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A comparison of two smartphone applications and the validation of smartphone applications as tools for fluid calculation for burns resuscitation

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ABSTRACT

We conducted a randomised, blinded study to compare the accuracy and perceived usability of two smartphone apps (uBurn© and MerseyBurns©) and a general purpose electronic calculator for calculating fluid requirements using the Parkland formula. Bespoke software randomly generated simulated clinical data; randomly allocated the sequence of calculation methods; recorded participants' responses and response times; and calculated error magnitude. Participants calculated fluid requirements for nine scenarios (three for each: calculator, uBurn©, MerseyBurns©); then rated ease of use (VAS) and preference (ranking), and made written comments. Data were analysed using ANOVA and qualitative methods. The sample population consisted of 34 volunteers who performed a total of 306 calculations. The three methods showed no significant difference in incidence or magnitude of errors. Mean (SD) response time in seconds for the calculator was 86.7 (50.7), compared to 71.7 (42.9) for uBurn© and 69.0 (35.6) for MerseyBurns©. Both apps were significantly faster than the calculator ($p = 0.013$ and $p = 0.017$ respectively, ANOVA: Tukey's HSD test). All methods showed a learning effect ($p < 0.001$). The participants rated ease of use on a VAS scale with a higher score indicating greater ease of use. The calculator was easiest to use with a mean score (SD) of 12.3 (2.1), followed by MerseyBurns© with 11.8 (2.7) and then uBurn© with 11.3 (2.7). The differences were not found to be significant at the $p = 0.05$ level after using paired samples *t*-test and a multiple correction was applied manually. Preference ranking followed a similar trend with mean rankings (SD) of 1.85 (0.17), 1.94 (0.74) and 2.18 (0.90) for the calculator, MerseyBurns© and uBurn© respectively. Again, none of these differences were significant at the $p = 0.05$ level.

1. Introduction

Fluid resuscitation remains a critical and challenging step in the initial management of major burn injury [1,2]. Numerous formulae have been described for intravenous fluid resuscitation; the most widely used is the "Parkland formula" developed by Baxter et al. [3]. This formula is based on total volume of resuscitation fluid to be infused, over 24 h of 3–4 millilitres-per-kilogram body weight per percentage total body surface area burned. Since the introduction of the Parkland formula in 1968 several authors have described various methods for calculating the fluid requirements using this formula [4–10].

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It is recognised that errors frequently occur in burn size estimation [11–16], and this will inevitably lead to inaccuracies in fluid resuscitation [16]. However, inaccuracies can also occur when using the Parkland formula, with one study showing that only 33% of surgeons and 17% of emergency medicine physicians were able to accurately calculate the initial fluid rate when using the Parkland formula from memory [8]. Another study of plastic surgery trainees, anaesthetists and burns nurse specialists showed that the fluid resuscitation requirement calculations were correct in only 55% of cases when using the Parkland formula [17]. A recent study by Theron et al. has attempted to quantify the magnitude of errors when using the Parkland formula – and has recorded errors of magnitude of ≥25%, ≥50% and ≥75% in 25%, 16.7% and 9.5% of calculations respectively for manual calculations, and 17.9%, 14.3% and 8.3% of calculations when a general purpose electronic calculator was used [18].

The last decade has seen an extensive development of smartphone technology and its evolving use and application in the healthcare sector [19]. This has been complimented by a steady increase in usage amongst doctors and medical students [20]. Further, the development of software applications (apps) related to medicine based on these platforms has added a new dimension to access and interpretation of medical knowledge. Apps have recently been developed for the calculation of fluid requirements following burns based on the Parkland formula. One such app, the Mersey Burns© App, has also been approved by the Medicines and Healthcare products Regulatory Agency (MHRA) authority as a class I medical device in the United Kingdom [21]. However there seems to be a lack of published literature assessing the validity or comparison between these smartphone apps and other methods for fluid calculation. The aim of this study was to compare two existing smartphone apps; the Uburn© and the Mersey Burns©; with a general purpose calculator method for calculating intravenous fluid requirements using the Parkland formula, using criteria of accuracy, response time and subjective ease of use (Figs. 1 and 2).

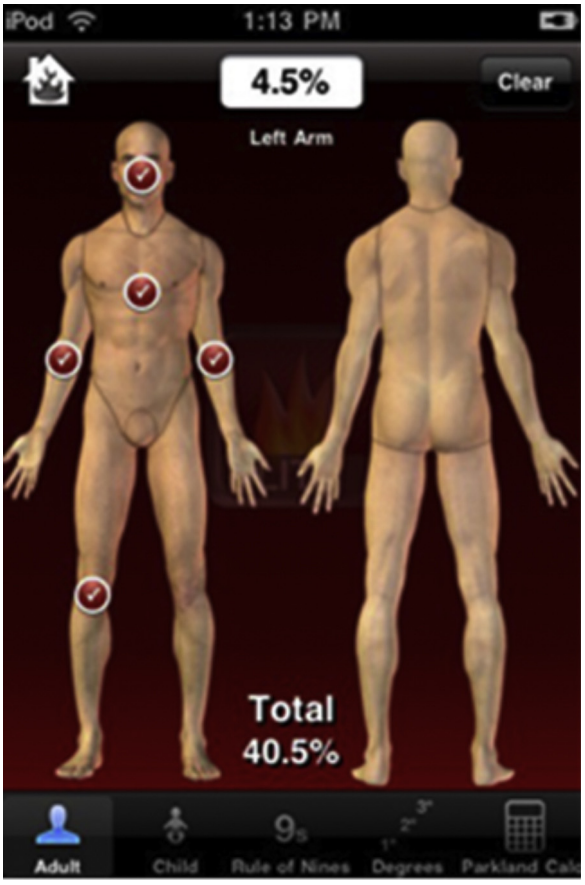

Fig. 1 – Screen shot of uBurn© application.

2. Method

2.1. Ethics

The study did not require a formal ethical review and appropriate letters of exemption were acquired from our National Health Service Trust's Research Ethics Committee and Research and Development office.

2.2. Design

We conducted an anonymised randomised volunteer study at our Regional Burns Centre from November 2012 to February 2013. Study design was based on and informed by similar previous studies [18,22]. The Uburn app© (JAMB innovations, London, UK), Mersey Burns© (St. Helens and Knowsley Teaching Hospitals NHS Trust) app and the calculator methods were assessed using a total of nine calculations per participant (i.e. three calculations using each method) over a 30–40 min period.

The choice of nine calculations per participant was an acceptable compromise between collecting sufficient data and potential bias due to participant fatigue. The null hypothesis was that ''There is no difference in accuracy or speed of calculation when comparing the three methods''.

Based on the data from a previous study [22] we found that the two most similar methods (Nomogram and Calculator) could be distinguished, in terms of error rates, by a sample size as low as 80 observations per method so required a total sample of $(80 \times 2)/9 = 17$ participants. To identify a 10% difference in response time (considered a lower threshold for relevance) we required a sample size of $n = 158$ individual calculations; or $(150 \times 2)/9 = 33$ participants. We therefore used this as a target our sample size, with the expectation of being able to distinguish between all three methods in regard to both response time and error rate.

In total 34 volunteers participated in the study, including trainee and consultant Burns and Plastic Surgery surgeons, anaesthetists and nursing staff. Individuals were not directly approached to participate. Recruitment of participants involved sending emails to all the doctors on the Burns and Plastic Surgery rota, all anaesthetists who cover the burns unit, and all senior nursing staff on the Burns unit. Awareness for the study was also raised at interdepartmental meetings. None of the volunteers were offered any financial incentives or benefit of any sort for participation; however, the educational value of experiencing new techniques in calculating burns