Closing the Virtuous Circle: Making the Nuances of Infusion Pump Use Visible

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Infusion pumps are sophisticated, safety critical devices that are used by people with a range of skills and backgrounds. Errors with various degrees of severity have been reported in their use, e.g. (ISMP, 2007), and they have been implicated in many medication errors (e.g. Husch et al, 2005). These incidents are typically not due to device failures, but to pumps being used in ways that were not anticipated by their developers. An example would be the avoidance of, or need to work around, Dose Error Reduction Systems (DERS) on IV infusion pumps. Such systems are designed to protect patients and users by limiting the potential for inadvertent, incorrect programing (Sims et al, 2010), but may not take into account specifics regarding the context in which they are being used (AAMI/FDA, 2010).

One of the challenges in developing infusion pumps that are fit for purpose is that they are used pervasively across many branches of healthcare for delivery of various treatments to people with many different conditions (Iacovides, Cox & Blandford, 2013). If intravenous medication and other procedures involving infusion devices are to become safer then there needs to be convergence between the ways they are intended to be used and the ways they are actually used in practice. This is a concern for all involved in the development, regulation, procurement, training and use of infusion devices.

Many factors influence the design of next-generation devices, including regulation and standards, and procurement policies and practices. In turn, the design of devices, local policies about use and the ways in which staff are trained influence performance. In principle, there should be a virtuous circle in which an understanding of actual use informs future regulation, procurement, design, policy, etc. However, this can be difficult to achieve in practice. Real performance is currently often invisible, and reports where actual use deviates from intended use tend to be dismissed as anecdotes, deviant behaviour, "off-label use", violations, etc. Post-market surveillance typically focuses on reported incidents and major problems. It is difficult for a rich understanding of real performance to feed back and influence regulation and procurement.

Without a complete loop in which understanding of actual use feeds into design, we end up with pumps that are not fit for purpose and whose safety is therefore compromised. The potential for a virtuous circle is missed because the feedback loop is broken. The aim of this paper is to "make visible", and give a voice to, some of the less prominent, but nevertheless important, activities that exemplify real practices that result from the design, policy and training decisions that precede them. We do this by summarizing issues that we have identified across a number of studies of infusion pump use and training and, where possible, the factors that shape behaviours.

Our paper includes examples from both published papers and work-in-progress, that describe nurse training, critical care, oncology, hematology, emergency room, surgery and medication administration record design (e.g., Rajkomar & Blandford, 2012; Furniss, Blandford & Mayer, 2011; Back & Cox, 2013). These examples of real practice cover only a small part of the space of all practices. But by "making visible" these practices, we move a step closer to being able to reason about implications for design, not just for devices but also for surrounding systems (prescribing, training, procurement, regulation, etc.), as well as implications for use (e.g. standardizing best practice within particular contexts).

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