



## Effectiveness of ECG educational workshops among undergraduate medical students

### Efficacité des ateliers éducatifs sur l'ECG pour les étudiants de premier cycle en médecine

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#### RÉSUMÉ

**Contexte:** L'électrocardiogramme (ECG) reste l'un des outils de diagnostic les plus couramment utilisés et les importants en médecine. À la Faculté de Médecine de Tunis (FMT), l'enseignement de l'interprétation de l'ECG chez les étudiants en première année du Premier Cycle des Etudes Médicales (PCEM1) est une partie importante du programme.

**Objectifs:** Évaluer l'efficacité des ateliers pédagogiques de l'apprentissage de l'ECG chez les étudiants du PCMS 1. Secondairement, évaluer la satisfaction des étudiants de ces ateliers.

**Méthodes:** Il s'agissait d'une étude descriptive, transversale et exhaustive conduite à la FMT au cours de l'année universitaire 2017-2018, ayant inclus des étudiants du PCMS 1. Tous les étudiants ont effectué un pré-test, une session d'atelier et un post-test. Chacun des tests est composé de cinq questions à choix multiples (QCM) couvrant les mêmes sujets. Une évaluation de la satisfaction des étudiants par rapport au tutoriel a été conduite à la fin de chaque session.

**Résultats:** Dix ateliers ont eu lieu à la FMT, incluant 160 étudiants. Le score global est passé de 4 points sur 10 dans le pré-test à 6,8 sur 10 points dans le post-test ( $p < 0,001$ ). Une amélioration statistiquement significative a été notée dans toutes les questions du test ( $p < 0,001$ ). Soixante et un apprenants (39,3%) étaient «insatisfaits» du nombre d'élèves par groupe. Dans l'ensemble, 83,8% ( $n = 130$ ) des étudiants ont trouvé la session bénéfique.

**Conclusions:** Les étudiants ont indiqué une attitude positive à l'égard de l'atelier et de son utilité. D'autres études auprès de populations similaires sont nécessaires pour étayer ces conclusions et évaluer l'efficacité des ateliers éducatifs à moyen et long terme.

**Mots clés:** électrocardiographie, ateliers, étudiants en médecine, évaluation

#### SUMMARY

**Background :** The electrocardiogram (ECG) remains one of the most important and commonly used diagnostic tools in medicine. At the faculty of Medicine of Tunis (FMT), teaching ECG interpretation to undergraduate medical students is an important part of the curriculum.

**Aims :** To assess the effectiveness of pedagogical workshops in ECG learning among students of First-year of the primary cycle of medical studies (PCMS 1). In addition, we aimed to assess the students' perceptions of the tutorials.

**Methods :** It was an exhaustive cross-sectional study that was carried out at the FMT during the academic year 2017-2018 and that included students from PCMS 1. All participants completed a pre-test, a workshop session and a post-test. Each of the tests consists of five Multiple Choice Questions (MCQs) covering the same topics. An evaluation of students' satisfaction with the tutorial was made at the end of the session.

**Results :** Ten workshops were held at the FMT, including 160 students. The overall score increased from 4 out of 10 points in the pre-test to 6.8 out of 10 points in the post-test ( $p < 0.001$ ). A statistically significant improvement was noted in all tests questions ( $p < 0.001$ ). Sixty-one learners (39.3%) were «Not satisfied» with the number of students per group. On the whole, 83.8% ( $n=130$ ) of students found the session beneficial.

**Conclusions :** Students indicated a positive attitude toward the workshop and its utility. More research among similar populations is needed to support these conclusions and to assess the effectiveness of medium- and long-term educational workshops on medical students.

**Keywords:** Electrocardiography, workshops, medical students, assessment.

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## INTRODUCTION

The electrocardiogram (ECG) remains one of the most important and commonly used diagnostic tools in medicine. Despite the widespread clinical use of ECG, several studies have shown that performance in ECG interpretation is poor among both undergraduate and postgraduate medical students, cardiologists included (1). Furthermore, studies showed that the majority of medical students felt a low level of self-confidence regarding their competence in ECG interpretation (2). Surveys of internal medicine clerkship directors at US and Canadian medical schools revealed that ECG interpretation is crucial for undergraduates during their clerkship (3). ECG interpretation tutorials need to be provided earlier in the medical curriculum, and the number of sessions must be increased (4).

At the Faculty of Medicine of Tunis (FMT), teaching ECG interpretation to undergraduate medical students is an important part of the curriculum. In the middle of the first year of the Primary Cycle of Medical Studies (PCMS 1), all medical students take part in a 58-hour course in the cardiovascular theme (theme IX), in which they review the anatomy, histology-embryology, physiology, and biophysics of the circulatory system. In the physiology module, students take formal lecture courses in ECG. In addition to this, the physiology section of FMT has scheduled workshop teaching sessions, in an attempt to teach students the steps of recognizing and analyzing a normal ECG as early as their first year of medical studies before their introduction into hospital training.

The primary aim of the present study was to assess the efficacy of workshops in ECG learning among PCMS 1 students. In addition, we aimed to assess the students' perceptions of the tutorials.

## METHODS

### Study design and population

It was a cross-sectional study that was carried out at the FMT during the academic year 2017-2018. The study was spread over five successive days, from 16<sup>th</sup> to 20<sup>th</sup> April, 2018. The workshops were held during the afternoon sessions in the simulation department at the FMT.

All students enrolled in the PCMS1 during the academic year 2017-2018 were included in this study, without any

selection process or sample calculations. Student's participation in these workshops was voluntary. Students attended a two-hour lecture on cardiac electrophysiology two weeks before the start of the workshop.

### Ethical considerations

Students participating in the study were clearly informed of the study objectives and informed consent was obtained from all participants. Moreover, the data were treated in the strictest confidence. The Dean of the faculty of medicine of Tunis approved the protocol.

### Workflow of the workshop

The workshop began with a theoretical presentation, in the form of a clinical case explaining the indications and the analysis steps of a normal resting ECG, followed by an interactive practical part of 1h30. The students took turns taking the ECG on a simulation mannequin. They were then tutored on how to interpret the tracing. The learning objectives were covered interactively between the teacher and the students: to perform a resting ECG, to interpret a resting ECG step by step, and to recognize a normal ECG. Students were asked to write an account of the ECG performed during the workshop. Each workshop lasted two hours, provided by the same university hospital teacher. Educational planning of workshop is given in Table 1.

### Assessment tools

During each of these workshops, the students completed a pre-test, a workshop session and a post-test with a satisfaction questionnaire. The pre-test was administered at the beginning of the workshop so as to evaluate the students' prior knowledge. The post-test was conducted immediately after the session. Each of the tests consists of five Multiple Choice Questions (MCQs). Pre- and post-test were identical. The MCQs were based only on the assessment of student knowledge and selected from previous exams of cardiovascular theme. *Table 2* shows themes of the assessment tests.

For each question, participants had to choose at least one answer from a list of five options. The questionnaires were conducted in limited time (60 seconds per question) under the supervision of the teacher. Students were asked to use the same non-identifiable code for pre-testing and post-testing in order to ensure anonymity.

**Table 1.** Educational planning of the ECG workshop

	Session 1	Session 2
<b>Educational objectives</b>	Interpreting the ECG step by step.	Practice of an ECG on a simulation mannequin
	Writing an ECG report.	ECG recording.
<b>Timing</b>	1 h 15	30 min
<b>Workshop stages and Educational support</b>	Presentation of the clinical case by PowerPoint.	
	Presentation of an ECG without mentioning the identity of the patient or the date.	
	ECG tracing given to each student	
	Interpretation of the ECG tracing step by step and discussion.	
	Reading of the ECG report by volunteer students and discussion.	
<b>Formative evaluation</b>	5 multiple choice questions at the beginning of the workshop.	Practice Assessment
	5 multiple choice questions at the end of the workshop.	

**Table 2.** The themes of the assessment tests

1)	Heart rhythm
2)	Heart rate
3)	Heart conduction time
4)	Electrical axis
5)	Electrode layering

Two blinded physiologists scored each student's answer on a scale from 0 to 2. A third cardiologist rater restored any disagreement between the two scores. For each answer given by the student, we noted 0 = incorrect answer, 1 = incomplete answer, and 2 = correct answer. Non-response was considered an incorrect answer. The test scores ranged from 0 to 10.

### Satisfaction survey

At the end of the session, the students assessment of the duration (question 1), the venue (question 2), the teaching pedagogy (question 3), student interactivity (question 4), and number of students per group (question 5) was assessed measured by means of a satisfaction questionnaire inspired by the Likert scale ranging from 1-5 (1 = not satisfied, 2 = little satisfied, 3 = moderately satisfied, 4 = satisfied, and 5 = very satisfied). The satisfaction evaluation focused on the overall results.

### Statistics analysis

Mean  $\pm$  standard deviation (SD) was calculated for numerical data. Frequency and percentage were calculated for categorical data. Intragroup comparisons were done using a paired-samples t-test to investigate differences between pre-test and post-test scores. Intergroup comparisons were performed using an independent-sample t-test. A Pearson correlation was used to investigate whether there were any correlations between the pre-test score and post-test score. A p-value  $< 0.05$  was considered statistically significant. All statistical calculations were done using the IBM SPSS software (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA) release 21.0 for Microsoft Windows.

## RESULTS

### Workshop characteristics

Ten workshops were held at the FMT, including 160 students. Thursday was the busiest day of the week for students ( $n = 35$ , 21.9%). The average number of learners per workshop was  $16.2 \pm 1.9$  students (min = 13, max = 20).

### Comparison between pre- and post-test results using paired series

All the evaluation questionnaires were included in this study. The overall score increased from  $4 \pm 2$  out of 10 points in the pre-test to  $6.8 \pm 1.7$  out of points in the post-test ( $p < 0.001$ ). There was a significant correlation between pre-test and post-test scores ( $r = 0.525$ ). The percentage of students with an average score greater than or equal to 5 out of 10 increased from 40.6% in the pre-test to 91.25% in the post-test ( $p < 0.001$ ). The average progress score was  $2.8 \pm 1.8$  points with extremes ranging from -2 to +7. Six students had a lower post-test score than the

pre-test score with an average of  $-1.33 \pm 0.51$  points. A statistically significant improvement was noted in all test questions ( $p < 0.001$ ).

### Progress Score Comparison by Workshop

By workshop, the participants of workshop N°10 ( $n = 16$ ) had the highest progress score of  $3.7 \pm 1.7$  points.

No significant difference was found in the progress score between the smallest and largest group ( $3.1 \pm 1.8$  versus  $3.6 \pm 1.9$ ;  $p=0.382$ ).

### Satisfaction survey

In total, we have analyzed 160 copies of the satisfaction survey. Five copies were excluded due to incomplete data sets. The duration of the workshop (2h) was considered adequate by 54.8% of students ( $n = 85$ ). The choice of venue, teaching pedagogy, and interaction among group members was considered appropriate by 56.8%, 66% and 51.5% of students, respectively. Sixty-one learners (39.3%) were «*Not satisfied*» with the number of students per group. There was no statistically significant correlation between the number of students per group and the satisfaction score ( $p=0.472$ ). On the whole, 83.8% ( $n = 130$ ) of students found the session beneficial.

Regarding free remarks, only 25 students (16.1%) made their written remarks, eight of which were «*Thank you for the initiative*» and eleven were «*Fewer students per workshop*».

## DISCUSSION

We found an effect of the tutorial as the overall mean test score improved significantly between the two tests and as the overall student satisfaction at the end of the session was positive.

### Impact of the ECG pedagogical workshop

In this study, the ECG workshop had a positive impact on students' knowledge. The overall score increased from 4/10 points before the workshop to 6.8/10 points after the workshop ( $p < 0.001$ ). The teaching methods that actively engage the student are more likely to be effective.

The workshop-based format involved a small group activity in which the participants were active learners. The participants were able to ask questions and to have one-to-one time with the instructor while working through sample ECGs and learning objectives (5). Teaching ECG

interpretation to medical students remains a challenge for medical educators. Several learning methods were tested to teach and improve ECG interpretation. Mahler et al. found that self-directed learning is less effective than a workshop or lecture (5). In a correspondence paper Rubinstein et al. stated that teaching ECG interpretation with puzzles is comparable to traditional teaching and may be particularly useful for certain subgroups of students (6). Web-based ECG learning programs are widely available and have been shown to be popular resources for medical students. It has been suggested that web-based learning can be superior to conventional teaching interventions when it is used as an adjunct to traditional teaching methods (7). However, the newly acquired skills are rapidly lost when the intervention is not repeated (8). A recent review on ECG interpretation learning concluded that no single method or format of teaching is most effective in delivering ECG interpretation skills (9).

### Low pre-test scores

During this study, the majority of students (59.4%) did not attain an average score in the pre-test. This may also reflect the lack of prior reading of the course material before attending the workshop. Raupach T et al. reported that only 20.9% of students read a book on ECG interpretation before starting the cardio respiratory-module (10).

### Importance of formative evaluation

To be successful, interactive teaching requires that feedback be provided by a formative evaluation of the students. This type of evaluation is of double interest: on the one hand, it provides teachers with qualitative and quantitative data to assess and improve their teaching. On the other hands, this assessment method gives the students feedback on their level of mastery and allows them to fill in the gaps. In the present study, a written assessment test on ECG interpretation was administrated before and after the workshop. We found a significant improvement between the two tests. However, there was a decline in the performance level of six students with an average of -1.33 points. This may be explained by a lack of concentration and attention on the part of the student due to fatigue or night duty.

By workshop, group N°10 (the last group) was the one who benefited the most from the tutorials. This can be explained by the effect of the teacher who has gained a better experience. By the last workshop, he became better

acquainted with the students' shortcomings and attempted to deal with them. Most teachers in medical education have primarily lecture-based experience. Though they show expertise in the discipline in which they have been trained, they have limited training in how to teach students (11).

### Satisfaction survey

At the end of each workshop, a satisfaction survey was conducted among the participants. The students' response provides the teacher with feedback on the quality of his teaching. Feedback is of a global character; he who really wants to improve his teaching will want to know about the benefits and will come to solicit the opinion of students. The students' reaction was positive for items 1-4 with proportions ranging from 51.5% to 66%. However, the majority of students found that the number of participants per group was inappropriate (item 5). Indeed, the interaction among group members is not possible if the number of participants is too large. Between eight to 12 is an optimal number that allows all participants to be regularly active. Twenty is perhaps the maximal effective size (12). Similarly, Raupach et al. showed that small-group peer teaching is more effective than lectures in enhancing medical students' ECG interpretation skills (13). A teaching skill essential for all medical educators is small group competence. All the participants have the opportunity to take part, and each can see for themselves the impact of their views on the other members of the group (12).

### Limitations and difficulties of the study

There are several limitations in this study that need to be considered. This study was conducted at a single medical school (FMT), and participation was based on volunteering. It is possible that the results are not generalized to all medical students in Tunisia.

Regarding the evaluation of the impact of the training on professional practices, the study was initially intended to re-evaluate the students 3-6 months after the end of the workshop, which was not feasible given the limited time of the academic year.

We can also question the limitations of our questionnaire. The relevance of the choice of questions can be discussed. Indeed, the idea was to evaluate students on basic aspects of ECG reading such as, rhythm, heart rate, and heart axis all of which representing the knowledge essential to any medical students.

### Highlights of the study

Our study presents several strengths that need to be highlighted. Firstly, we showed the positive impact of the educational workshop on participants' skills. This is a relevant training that could be an indispensable complement to the didactic course. Secondly, to the best of our knowledge, this is the first study to use ECG workshops among Tunisian medical students. Thirdly, we chose a questionnaire evaluation method. It is a suitable and objective method for collecting quantified data on the results of training. Finally, several studies have evaluated the effectiveness of different methods ECG teaching methods. Most of these studies have limitations such as, the small size of the sample recruited, the study population which is characterized by its heterogeneous skill levels (student, resident, and assistant). The target population of our study was first-year medical students, and the strength of our study lies in the homogeneity of the sample chosen.

### CONCLUSIONS

This article highlights the considerable and sustained efforts of the Faculty of Medicine of Tunis to improve ECG teaching among undergraduate medical student. It is essential to introduce practical workshops in the curriculum of medical students. Likewise, students indicated a positive attitude toward the workshop and its utility. More research among similar populations is needed to support these conclusions and to assess the impact of medium- and long-term educational workshops on medical students.

### REFERENCES

1. Sibbald M, Davies EG, Dorian P, Yu EH. Electrocardiographic interpretation skills of cardiology residents: Are they competent? *Can J Cardiol.* 2014;30(12):1721-4.
2. McAloon C, Leach H, Gill S, Aluwalia A, Trevelyan J. Improving ECG competence in medical trainees in a UK district general hospital. *Cardiol Res.* 2014;5(2):51-7.
3. Elnicki DM, van Londen J, Hemmer PA, Fagan M, Wong R. U.S. and Canadian internal medicine clerkship directors' opinions about teaching procedural and interpretive skills to medical students. *Acad Med.* 2004;79(11):1108-13.
4. Jama MP, Coetser JA. The electrocardiogram made (really) easy: Using



small-group tutorials to teach electrocardiogram interpretation to final-year medical students. *AJHPE*. 2016;8(2):140–3.

5. Mahler SA, Wolcott CJ, Swoboda TK, Wang H, Arnold TC. Techniques for teaching electrocardiogram interpretation: Self-directed learning is less effective than a workshop or lecture. *Med Educ*. 2011;45(4):347–53.
6. Rubinstein J, Dhoble A, Ferenchick G. Puzzle-based teaching versus traditional instruction in electrocardiogram interpretation for medical students – a pilot study. *BMC Med Educ*. 2009;9(4):1–7.
7. Nilsson M, Bolinder G, Held C, Johansson BL, Fors U, Östergren J. Evaluation of a web-based ECG-interpretation programme for undergraduate medical students. *BMC Med Educ*. 2008;8(1):1–7.
8. Rolskov Bojsen S, Räder SB, 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*. 2015;15(36).
9. Fent G, Gosai J, Purva M. Teaching the interpretation of electrocardiograms: Which method is best? *J Electrocardiol*. 2015;48(2):190–3.
10. 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.
11. Dolmas DH, Gijsselaers WH, Moust JH, De Grave WS, Wolfhagen IH, Van Der Vleuten CP. Trends in research on the tutor in problem-based learning: conclusions and implications for educational practice and research. *Med Teach*. 2002;24(2):173–80.
12. Walton H. Small group methods in medical teaching. *Med Educ*. 1997;31(6):459–64.
13. Raupach T, Hanneforth N, Anders S, Pukrop T, Th J, Ten Cate O, Harendza S. Impact of teaching and assessment format on electrocardiogram interpretation skills: Electrocardiogram training and assessment. *Med Educ*. 2010;44(7):731–40.