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Letter to the Editor

An observational study of the quality of ECGs recorded by inexperienced staff in a resource-poor African hospital using a reusable ECG belt linked to an internet ECG device

Sir

Although the electrocardiogram (ECG) is a rapid, valuable and non-invasive test, most machines are delicate, relatively expensive and require servicing and the use of consumables such as paper and electrodes. The secure storage of ECG tracings also incurs additional costs. All these factors limit ECG use and availability in the developing world [1]. This study reports the quality of ECGs recorded by inexperienced staff in a resource-poor African hospital using a novel ECG Electrode Belt system.

From August 16th to October 14th 2016 two recently qualified nurses who had never performed an ECG prior to this study, used the LevMed reusable ECG Belt (LevMed Ltd.) and the HeartView 12 L ECG device (Aerotel Medical Systems) to obtain a daily ECG on every acutely ill medical in-patient at St Joseph's Hospital, Kitovu, located near Masaka, Uganda. Since this belt system has a "one size fits all" design ulnar length and mid-arm circumference were measured to determine if body build influenced ECG quality. Clinical status and vital signs were also entered daily at the bedside into tablet computer program (Rapid Electronic Assessment Data System, Tapa Healthcare DAC), which automatically calculated the National Early Warning Score that we used as a measure of severity of illness. Ethical approval of the study was granted by the hospital's ethics committee.

The HeartView 12 L device uploads a signal from the patient to a cloud server, which then generates and stores an ECG report that is downloaded so that it can be reviewed on a tablet computer at the bedside. Since all ECGs generated by the system are stored, it is possible to determine how often an ECG tracing has to be repeated before one of acceptable quality is obtained.

The quality of all ECG recordings was assessed as follows:

- **Good:** free of all artefacts
- **Fair:** despite artefacts the tracing was still interpretable with certainty
- **Poor:** artefacts made it difficult to interpret the ECG with certainty
- **Unreadable:** so much artefacts that interpretation was impossible.

During the study period 734 ECGs were performed on 210 patients: of these 655 (89.2%) could be interpreted at the first attempt and only seven (1%) had to be repeated more than twice. Better quality tracings

tended to be associated with a shorter ulnar bone, a lower NEWS and a higher mid-upper arm circumference (Table 1). Unreadable tracings were associated with male sex (odds ratio 2.24, 95% CI 1.08 to 4.70, Chi square 5.88, p 0.03), a NEWS ≥ 7 (odds ratio 2.83, 95% CI 1.34 to 5.94, Chi square 8.22, p 0.004) and an ulnar bone length > 27 cm (odds ratio 2.76, 95% CI 1.05 to 7.67, Chi square 4.36, p 0.04). However, on logistic regression the only independent predictor for an unreadable ECG was an admission NEWS ≥ 7 [2].

This study showed that in a resource poor hospital inexperienced nursing staff performed ECGs of acceptable standard using the re-usable ECG belt: over 90% of the ECG recordings were interpretable after the first attempt and 99% after the second. The cost of performing ECGs and securely storing them was negligible, and the major determinant of ECG quality was the severity of illness.

There are many reasons why obtaining a good quality ECG may be more difficult in severely ill patients. Sick patients may be less cooperative, less likely to lie still while a recording is being made, may have tremors and other involuntary movements, and if severely dehydrated may have dry skin with a high impedance that impairs electrode contact [3,4].

A survey in Bangladesh reported that 10% of the ECGs had technical errors like limb lead switching, improper voltage standardization and improper pre-cordial lead placement induced errors [5]. In a South African study only 69% of ECGs performed by physicians' offices were considered acceptable: 18% had an unstable base-line and/or marked electrical or movement artefact and/or missing or illegible leads, 11% were either not standardised or recorded at the wrong standardisation, and 2% had leads incorrectly placed [6]. The re-usable ECG belt eliminates incorrect lead placement and the HeartView 12 L prevents improper voltage standardisation. The entire system was simple, intuitive, robust, rapid, had minimal power requirements, and tracings could be easily compared with previous tracings, which greatly increased the accuracy of their interpretation. In conclusion, the use of a reusable belt and an internet ECG device eliminated incorrect lead placement and provided affordable, practical and secure access to high quality ECGs in a resource-poor African hospital.

Conflict of interest

The authors wish to acknowledge and thank LevMed Ltd. (www.levmed.net) who provided the LevMed Reusable ECG Belt and the HeartView 12 L ECG device at no charge, and Tapa Healthcare DAC

Table 1

Mean NEWS, ulnar length and mid-upper arm circumference of different quality ECGs: SD = standard deviation.

ECG quality	Patient number	NEWS	Ulnar length (cm)	Mid-upper arm circumference (cm)
Good	510 (69.5%)	4.2 SD 3.0	27.6 SD 2.1	25.6 SD 4.0
Fair	145 (19.8%)	4.1 SD 2.9	27.7 SD 1.9	25.4 SD 4.6
Poor	43 (5.9%)	4.2 SD 2.8	27.9 SD 1.8	24.3 SD 3.9
Unreadable	36 (4.9%)	5.8 SD 3.5	28.6 SD 2.1	24.5 SD 3.4

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