Upscaling Anaesthesia through Technology in Low Resource Settings: Lessons from Lifebox

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INTRODUCTION– FACING THE CHALLENGE OF GLOBAL ANAESTHESIA

We face a massive deficit in global surgical and anaesthetic provision; 5 out of 7 individuals worldwide lack access to safe, affordable surgical and anaesthetic care[1]. Regarding anaesthesia, multiple factors hinder its safe delivery, including a lack of equipment, drugs, trained workforce and infrastructure[1,2]. Tackling the anaesthesia shortfall will be a long term commitment -measures such as anaesthetist training and infrastructure implementation will take years[3,4]. Technological innovation provides a potential solution for ameliorating some of the barriers faced in anaesthesia delivery[5–8], although it is not without its challenges, as can be seen in the example of the Lifebox Pulse Oximeter; this case study aids in exploring the wider principles underlying successful anaesthetic tech design.

CASE STUDY: LIFEBOX PULSE OXIMETER

Development and Design

- Pulse Oximeters are considered essential for the delivery and management of safe anaesthesia[9,10], however estimates suggest 20% of theatres worldwide (and over 70% in some LMICs) do not have access to a single oximeter[11]
- This influenced Lifebox to specifically design their pulse oximeter for use in low resource settings[12] (Box 1)
- They conducted extensive groundwork—particularly in terms of power sourcing, maintenance and operability —aiming to avoid the "equipment graveyard" faced by up to 70% of medical equipment in LMICs[6] (often due to failed compatibility)
- The ongoing demand, distribution and training by Lifebox would appear testament to the success of their tech design and extensive groundwork[10,13,14] (Box 2)

Box 1—LIFEBOX' PULSE OXIMETER SPECIFICATIONS[15]

- ***Durable***
  - *2 year warranty*
  - *Rechargeable batteries*
  - *10h+ runtime*
  - *Power surge protected*
- ***Cheap***
  - *≈£200/unit*
- ***Ease of Operation***
  - *Paediatric and adult compatible*
  - *Instructional DVD (10 languages)*
  - *Online troubleshooting*

Figure : Lifebox Oximeter[21]

BOX 2—PULSE OXIMETER REACH

Since 2011[16]*:*

- *18,000+ oximeters distributed*[14] *(n over 90 countries)*[13]
- *10 million operations facilitated*[16]
- *6000+ individuals trained*[14]
- *3000+ hospital partnered*[14]

Lifebox's success: avoiding the equipment graveyard[22]

Oximeter Outcome Monitoring

Despite Lifebox's success in terms of oximeter demand and delivery, the project has shortcomings in terms of its **evaluation** :

- Lifebox is a charity[16], so there may be an element of **bias** in its reporting
- There has been **no global review**—independent or otherwise—of Lifebox oximeter impact on **clinical outcomes** to date
  - *3 country based studies did demonstrate that Lifebox had improved prevalence of oximetry monitoring and earlier detection of hypoxia during anaesthesia*[17–19] *. However they did not discuss whether the infrastructure was available—e.g. 02 delivery systems, a dedicated anaesthetist on hand - to respond to a hypoxic event , which is the ultimate influence on clinical outcomes and oximeter success*
- **Oximeter functionality** must also be considered, e.g. device **longevity** or whether it remains in the same distribution **location**.
  - *Lifebox have sent back teams to monitor individual projects —e.g. assessing oximeter use and repairs in Guatemala over 2 years*[20]*— however this is again on a country basis rather than a universal scale*

Of course, in low resource settings, it is likely that long-term follow-up is challenging –particularly if we wish to compare anaesthetic outcomes with those pre-Lifebox, where such data may not have been collected—however, this reiterates the need to incorporate strategies for evaluation during the design process, both to assess functionality and refine future designs.

CONCLUSION

Lifebox illustrates crucial considerations that must be made in the design of wider technologies for successful anaesthesia upscaling (see Box 3).

For the long term, the ethics of introducing a technology and the transferability of an innovation (should a new disruptive technology arise) must also be considered. Ultimately though, no single piece of tech—no matter how innovative or well designed—will solve the problem of global anaesthesia; this will require multi-specialist collaboration and investment across all current infrastructural barriers before universal, safe anaesthesia can be realised.

BOX 3— KEY MESSAGES FOR LOW RESOURCE TECH DESIGN

- *Context Based Design*
- *Integrates well with current infrastructure*
- *Easy Maintenance*
- *Training Strategy*
- *Evaluation Plan*

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