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Article Title: Safety of Computer Interpretation of Normal Triage Electrocardiograms

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Authors: Katie E. Hughes, MD, Scott M. Lewis, BA, Laurence Katz, MD, and Jonathan Jones, MD have no relevant financial relationships to disclose.

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CME Safety of Computer Interpretation of Normal Triage Electrocardiograms

Katie E. Hughes, MD, Scott M. Lewis, Laurence Katz, MD, and Jonathan Jones, MD

ABSTRACT

Objectives: Frequent interruptions within the emergency department may lead to errors that negatively impact patient care. The immediate review of electrocardiograms (ECGs) obtained from triage patients is one source of interruption. Limiting triage ECGs requiring immediate attending review to those interpreted by the computer as abnormal may be one way to reduce interruption. We hypothesize that triage ECGs interpreted by the computer as "normal ECG" are unlikely to have clinical significance that would affect triage care.

Methods: All triage ECGs performed at the University of North Carolina were collected between November 14, 2014, and March 3, 2015, according to a standard nursing triage protocol using GE machines running Marquette 12SL software. Triage ECGs with a computer interpretation of "normal ECG" were compared to an attending cardiologist's final interpretation. Triage ECGs for which the cardiologist's interpretation differed from the computer interpretation of normal ECG were presented to two emergency physicians (EPs) blinded to the goals of the study. The physicians were asked to evaluate the ECG for clinical significance. Clinical significance was defined as any change from normal that would alter triage care. Triage ECGs were considered true negatives if either the cardiologist agreed with the normal computer interpretation or if both EPs agreed that the ECG did not show clinical significance.

Results: A total of 855 triage ECGs were collected over 16 weeks. A total of 222 (26%) were interpreted by the computer as normal. The negative predictive value for a triage ECGs interpreted by the computer as "normal" was calculated to be 99% (95% confidence interval = 97% to 99%). Of the ECGs with a computer interpretation of normal ECG, 13 had an interpretation by an attending cardiologist other than normal. Two attending EPs reviewed these triage ECGs. One of the 13 ECGs was found to have clinical significance that would alter triage care by one of the EPs. The stated triage intervention was "bed immediately."

Conclusions: Our data suggest that triage ECGs identified by the computer as normal are unlikely to have clinical significance that would change triage care. Eliminating physician review of triage ECGs with a computer interpretation of normal may be a safe way to improve patient care by decreasing physician interruptions.

ECGs are frequently initiated in triage through nursing protocols to avoid delays in care due to long waiting room times. In accordance with American Heart Association guidelines, ECGs obtained in triage are brought to the attending emergency physician (EP) for immediate interpretation within 10 minutes of arrival to the emergency department (ED).[1] While this strategy may reduce the time to interpretation of the ECG, this constant flow of triage ECGs may interrupt the EP from direct patient care. Studies suggest EP interruptions are frequent[2] and may lead to increased medical errors.[3,4] An automated approach that accurately identifies normal ECGs may obviate the need for immediate EP review of these ECGs and reduce the frequency of interruption of patient care.

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Received May 13, 2016; revision received July 27, 2016; accepted July 27, 2016.
The abstract for this manuscript was presented at the American College of Emergency Physicians Research Forum, Boston, MA, October 26, 2015.
The authors have no relevant financial information or potential conflicts to disclose.
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ACADEMIC EMERGENCY MEDICINE 2017;24:120–124.

doi: 10.1111/acem.13067
ISSN 1069-6563
PII ISSN 1069-6563583

There are limited studies investigating whether a computer can reliably identify normal triage ECGs in adult patients.[5,6] We hypothesized that triage ECGs interpreted as "normal" by computer analysis would not have immediate clinical significance and therefore would not warrant immediate EP review.

METHODS

Study Design

This was a prospective cohort study. The study was approved by the institutional review board at the University of North Carolina (UNC).

Study Setting and Population

All patients that had triage ECGs obtained at the UNC adult ED between November 14, 2014, and March 3, 2015, were included in the study. ECGs were performed by technicians and triage nurses according to a standard triage protocol. ECGs were excluded from the study if the patient was less than 18 years of age. The nurse triage ECG protocol requires obtaining an ECG on patients with a chief complaint of chest pain; chest pressure; chest tightness; weakness; unusual fatigue; palpitations; syncope; dyspnea; or any atypical symptoms such as nausea and vomiting or pain in the jaw, upper back, or upper abdomen. ECGs were obtained within 10 minutes of arrival and immediately given to an attending emergency medicine physician for review.

ECGs were obtained with a GE MAC 5500 machines and interpreted using Marquette 12SL. All ECGs obtained within the ED were uploaded to a secure hospital server. Board-certified cardiologists blinded to the study reviewed the ECGs and entered the final interpretation into the medical records.

Study Protocol

ECGs performed according to triage protocol during the designated study period were prospectively collected. A chart review was performed to determine the cardiologist's final interpretation, patient chief complaint, and ED disposition of triage ECGs reported as normal by computer interpretation.

Data Analysis

Each ECG interpreted by the computer as normal ECG was compared to the cardiologist's final interpretation. If the cardiologist interpretation was also normal ECG this was considered an accurate computer interpretation. If the cardiologist's interpretation differed from normal, these ECG's were presented to two board-certified EPs blinded to patient presentation, patient care, and the goals of the study. The EPs were asked to evaluate the ECG for clinical significance. Clinical significance was defined as an ECG change from normal ECG that would alter standard triage care.

Triage ECGs were considered truly normal if either the cardiologist agreed with the normal computer interpretation or if both EPs agreed that the ECG's findings would not alter the triage care. The negative predictive value (NPV) of a computer normal ECG was determined. Confidence intervals (CIs) were calculated using Wilson's method of CI on a proportion. A sample size of 379 ECGs with a normal computer interpretation would be necessary to obtain a NPV of 100% with a lower limit 95% CI of >99% assuming no false negatives.

RESULTS

A total of 855 triage ECGs were collected over 16 weeks. A total of 222 of these (26%) were interpreted by the computer as normal ECG and five of the ECGs were interpreted as STEMI. The NPV for a computer interpretation of normal ECG was 99% (95% CI = 97% to 99%). Of the subset of triage ECGs with a computer interpretation of normal ECG, 13 had an interpretation by an attending cardiologist other than normal (Table 1). Two attending EPs reviewed these 13 triage ECGs. One of the 13 ECGs, with an "abnormal" cardiology interpretation, was interpreted by one of the two EPs as having an abnormality that would alter triage care. The stated intervention by this physician was "bed immediately" from triage. Subsequent chart review showed that the patient was discharged from the ED to follow-up for a next-day stress test, which was within normal limits. None of the 222 computer-interpreted normal ECGs were interpreted as a STEMI or other interpretation necessitating immediate catheterization lab activation by either cardiology or two ED physicians.

DISCUSSION

Emergency physicians routinely multitask while managing time-dependent disease processes. Additional responsibilities are time depleting and may cause loss of

Table 1
Cardiologist and ED Physician Interpretations for the Subset Computer "Normal" ECGs Interpreted by a Cardiologist as Abnormal

		ED Physician 1		ED Physician 2	
	Cardiologist Interpretation	Interpretation	Triage Disposition	Interpretation	Triage Disposition
ECG1	Sinus arrhythmia	Normal	No change	Normal	No change
ECG2	Nonspecific T-wave abnormality	Normal with RSR′	No change	Normal	No change
ECG3	Nonspecific T-wave abnormality	Nonspecific ST changes	No change	Normal	No change
ECG4	Rightward axis for age, otherwise WNL	Normal	No change	Normal	No change
ECG5	Nonspecific ST abnormality	Normal	No change	Short PR	No change
ECG6	Minor nonspecific T-wave abnormality	Normal	No change	Normal	No change
ECG7	Nonspecific ST abnormality	Long QT, nonspecific ST changes, essentially normal	No change	Normal	No change
ECG8	Normal variant RSR′ pattern in V1, WNL	Nonspecific changes, essentially normal	No change	Normal	No change
ECG9	Poor data quality, interpretation may be adversely affected	Poor baseline, essentially normal	No change	Normal	No change
ECG10	Nonspecific ST abnormality	Lateral/inferior ST changes	No change	Normal	No change
ECG11	Nonspecific ST abnormality	Normal	No change	Normal	No change
ECG12	Left-axis deviation, poor R-wave progression in precordial leads	T-wave flattening anterolateral leads	No change	ST elevation aVR, ST depression lead II, T-wave inversion lead III	Bed immediately from triage
ECG13	Rightward axis, nonspecific T-wave abnormality	T-wave flattening inferior leads	No change	Normal	No change

fidelity for complex thought processes or outright forgetting to return to important tasks. The results of our study confirm that a large percentage of ECGs performed in triage are normal. Eliminating the need to immediately review computer interpreted normal ECGs may reduce some time burdens experienced by EPs.

The results of this study are consistent with prior studies showing a high NPV for the computer interpretation of normal ECG.[5] Significant advances have been made since the first computer program was designed to detect abnormal ECGs in 1961.[7] In spite of these advances the sensitivity of computer detection of ECGs requiring time-sensitive interventions such as STEMIs remains low.[8] One advantage physicians retain when interpreting ECGs is the ability to use clinical history when acting on the results of ECGs. It seems unlikely that computer interpretation will completely replace physician interpretation; however, it may be possible for the computer to identify clinically insignificant ECGs. Our data suggest that it may not be necessary for the EP to immediately review computer normal ECGs. This strategy has the potential to reduce interruptions in direct patient care provided by EP physicians.

LIMITATIONS

There are a number of study limitations. First, our sample size was small. A larger sample size will be required to confirm the safety of the delayed review of computer-interpreted normal ECGs. Additionally since the overall incidence of STEMI in the ED population is low[9] our small sample size lead to few patients presenting with STEMI. Second, the Marquette 12SL ECG computer analysis software was used in a university hospital setting, so our findings may not extrapolate to other clinical settings. Finally, the attending cardiologists interpreting the ECGs were not blinded to the computer interpretation, which may lead to bias.

CONCLUSIONS

The findings of our study suggest that computer-interpreted normal triage electrocardiograms may not need immediate review. No delay in patient care or poor outcome was associated with computer-interpreted normal electrocardiograms. Limiting immediate review of computer-interpreted triage electrocardiograms designated as abnormal has the potential to reduce interruptions in patient care.

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