Original Article

Electrocardiogram Visual Tutorials for Nurse Practitioner Students

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Abstract

Background: The ability to interpret electrocardiograms (ECG) is diagnostically important, both for medical doctors and for nurse practitioners in primary-care settings. The process of learning to read complex rhythm strips and 12-lead ECGs can be very frustrating for students; teaching it can be challenging for some faculty members. Of the many available textbooks and online courses, most are excellent and all have something to offer. However, many nurse practitioners in primary care lack confidence in their ability to identify abnormalities in ECG strips correctly.

Methods: A quasi-experimental, one group pretest-posttest research design was used to determine the effectiveness of the intervention. Overall, 637 student-nurse practitioners from one university participated in the study. A quiz was used to evaluate the participants' ability to interpret electrocardiograms and their scores were collected as pretest data. The students took part in an intervention that consisted of video lessons and associated quizzes. Their scores from a later quiz on electrocardiogram interpretation were collected as posttest data.

Results: A paired samples t-test was conducted to assess the difference between pretest and posttest scores. The results revealed a statistically significant difference between pretest and posttest scores, $t(636) = 59.713$, $p = 0.000$. The mean difference was 49.330, indicating that the students significantly increased their ability to interpret electrocardiograms as a result of participating in the intervention.

Conclusion: Online visual tutorials were an effective means of teaching student-nurse practitioners to interpret ECGs.

Keywords: Electrocardiogram (ECG), ECG teaching methods, nurse practitioners, ECG interpretation

Introductionz

The ECG process is a vital clinical-test procedure performed in primary care. The ability to interpret electrocardiograms (ECG) is an important diagnostic skill, not only for medical doctors but also for nurse practitioners in primary-care settings. However, it can be very frustrating for nurse practitioner students to learn to read complex rhythm strips and 12-lead ECGs; the topic can also be challenging for faculty members to teach. Consequently, many nurse practitioners in primary care lack confidence in their ability to correctly identify abnormalities in an ECG strip, despite the availability ofseveraltextbooks and online courses.[1] However, primary care "providers are instrumental in identifying abnormalities on ECGs for further evaluation and life-saving treatments. As

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the population ages, the incidence of abnormalities expressed on ECGs grows significantly, which poses a challenge to providers".[2] The ability to interpret electrocardiograms correctly in clinical practice is an important skillset nurse practitioner are generally expected to possess.

Nurse practitioners face many challenges in trying to interpret ECG readings correctly during clinical practice, owing largely to deficits in training. Student nurse practitioners find it difficult to memorize the volume of information needed to interpret every strip accurately, including the ECG axis and rhythm.[3] Textbooks and online courses are either too basic or difficult for some learners of ECG. As a consequence, nurse practitioners face many challenges in trying to interpret ECG readings correctly during clinical practice.

Erroneous interpretations of electrocardiogram readings in medical practice can lead to adverse patient outcomes.[4] When the electrocardiogram signals that emanate from damaged electrodes are analyzed, there is a significant risk that providers will make diagnostic errors when treating patients. Examples include the erroneous identification of anteroseptal infarction, anterior infarction, and ventricular hypertrophy.[5] As a result, life-threatening misdiagnoses can be made.

Educators in the field of clinical practice have embraced many methods to teach students to read ECGs and increase confidence. Continuous exposure has been shown to increase the confidence levels of medical students during multiple ECG-interpretation exercises conducted in the presence of faculty facilitators.[6] Visual tutorials are one method used to train nurse practitioners to read and interpret electrocardiograms correctly. Nurse practitioner educators can use visual tutorials to increase practitioner students' ability to retain information during weekly ECG-interpretation exercises. As the electrocardiogram-related competence of nursing practitioners is extremely critical, it is important to analyze the teaching methods that educators use to impart the curriculum and essential ECG-interpretation skillsets to student-nurse practitioners.

To evaluate the effectiveness of visual tutorials, student-nurse practitioners in a Historically Black University in the Southwestern region of the United States used an online visual tutorial to learn to interpret ECG readings correctly. This article examines the effectiveness of visual tutorials in enhancing ECG interpretations by student-nurse practitioners.

The EKG module was a class assignment and student consent was not obtained. Results were de-identified prior to running the statistical analysis.

Literature Review

ECGs are among the most important and widely used medical tests. Consequently, there is a clear focus on the extent to which medical graduates are able to make and interpret correct electrocardiogram readings after completing the undergraduate medical curriculum. When medical practitioners misinterpret ECGs, they risk making the wrong clinical decisions, which can lead to serious adverse medical outcomes, especially in relation to myocardial infarction and arrhythmias.[4]

Findings based on a study of medical-student interpretations of ECG readings have shown that many students lack confidence during ECG-interpretation exercises.[7]The most disturbing findingis that most medical students cannot interpret electrocardiograms correctly, especially when faced with life-threatening clinical emergencies, such as atrial fibrillation and complete cardio block.[7] Medical practitioners who major in cardiology, emergency medicine, and internal medicine are also moderately incompetent at interpreting electrocardiograms.[7] These results are concerning because the ability to interpret ECGs is a key skill in daily medical practice.

An electrocardiogram analysis is a detailed examination of electrocardiogram tracing, which typically requires the proper evaluation of every waveform and rhythm and the correct measurement of intervals. ECG interpretation is defined as the determination reached once the process of ECG analysis is complete.[3] ECG competence is a medical practitioner's ability to analyze and interpret ECGs correctly. The process of understanding ECG concepts is commonly referred to as ECG knowledge.[3]

However, both medical students and nurse practitioners find the process of analyzing and interpreting ECGs very daunting at times. One reason

is that nurse practitioners are generally required to have a sound understanding of the physiology and anatomy of the cardiovascular conduction system before studying ECGs. In addition, students cannot analyze ECGs without understanding vectors and how they are impacted by pathology and lead placement.[8]

Another study showed that medical students needed two types of logical thinking to interpret ECGs: a non-analytical logical pattern that recognizes both rhythms and abnormal waveforms; and analytical thinking that includes a systematic analysis of all 12-lead ECGs.[7] Although nurse practitioners can achieve the best clinical results when simultaneously employing both ways of thinking when interpreting ECGs, many find this overwhelming. Although the ability to interpret ECGs accurately depends on students' levels of clinical exposure, there is a need to supplement the entire ECG-interpretation training process through a structured teaching method.

Visual tutorials have been shown to facilitate students' learning about ECG analysis and interpretation. The rising use of visual tutorials to teach ECG interpretation in medical school can be attributed to the increased digital literacy of students in the education sector since the advent of computers and smartphones.[3] Visual tutorials enable tutors to teach more students effectively, helping them retain information more easily and for longer periods of time. Recent meta-analyses have confirmed the importance of visual tutorials in conveying healthcare curricula, and especially ECG interpretation.[3] Properly assessing the competence level of students who have been trained using particular methods makes it possible to develop key objectives, which must be achieved for the tutoring to be a success. By testing the student-nurse practitioners' ability to interpret and analyze ECGs, it is possible to measure their skillsets and ECG competency.

The visual tutorial model can be used immediately, with delayed assessment methods after a learning intervention.[4] Conducting an assessment shortly after the student acquires knowledge can make it easier to test a student's level of ECG competence. By contrast, a delayed assessment checks the student's ability to retain knowledge associated with ECG competence. The Kirkpatrick modelis a widely accepted testing method that medical educators use to gauge the effectiveness of visual tutorials in ECG-interpretation training.[9] This model is known for properly measuring student assessments of the learning experience, acquired skillsets, the ability to transfer learning to actual clinical emergencies, and the impact of the student learning process on patients.

The effectiveness of the visual learning method should not be measured without factoring in other important determiners of the learning process. They include the environment in which the tutoring process is carried out, for example in a clinical setting, classroom, or computer laboratory.[3] Another determiner is the distribution of studied material (e.g., distributed vs. massed instruction), which has a direct impact on student retention.[3]

A range of learning theories can explain the different types of tutoring methods. These can be classified as instrumental, humanistic, transformative, and social-learning approaches. The instrumental-learning approach emphasizes the importance of learning through practice, stating opinions, and reinforcing taught content. The humanistic learning approach steers the student-learning process intrinsically, rather than through extrinsic motivation. The transformative-learning approach emphasizes the student's ability to reflect critically. The social-learning approach encourages collaborative learning through direct interactions between students and tutors.[10]

Visual tutorials are used in instrumental, humanistic, and transformative teaching approaches to transmit ECG knowledge to students, making them particularly effective.[11] The visual-learning approach enables nurse practitioners to visualize the medical situations they are likely to face when administering ECGs to patients. Furthermore, being able to pause visual tutorials helps students understand and retain information on ECG methods. Proper assessments are needed to identify and correct the key weaknesses associated with visual tutorials in limiting social interactions between nurse practitioners and educators. It is therefore important to increase the extent to which faculty members use this learning method effectively.

Methods

The present study uses a quasi-experimental, one-group, pretest-posttest research design to determine the effectiveness of the intervention. Pretest-posttest designs are used to measure the change that results from experimental treatments.[12] This study measures changes in the students' ability to interpret electrocardiograms, providing a vehicle for assessing the impact of educational interventions based on the visual tutorial modules.The specific research question that guides this study is as follows:Does ECG onlinevisual tutorials improve participants' ability to interpret electrocardiograms?

The participants were graduate students enrolled in the Family Nurse Practitioner program at a historically black university in the Southwestern region of the United States. Data were collected from 637 student-nurse practitioners for seven academic years, enrolled in clinical rotations. A pretest was administered to participants at the beginning of the course. Throughout the course, the students participated in several video lessons designed to help them analyze ECGs with confidence. Following each video lesson, the students were quizzed on the content of the video lessons. They also viewed several online videosthat provided a practical "how-to" approach to a real cardiac rhythm strip. They were then quizzed on the content of the those videos. At the end of the course, the participants took a posttest that served as the final examination to evaluate the study's primary outcome, change in ECG reading and interpretation knowledge/competence.

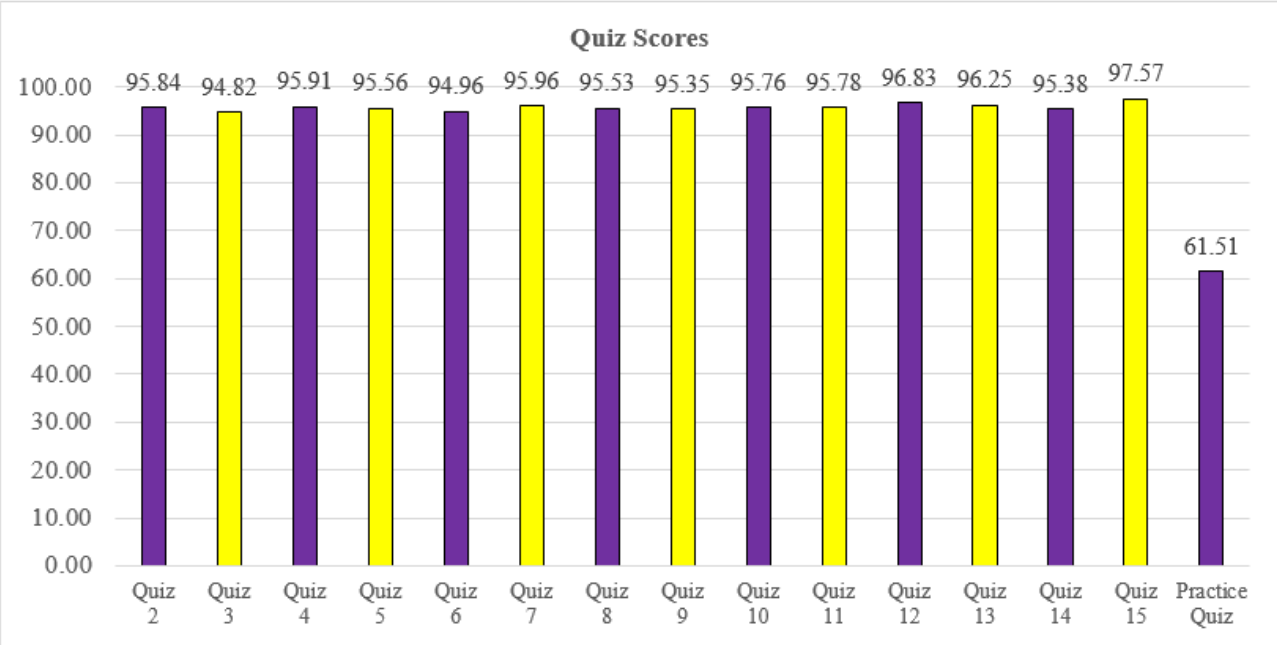
Results

Overall, 637 students completed the pretest and posttest in this study. Table 1 presents the mean pretest and posttest scores, which are 41.87 and 91.20, respectively.

Table 1. Pretest and posttest descriptive statistics

	N	Mean	Std. Deviation
ECG Pre-test Quiz	637	41.87	16.107
Level 1 Final Exam	637	91.20	13.228

As previously stated, students participated in video lessons, followed by quizzes, as an intervention designed to improve their ability to interpret electrocardiograms. Figure 1 presents the students' mean scores for the video-lesson quizzes and the practice quiz.



A paired samples t-test was conducted to determine whether there was a statistically significant difference between the pretest and posttest scores. Table 2 presents the results of the paired samples t-test.

Table 2. Results of the paired samples t-test.

	Mean Difference	Std. Deviation	t	Sig.	Effect Size (Cohen's d)
Level 1 Final Exam - ECG Pre-test Quiz	49.330	20.850	59.713	.000	3.35

The results of the paired samples t-test reveal a statistically significant difference between the pretest and posttest scores, $t(636) = 59.713$, $p = 0.000$. The mean difference is 49.330, indicating that the students significantly increased their ability to interpret electrocardiograms by participating in the intervention. Furthermore, the effect size of the study is 3.35, showing that the intervention led to an extremely large effect.

IMPLICATIONS FOR PRACTICE

The use of visual tutorials to teach nurse practitioners the ECG skillset has numerous implications for generating positive impacts in clinical practice. As a result, visual-tutorial teaching has quickly replaced older learning methods. Some educators have also created a hybrid ECG teaching method that uses traditional and visual learning methods in tandem.[4] The extent to which student-nurse practitioners engage in studying ECGs has also increased.

Visual tutorials expand the knowledge that students acquire at the pre-intervention stage of ECG procedures. Student-nurse practitioners acquire a significant amount of information by reviewing visual tutorials that depict pre-intervention stages. No traditional study models present nurse practitioners with such opportunities because they allow only theoretical explanations of the procedures that students must follow. Furthermore, the huge amount of data consumed by nurse practitioners at the pre-intervention stage of any clinical condition can significantly help practitioners perform ECGs on patients, effectively increasing their survival chances.

Conclusion

The use of visual tutorials in ECG tutoring can minimize the rate at which future nurse practitioners give erroneous ECG readings and interpretations. It is widely known in medicine that misinterpreted ECG readings can jeopardize patient health. When doctors and nurse practitioners misread ECGs, they generally make diagnostic errors, erroneously identifying conditions such as anteroseptal infarction and anterior infarction in their patients. This causes them to administer the wrong treatments, increasing their patients' health risks. The potential effectiveness of visual tutorials in helping students interpret ECGs can save many lives in clinical practice by significantly reducing erroneous ECG readings and interpretations.

The use of visual tutorials to teach nurse practitioners ECG-interpretation skills can increase patients' levels of trust in practitioners, particularly when they are administering ECG tests. Visual tutorials can strengthen the confidence of nurse practitioners during the ECG learning process. Confidence levels increase when nurse practitioners confront various clinical conditions via visual tutorials that teach them to perform electrocardiograms. The increased confidence levels of nurse practitioners during ECG administration allow patients to trust their actions, enhancing the positive relationship between nurse practitioners and their patients.

Nurse practitioners conduct ECG procedures while treating numerous clinical conditions in daily practice and emergency situations. As a result, accurate ECG-interpretation skills are needed to enhance medical-team performance during treatment. Visual tutorials offer a simple way for working nurse practitioners to refresh their ECG-interpretation skillsets effortlessly. In addition, visual tutorials allow practitioners to refresh their skillsets and provide much-needed flexibility in their everyday duties. This enables nurse practitioners to maintain high standards when conducting electrocardiogram procedures.

The results of this study show a huge improvement in the ECG competence of student-nurse practitioners, outpacing traditional modes of teaching. The findings of this assessment show that students easily understand and retain information taught using visual modes of teaching, as opposed to older teaching methods. The use of Visual

tutorials to teach the nursing curriculum has a high success rate, with the potential to introduce other forms of visual tutoring, such as virtual reality. These significantly expand the clinical experiences of practitioners. Just as visual tutorials have been shown to be more effective than traditional teaching methods, educators must engage actively with students during the ECG learning process, given the technical nature of electrocardiogram exercises.

Ethical Considerations: The study was approved by the Institutional Review Board ofPrairie View A&M University, Office of Research Compliance, Prairie View Texas, with IRB Protocol #2023-009.

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Conflict Of Interest: Nil

References

1. Burns, W.P., Hartman, N.D., Weygandt, P.L., Jones, S.C., Caretta-Weyer, H., & Moore, K.G. Critical electrocardiogram curriculum: Setting the standard for flipped-classroom EKG instruction. Western Journal of Emergency Medicine: Integrating Emergency Care with population Health. 2019;21(1):52-57. doi:10.5811/westjem.2019.11.44509
2. Campo, T.M. Foreword. In M.A. Knechtel, EKGs for the Nurse Practitioner and Physician Assistant. 3rd ed. New York: Springer Publishing; 2021. p.xi – xi.
3. Dzikowicz, Dillon J., & Carey, M. G. Implementing interactive technology to teach electrocardiographic interpretation online. Journal of Professional Nursing. 2002; 42: 148-155.
4. Amini, K., Mirzaei, A., Hosseini, M., Zandian, H., Azizpour, I., &Haghi, Y. Assessment of electrocardiogram interpretation competency among healthcare professionals and students of Ardabil University of Medical Sciences: a multidisciplinary study. BMC Medical Education. 2022; 22(1): 1-10.
5. Dekie, L., & Kleiman, R. B. False negative ECG device results may increase the risk of adverse events in clinical oncology trials. Therapeutic innovation &regulatory science. 2022; 56(4): 667-676.
6. Viljoen, C. A., Millar, R. S., Manning, K., & Burch, V. C. Effectiveness of blended learning versus lectures alone on ECG analysis and interpretation by medical students. BMC medical education. 2020; 20(1): 1-16.
7. Hatala, R., Gutman, J., Lineberry, M., Triola, M., &Pusic, M. How well is each learner learning? Validity investigation of a learning curve-based assessment approach for ECG interpretation. Advances in Health Sciences Education. 2019; 24(1): 45-63.
8. Bauman, B., Kernahan, P., Weinhaus, A., Walker, M. J., Irwin, E., Sundin, A.et al. An interprofessional senior medical student preparation course: Improvement in knowledge and self-confidence before entering surgical training. Advances in Medical Education and Practice. 2021;12: 441.
9. Kirkpatrick, D.L. & Kirkpatrick, J. D. Evaluating Training Programs.Oakland, CA: Berrett-Koehler; 2016
10. Mukhalalati, B.A. &Taylor,A. Adult learning theories in context: A quick guide for healthcare professional educators. Journal of Medical Education and Curricular Development. 2019:doi: 10.1177/2382120519840332
11. La Cerra, C., Dante, A., Caponnetto, V., Franconi, I., Gaxhja, E., Petrucci, C., et al.Effects of high-fidelity simulation based on life-threatening clinical condition scenarios on learning outcomes of undergraduate and postgraduate nursing students: a systematic review and meta-analysis. Open. 2019; BMJ, 9(2): e025306.
12. Dimitrov, D.M., Rumrill, P.D. Pretest-Postest designs and measurements to change. Work,2003; 20(2): 159-65. PMID: 12671209 PubMed.