RELIABILITY OF COMPUTERISED ELECTROCARDIOGRAPHIC REPORTS

H T Ong, S H Kuah, S P Chew

ABSTRACT

The aim of this study is to assess the reliability of computerised reporting of electrocardiograms (ECG). Fifty ECG performed consecutively at the outpatient department of the Penang Adventist Hospital on the Marquette 12SL-SC were studied. Two physicians independently reviewed the ECG and the manual readings were compared with each other and to the computer reports. There was no significant difference in the measurement of rate. The PR and QT intervals measured by the two physicians were similar but each was significantly different from the computer reading. The QRS duration assessed by Physician 1 was similar to the computer reading but each was significantly different from that of Physician 2. The overall diagnosis was the same between the two physicians in 76%, between Physician 1 and the computer in 68%, and between Physician 2 and the computer in 78%. No ECG was reported as normal by the computer and said to be abnormal by either physician. Thus, the computer programme is reasonably reliable in ECG reporting with computer-physician variability being comparable to inter-physician variability.

Keywords: *Computer, electrocardiograms (ECG), reliability.*

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INTRODUCTION

Computerised electrocardiographic reporting has become more sophisticated and inexpensive, and its use has increased in general and hospital practice in the last decade[1]. We devised a study to assess the reliability of one such programme, the Marquette 12SL-SC (Marquette Electronics Incorporated, Milwaukee, Wisconsin, USA.). Two physicians independently read the electro-cardiograms (ECG) and the physicians' reports were compared with each other and with the computer analysis.

METHOD

Fifty consecutive ECG taken at the Penang Adventist Hospital on the Marquette 12SL-SC were studied. Two physicians independently read the ECG blind of the computer reports. The parameters reviewed were the ventricular rate, PR interval, QRS duration, QT interval and the overall diagnosis. The heart rate was taken over five RR intervals as measured in long lead II. The PR interval was taken from the onset of the P wave to the onset of the QRS complex as noted in lead II, this being the lead usually closest to the P wave axis[2]. If the P wave was not well visualised in lead II, lead VI was chosen instead. The QRS interval was measured from the onset of the Q wave to the termination of the S wave; the QT interval is that from the onset of the QRS complex to the termination of the T wave. The measurements were taken from lead II or leads V2 and V3, these being the leads with the most prominent QRS complex and T wave[2].

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Overall diagnosis was considered to be normal, abnormal or borderline (others). The physicians agreed that it was impractical to be restricted by rigid definitions of what was normal, abnormal or borderline. ECG were reported as they were in routine clinical practice. A normal ECG must be in sinus rhythm with a normal axis, normal intervals and normal waveforms. Borderline ECG were those likely to represent normal variants and included sinus bradycardia and sinus tachycardia, isolated left or right axis deviation, isolated voltage criteria for left or right ventricular hypertrophy, isolated ST segment deviation (upsloping depression < 1 mm or high take-off configuration) and minor T wave inversion. Abnormal ECG were those possibly associated with clinical abnormality. These included any arrhythmia other than sinus bradycardia and tachycardia, definite ST segment depression (horizontal or downsloping depression > 1 mm), pathological Q wave, ST elevation or deep T wave inversion, definite chamber enlargement (eg left ventricular hypertrophy with strain), and left bundle branch block. The computer definition of normal, abnormal or borderline is set out in its accompanying manual[3].

The computer measurement of rate, PR interval, QRS duration and QT intervals were compared with those of the physicians by randomised block design with analysis of variance to determine whether the measures were significantly different. When a significant difference was present, Duncan's Multiple Ranges were then applied to determine the level of significance. Statistical analysis on the diagnosis was by cross-tabulation comparing in turn Physician 1 with the computer, Physician 2 with the computer and Physician 1 with Physician 2.

RESULTS

In assessing the ventricular rate, the value as noted by Physician 1 was 76.54 ± 2.38 bpm, by Physician 2 was 76.66 ± 2.37 bpm and by the computer was 76.88 ± 2.43 bpm. There was no significant difference between these values ($p>0.05$).

In assessing the PR interval, the value obtained by Physician 1 was 0.173 ± 0.004 s, by Physician 2 was 0.174 ± 0.003s and that by the computer was 0.158 ± 0.003 s. There was no significant difference in the values obtained by the physicians ($p > 0.05$) but each was significantly different from the computer measurement ($p < 0.01$).

In measuring the QRS duration, Physician 1 recorded 0.097 ± 0.003 s, Physician 2 recorded 0.086 ± 0.003 s and the

computer recorded 0.095 ± 0.003 s. There was no significant difference between the values obtained by Physician 1 and the computer ($p > 0.05$). However the value obtained by Physician 2 was significantly different from that of Physician 1 and the computer ($p < 0.01$).

In assessing the QT interval, the mean value obtained by Physician 1 was 0.378 ± 0.005 s, by Physician 2 was 0.380 ± 0.005 s and by the computer was 0.389 ± 0.005 s. There was no significant difference between the values obtained by the physicians ($p > 0.05$), but the computer measurement differed significantly from each physician ($p < 0.01$).

Physician 1 reported 23 normal ECG, 15 abnormal ECG and 12 were borderline (others). Physician 2 reported 21 normal ECG, 16 abnormal ECG and 13 were borderline. The computer reported 20 normal ECG, 21 abnormal ECG and nine were borderline. There was a 68% agreement between the overall diagnosis of Physician 1 and that of the computer (Table I). There was a 78% agreement between Physician 2 and the computer (Table II), while the two physicians were in agreement in 76% (Table III).

DISCUSSION

There was marked interobserver variation in ECG reporting with the agreement between cardiologists independently reading ECG varying between 22% and 80%[1,4]. Our study was designed to simulate practical clinical conditions and the two physicians reported on the ECG as they would in routine daily practice without predetermined rigid guidelines. There was agreement in the measurement of heart rate, PR interval and QT interval. The same diagnostic conclusion was reached in 76% of the ECG. Given the difficulty of getting two physicians to agree on methodology of measurement of intervals and diagnostic criteria, this compatibility between physicians in our study is heartening. It also enables us to assess computer reliability by comparing computer-physician variability with the interphysician variability in ECG reporting.

Computer assessment of heart rate, PR interval, QRS duration and QT interval has been found to be comparable to manual reporting[5]. In our study, the PR and QT intervals assessed by the computer differed significantly from the physicians' readings. In our study both physicians measured the intervals to the nearest 0.01s while the computer measurements were to the nearest 0.001s. This may have contributed to the difference in mean PR and QT measurement. The difficulty of determining exactly when the P-wave began or when the T-wave terminated may have added to the problem.

Our study confirms the reliability of a computer generated overall ECG diagnosis[6,7]. In fact, if a physician reviews a computerised report, over 90% of the statements have been found to be retained[8]. The agreement between computer and physician in our study was between 68% and 78%. In no instance was an ECG reported as normal by the computer and assessed to be abnormal by either physician. The reliability of a computer generated normal overall diagnosis has been noted before[7]. This could be relevant in a busy unit where such normal ECG could receive less priority in subsequent physician review.

In conclusion, present day computer programmes are a significant advance on the initial types and are reliable in measurement of intervals as well as in reaching an overall diagnostic conclusion[1,6]. Computers however cannot replace humans and there is a need for all computer reports to be reviewed by physicians[5,7]. It is important to remember that the ECG is only one facet of the clinical work-up and must be considered together with other relevant clinical features.

Table I – Comparison of diagnostic conclusion of the computer with that of Physician 1

Physician 1 \ Computer	Normal	Others	Abnormal
Normal	17	5	1
Others	3	3	6
Abnormal	0	1	14

Percentage matching = $\frac{17 + 3 + 14}{50}$ x 100 = 68%

Table II – Comparison of diagnostic conclusion of the computer with that of Physician 2

Physician 2 \ Computer	Normal	Others	Abnormal
Normal	18	2	1
Others	2	6	5
Abnormal	0	1	15

Percentage matching = $\frac{18 + 6 + 15}{50}$ x 100 = 78%

Table III – Comparison of diagnostic conclusion of the computer with that of Physician 3

Physician 2 \ Physician 1	Normal	Others	Abnormal
Normal	18	2	1
Others	5	7	1
Abnormal	0	3	13

Percentage matching = $\frac{18 + 7 + 13}{50}$ x 100 = 76%

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