A NOVEL ULTRASOUND BASED METHOD FOR SCREENING FOR HEART FAILURE

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Introduction

The ventricles accelerate and decelerate blood; the resulting disturbances propagate through the arterial system as waves. The magnitude and timing of these waves vary with cardiac performance and their speed depends on arterial stiffness. These properties can be studied by using ‘Wave Intensity Analysis’ (WIA), which is a method that describes the energies that drive arterial flow as distinct ‘waves’. WIA has been shown to be altered in heart failure with reduced ejection fraction (HFrEF) and thus has diagnostic potential. Routine clinical application of WIA has been limited, because conventional WIA relies on invasive catheter measurements of blood pressure and velocity. However, we have developed and validated a new non-invasive ultrasound-based method for WIA. We have previously shown in-vivo that this method allows accurate WIA compared to invasive catheter measurements in rabbits.

Aim

We aimed to evaluate the feasibility of using this novel non-invasive WIA technology to predict heart failure with reduced ejection fraction.

Methods

Patients attending outpatient Cardiology clinics and their accompanying friends and family were invited to participate. Diameter and velocity were simultaneously measured using an ultrafast ultrasound imaging system (Verasonics, Kirkland, USA). Blood signal was enhanced using spatio-temporal filtering. After applying standard cross-correlation techniques, a novel WIA formulation based upon diameter and velocity was calculated. Three ultrasound measurements of six seconds each were taken at each of the left carotid, right carotid and left or right brachial arteries. Post-processing and analysis were performed using custom-written software (Matlab). Heart failure was assessed by clinical evaluation. Echocardiography was performed by a trained echocardiographer to the British Society of Echocardiography guidelines within 1 year of the ultrasound measurements for all heart failure patients and for most non-heart failure patients.

Results

There were 227 attendances to the emergency department during the six months of the study period. 186 patients were admitted and 41 patients were discharged home. One patient visited the emergency department on 3 occasions therefore 39 patients attended the emergency department. The average age was 72.7 years with 59% male. A new diagnosis was established in 56% (22) with a pre existing diagnosis in the others. After the emergency department attendance 49% (19) had no follow up arranged. In 64% (25) no NTproBNP was undertaken. an echocardiogram was ordered for 28% (11). Patients not requiring an echocardiogram due to low NTproBNP or previous echo in last 6 months 30% (12). In 23% (9) none of the key indicators were undertaken; no NTproBNP, echocardiogram or follow up.

Conclusion

Nearly a quarter of patients 23% (9) were discharged from the emergency department with a diagnosis of heart failure and did not receive any of the performance indicators of NTproBNP, echocardiogram or follow up. It is unsure if these patients do actually have heart failure and potentially may have been started on inappropriate medication or if they indeed do have heart failure and are not treated appropriately with the impact of increased mortality and further readmissions. This is a gap that has been identified in our local heart failure service provision and suspect that such a provision gap may be widespread in other areas. A redesign of our service is intended to address this gap.

Conflict of Interest

None
with 41% and 40% of appointments respectively. A median of 8 minutes was spent by clinicians between patients. Patients’ median total waiting time, i.e. time spent in hospital by patients outside of consultations and tests, was 64.5 minutes (IQR 31.75 – 94.5). New patients had longer consultations on average, with a median of 28.5 minutes (IQR 21.5 – 37) compared with 18.5 minutes for follow-up appointments (IQR 13 – 24) (p = 0.018) and spent longer in hospital than follow-up patients (median time 150.5 minutes vs 101 minutes, p = 0.040). Estimated travel times were a median of 45 minutes in each direction (IQR 29 – 87), and therefore a median of 90 minutes for a round trip. The estimated combination of travel time and time spent in hospital was a median of 190 minutes (IQR 149 – 283). Figure 2 illustrates the breakdown of total patient time spent in consultation, investigation, waiting or in travel.

**Conclusion**
Most clinic appointments were delayed. Most patient time was spent in travel and waiting between activities on the day of a HF clinic appointment. There is huge scope for improvement in clinic efficiency and patient convenience by rationalisation of clinic services and increased use of telemedicine in HF.

**Conflict of Interest**
Dr Singhal’s salary is funded by a fellowship from Abbott.

**Estimations of Plasma Volume Status in Patients with Chronic Heart Failure: A Useful Tool for Diagnosing and Treating Congestion?**

**Introduction**
Neurohormonal activation in patients with chronic heart failure (CHF) causes plasma volume expansion which, if untreated, leads to overt venous congestion. Plasma volume status (PVS) can be estimated using formulae based on a patient’s sex, weight, haemoglobin and haematocrit. Such non-invasive methods to assess congestion may be useful, particularly in the wake of the COVID-19 pandemic. We compared the clinical value of two measures of PVS in a cohort of unselected outpatients with CHF (The Hull LifeLab).

**Formulae used to calculate plasma volume status**

**Hakim Formula**

\[
\text{Actual Plasma Volume (mL)} = (1 - \text{hct}) \times (A + (B \times \text{weight in kg}))
\]

\[
A = 1530 \text{ for men; } A = 864 \text{ for women; } B = 41 \text{ for men; } B = 47.9 \text{ for women}
\]

**Ideal Plasma Volume (mL)**

\[
C \times \text{weight in kg}
\]

\[
C = 39 \text{ for men; } C = 40 \text{ for women}
\]

\[
\text{Plasma volume status} = \frac{\text{Actual plasma volume} - \text{ideal plasma volume}}{\text{Ideal plasma volume}} \times 100
\]

**Duarte Formula**

\[
\text{Plasma volume status} = \frac{100 - \text{haematocrit} \%}{\text{haemoglobin (g/dL)}}
\]