (4-5)	5.2 (2-8)
6-7	29	25 (22-31)	18/28 (64%)	22/29 (76%)	6.3 (6-7)	5.1 (1-8)
8-9	7	24.7 (22-28)	2/7 (29%)	7/7 (100%)	8.6 (8-9)	6.6 (5-9)

Table 2. Impact of teaching on student's knowledge categorised based on pre-teaching examination scores.

Female	59% (23/39)
Age (range)	25.5 (22-41)
Undergraduate	74.4% (29/39)
Confidence pre-course (range)	4.8/10 (2-8)
Confidence post-course (range)	6.7/10 (4-8.5)

Table 3. Impact of teaching on subjective assessment of students' confidence in ECG interpretation.

Thirty-nine students completed feedback questionnaires on their confidence in ECG interpretation. The results can be seen in table 3. Confidence improved in 87.2% (34/39) of respondents, decreased in 7.7% (3/39), and was unchanged in 5.1% (2/39) after attending the course. There was a statistically significant improvement in subjective assessment of confidence after attending the teaching ($p < 0.001$).

Discussion

The purpose of this study was to assess the impact of a short period of intensive ECG teaching on ECG knowledge and confidence in ECG interpretation. A single session of intensive ECG teaching was provided to students who had completed their teaching and clinical practice curriculum, a cohort reflective of junior doctors in training. The teaching was provided by Cardiology trainees rather than consultant Cardiologists. This was designed to reflect the doctors providing the majority of bedside teaching within hospitals. The method of testing in our study was also different to previous similar studies. Our test involved the interpretation of 10 ECGs taken from clinical practice with a short clinical scenario attached. Instead of multiple choice answers the participants were required to provide a free hand answer. This is more reflective of ECG interpretation in clinical practice.

This study found an improvement in both ECG knowledge and ECG interpretation after a 2 hour session of

teaching. The improvement in examination results was modest but statistically significant. The standard of knowledge tested was high and the marking scheme was strict. The examination was brief but deliberately covered a broad spectrum of ECG knowledge. Therefore it is unsurprising that there was a wide range of examination results. The free hand answering format also impacted on the scores. For instance, when interpreting the ECG in normal sinus rhythm many participants answered "regular rhythm". This was considered an incorrect answer. If provided with multiple choice questions it is possible many of these participants would have answered correctly. Similarly, the questions on STEMI asked for identification of the STEMI territory rather than identification of a STEMI. In clinical practice, identification of an ECG concerning for a STEMI would lead to specialist cardiology involvement and the non-cardiology doctor's inability to identify the territory involved is unlikely to significantly impact on the clinical course for the patient. Incorrect answers of this nature are unlikely to reflect a risk to patient safety in clinical practice.

Participants with a lower baseline knowledge had a more significant improvement than students with a higher baseline knowledge, who in fact had a disimprovement in their scores. On subcategory analysis, there was a greater improvement in the basic skills of ECG interpretation e.g. rate and rhythm assessment, compared to complex concepts e.g. conduction abnormalities. There was a highly variable level of ECG knowledge prior to attending this session despite all students having completed their teaching curriculum. This style of teaching was most effective at improving basic ECG principles and was less effective with complex concepts. Therefore, participants who scored poorly in the basic principles were more likely to improve on the post-teaching examination.

Study limitations

This was a single centre study and therefore there is an inclusion bias in our sampling. The investigators of the study designed the ECG interpretation examination and were therefore aware of the concepts that would be tested in the examination when delivering the teaching. The completion rate of feedback questionnaires on confidence in ECG interpretation was low and therefore may not fully reflect the effect of the teaching session on confidence in ECG interpretation.

Conclusion

This study showed an improvement in both ECG knowledge and confidence with ECG interpretation following 2 hours of teaching. The assessment of simple concepts such as heart rate improved more significantly than complex concepts such as conduction abnormalities. This was likely impacted by the limited duration of teaching. Our findings suggest a benefit from dedicated ECG revision programmes for medical students and doctors in training to enhance their ECG knowledge and confidence with ECG interpretation. Emphasis on basic concepts of ECG interpretation would be more beneficial during short teaching sessions.

References:

1. Trzeciak S, Erickson T, Bunney EB, Sloan EP. Variation in patient management based on ECG interpretation by emergency medicine and internal medicine residents. Am J Emerg Med. 2002;20(3):188–95.
2. Jayes Jr RL, Larsen GC, Beshansky JR, D'Agostino RB, Selker HP. Physician electrocardiogram reading in the emergency department–accuracy and effect on triage decisions: findings from a multicenter study. J Gen Intern Med. 1992;7(4):387–92.
3. Berger JS, Eisen L, Nozad V, D'Angelo J, Calderon Y, Brown DL, et al. Competency in electrocardiogram interpretation among internal medicine and emergency medicine residents. Am J Med. 2005;118(8):873–80.
4. 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(9):751–60.
5. Zeng R, Yue RZ, Tan CY, Wang Q, Kuang P, Tian PW, et al. New ideas for teaching electrocardiogram interpretation and improving classroom teaching content. Adv Med Educ Pract. 2015 Feb 10;6:99-104. Doi: 10.2147/AMEP.S75316. eCollection 2015.

6. Fent G, Gosai J, Purva M. Teaching the interpretation of electrocardiograms: which method is best? J Electrocardiol. Mar-Apr 2015;48(2):190-3.doi: 10.1016/j.jelectrocard.2014.12.014. Epub 2014 Dec 23.
7. Rolskov Bojsen S, Räder SBEW, Holst AG, Kayser L, Ringsted C, Svendsen JH, et al. The acquisition and retention of ECG interpretation skills after a standardized web-based ECG tutorial–a randomised study. *BMC Med Educ* **15,** 36 (2015). https://doi.org/10.1186/s12909-015-0319-0