Microanalysis of simulated paediatric resuscitations to determine hierarchy for drug information in medication safety mobile application

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Background

Medication errors are the leading cause of preventable harm in healthcare systems worldwide [2], with an estimated 237 million medication errors occurring in the UK per year [1]. There is therefore much focus on identifying areas of high risk and implementing systems of design to promote safety in these areas [3].

Medication errors are up to three times more common in children than in adults [4]. Due to differences in size, physiology and metabolism across a large age range [5], children require individualised, weight-based doses, which are dependent on both a knowledge of the available formulations and the ability to calculate the correct preparation and administration requirements. In combination, these factors lead to greater likelihood for error [6].

The error rate climbs in high-pressure environments, as has been reported in 7 out of 10 simulated resuscitations [7]. Studies have shown that in paediatric resuscitations between 26% [8] and 70% [9] of all administrations are the wrong dose, with many being of large magnitude.

Phase 1 methods

30 immersive simulations of paediatric resuscitation scenarios were conducted in a London teaching hospital between April and October 2017.

60 study participants were recruited from across the paediatric emergency and general paediatrics departments. Teams consisted of 2 doctors (CT1+ and ST3+) and 2 nurses (Band 5+ and Band 6+), who are regularly involved in either the prescription of, or the preparation and administration of drugs to children.

High definition cameras were used to record the simulations which were then analysed by an experienced nurse using task microanalysis.

Each medication event was analysed as part of a comprehensive Human Reliability Analysis, including a Hierarchical Task Analysis (HTA). Systematic Human Error Reduction and Prediction Approach (SHERPA) error modes were applied to define process vulnerabilities to error.

Phase 1 results

362 medications were administered during the simulations, and these were analysed in detail against the HTA framework.

During this preliminary phase of analysis of the HTA and SHERPA error modes we were able to identify key areas within the entire medication process that are particularly susceptible to error.

One area we have chosen to focus on for this presentation is the way information resources were used during the medication process. Within this, three within-stage problems were identified:

- Excessive time taken to identify correct information
- Isolating dose instructions for a particular indication
- Inconsistent data represented across resources

One example error that highlights the problem is that of Calcium Gluconate for the treatment of hypocalcemia in a patient with severe hypotension.

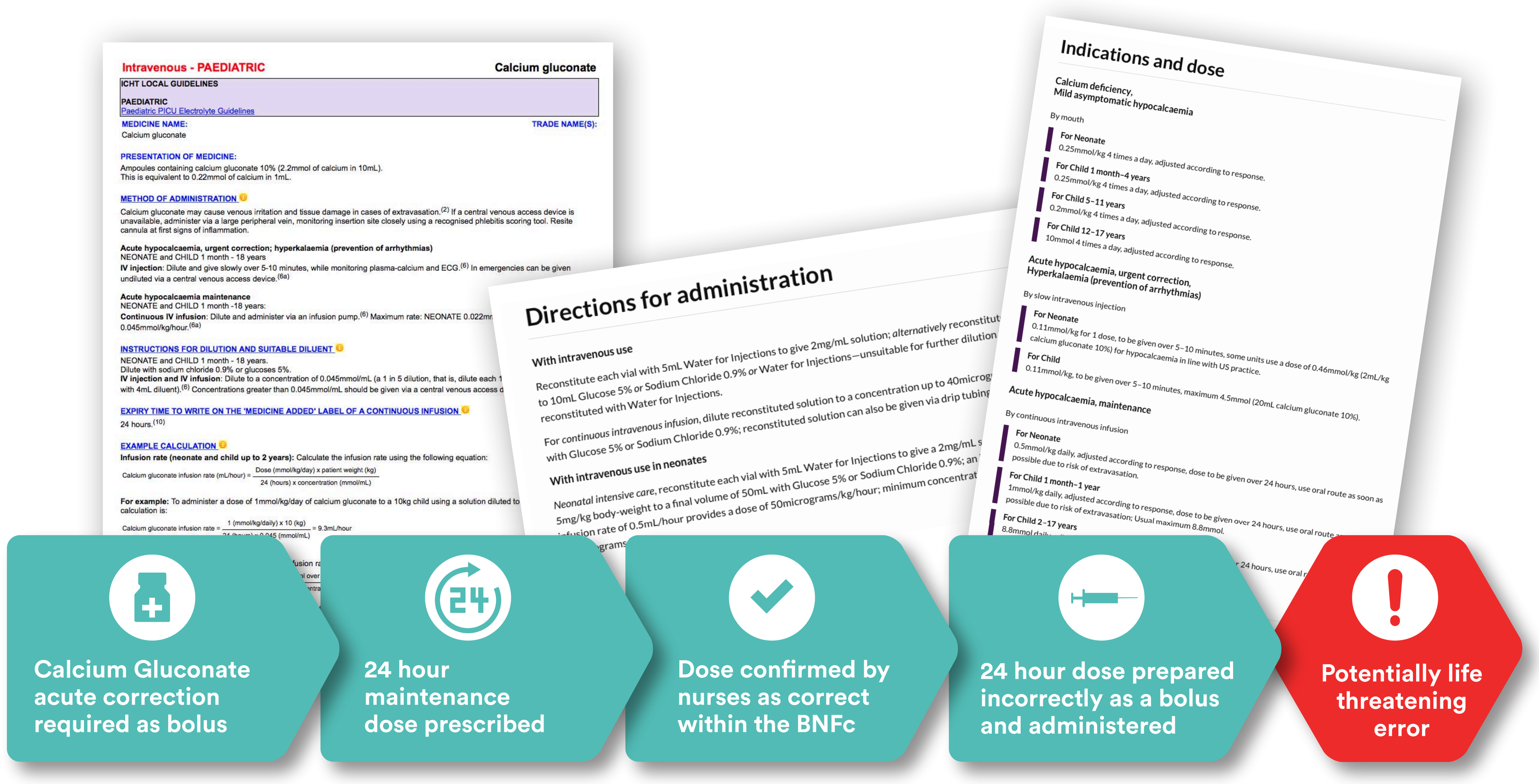

Fig 1. Examples of existing electronic information resources that led to the example error illustrated in the flow chart.

Phase 2

Our Human Centred Design (HCD) approach involved iterations of test and improve cycles. We prototyped ideas to be tested with representative end users. We record feedback to inform the next iteration. For example, our iterative process helped us uncover the challenges of expecting users to consult multiple sources of information in drug preparation, leading to our unified experience within one software application. Every feature within the application has been validated through user involvement, both in terms of purpose and ease of operation.

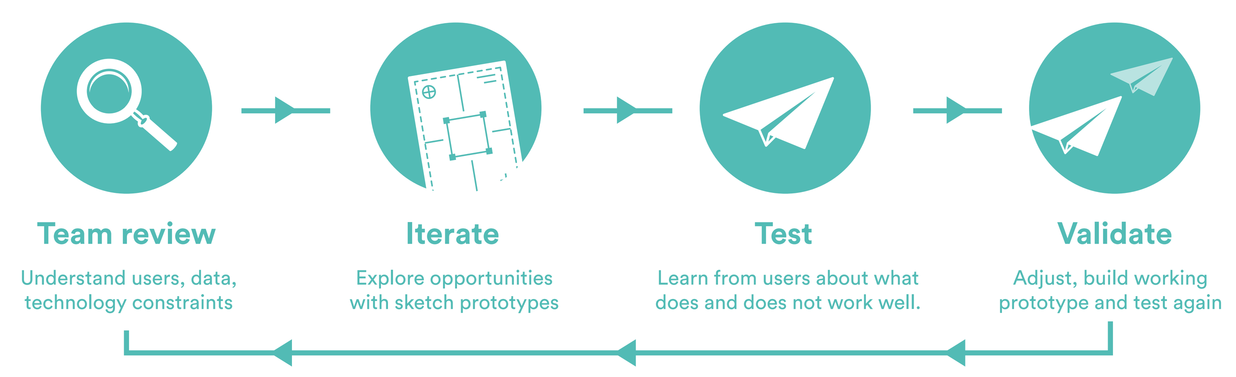

Fig 2. Schematic of the iterative human centred design process

Our human-centred design principles

1. Our users' requirements directly lead technological development.
2. We streamline the user's experience to deliver the right information at the right time; but recognise that the process is not always linear and that the user needs the ability to navigate all the available information intuitively.
3. We design to build on existing habits, skills and intuitions, rather than requiring significant changes to user behaviour.
4. We provide choice and control to the user, the product should recognise and reinforce the user's knowledge and skill.

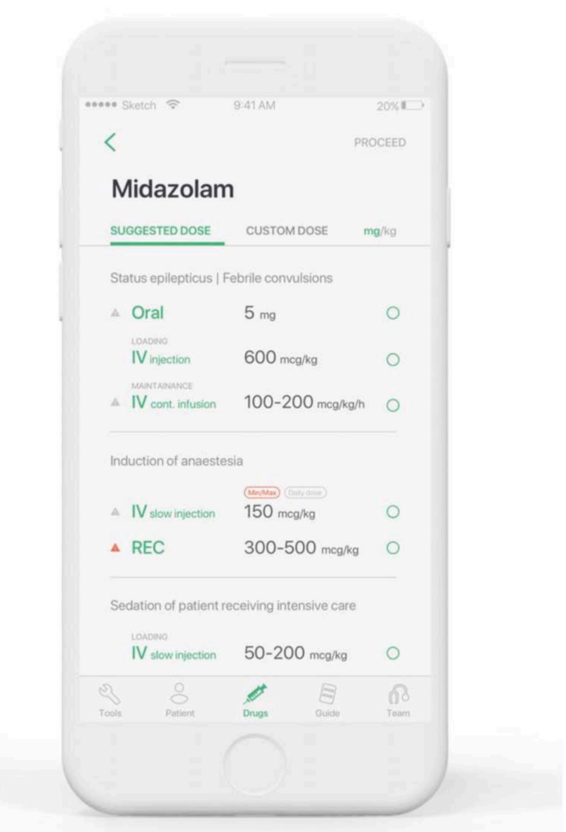

Fig 3. A 'suggested dose' screen from our smartphone application.

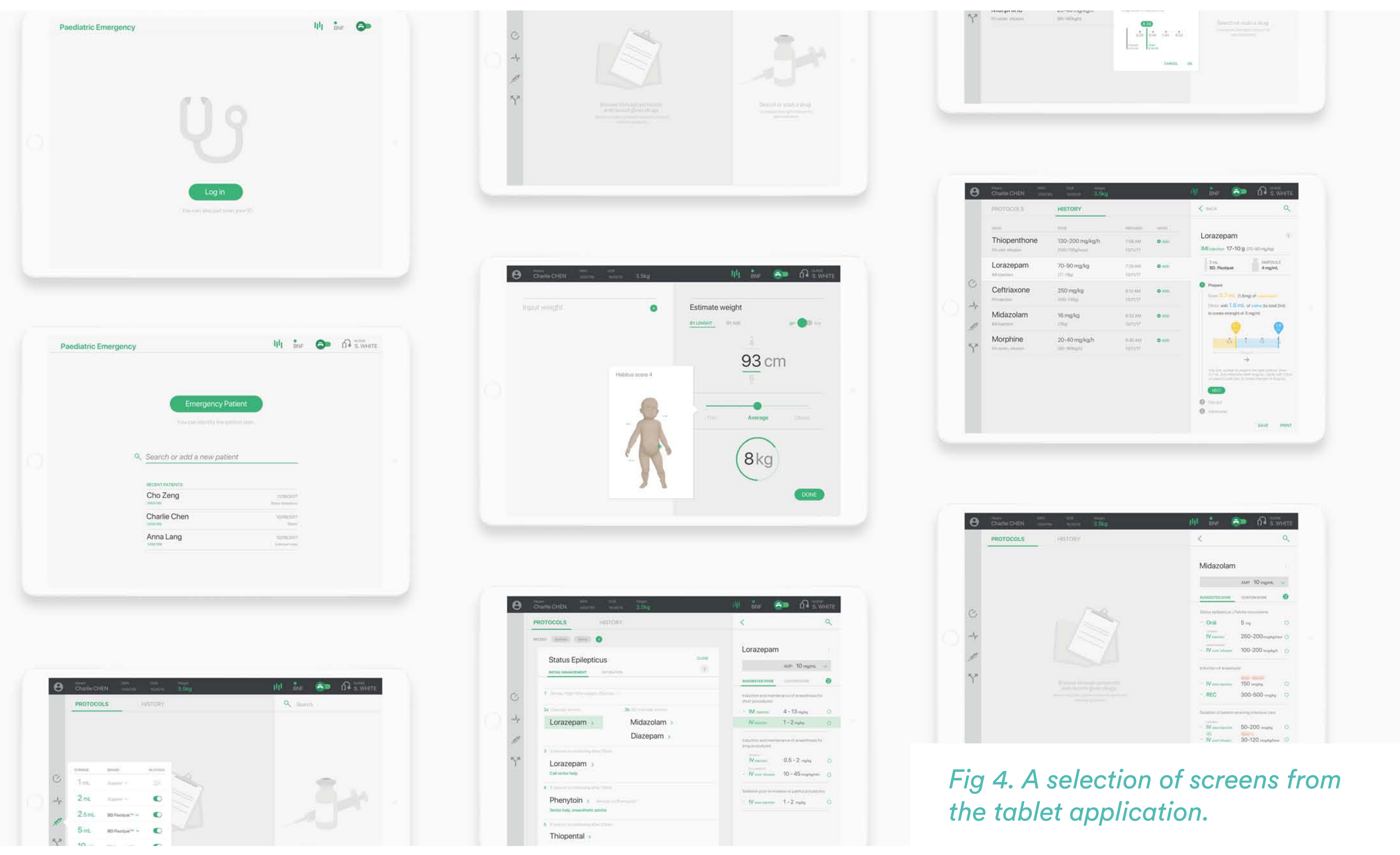

Fig 4. A selection of screens from the tablet application.

Conclusion

We applied a Human Centred Design methodology to transform the HTA findings into an optimised user-journey, identifying touch-points for design solutions, followed by design-test-iterate cycles. This process ultimately yielded novel mobile application designed to support the safe preparation and administration of drugs to children. This new mobile application will now be piloted in a paediatric clinical setting in 2019.

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