DANGER: This alert might be dangerous
The human factors of alert design

Have you ever tried to buy a train ticket from an automatic ticket machine and struggled with the task? Or the reverse – bought a movie ticket from an automatic machine at the cinema only to be surprised at how quick and easy the task was? We encounter examples of well-designed and poorly designed systems every day.

Just pause for a moment and think about the technology you have to hand right now. Is it easy to use? And – to raise the stakes – what about the alerts that pop-up when you’re using electronic medication management at work?

Human Factors (HF) is the scientific discipline that applies evidence-based methods and knowledge about people to design and improve the interaction between people, systems and organisations.1 The goal of HF is safe and optimal performance, and this is achieved by ensuring there is a good fit between people and the environment in which they work.

While health care has lagged behind other industries (e.g. transport, nuclear power) in its recognition and adoption of HF methods and approaches, momentum is building, with HF researchers and practitioners beginning to permeate many aspects of the healthcare system. In this article, I will focus on the application of HF to computerised alert design and describe some of the studies we have conducted to evaluate and improve alert design.

WARNING: This warning isn’t well-designed

There is a large body of HF literature focusing on principles of good warning design. This tells us that a good warning should be structured in short, concise statements and should include four key components: a signal word, a hazard statement, a consequence statement and a recommendation for avoiding the hazard (see Figure 1a).2, 3 In applying these principles to medication safety alert design, a well-designed alert should look something like Figure 1b. Does this resemble the
computerised alerts you encounter in your electronic medication management (EMM) systems?

Poor alert interface design is a frequent complaint from users of EMM systems, so we set out to test alert design in a systematic way. We reviewed drug–drug interaction alert interfaces from eight computerised systems currently in use in Australia (inpatient and outpatient) and assessed them with respect to their compliance with HF principles. 4, 5

You can probably guess what we found. All alerts complied with about half the principles of good warning design.

We have lots of work to do to improve the design of our computerised alert interfaces, but we’re faced with a significant challenge: how do we get alert designs changed? What’s in it for vendors? Happier users? Simulation studies in the US have shown that applying HF principles to improve alert design results in more efficient prescribing, improved satisfaction, reduced workload, and fewer prescribing errors. 6, 7 I think this provides us with a solid foundation when making the case to get our alert interfaces up to scratch!

CAUTION: This caution depends on your context

In addition to the design of alert interfaces, there are many other challenges associated with alert design in EMM systems. Alert fatigue is a common problem both internationally and here in Australia. 8 This well-known phenomenon describes the situation in which users experience so many irrelevant alerts that they begin to ignore all alerts presented – even those that are clinically relevant. This is unsafe (more unsafe, in my opinion, than having no computerised alerts in a system) because critical information can easily be missed. To minimise alert fatigue, we need fewer alerts and smarter alerts, both tricky things to achieve – and a big enough topic that this requires a whole other paper.

Another key factor impacting alert effectiveness is context of use. A powerful method used by HF researchers is observation of people using tools and technology in practice, as this often uncovers numerous problems with a system not identified during development or testing. This is because the context in which a system is used can have an enormous impact on how a system is used.
We ran a series of observational studies in a Sydney teaching hospital to determine what impact computerised alerts were having on prescribing behaviours. We shadowed teams of doctors during ward-rounds and junior doctors after-hours and noted all alerts triggered, if the alerts were read (we were very lenient in how we defined ‘read’), and if the alerts had any influence on prescribing decisions.9–12

We uncovered a very interesting thing. After my initial shock on discovering how fast-paced, cut-throat and hierarchical ward-rounds were subsided, it became immediately apparent that the alerts being triggered during ward-rounds were targeting the wrong person. Senior doctors were making the prescribing decisions, but junior doctors were the ones entering orders into the EMM system. As a consequence, we saw very few alerts being read and no alert resulted in a change to a medication order. Perhaps it’s not so surprising that none of the junior doctors questioned a senior’s decision to prescribe a medication following the triggering of an alert. In contrast, after-hours, we saw junior doctors read most of the alerts triggered. This research highlighted that the primary end-users of alerts are junior doctors and the primary context of use is outside ward rounds. So, let’s think carefully about who we involve in the decision-making processes surrounding alert selection, design and monitoring.

**ALERT: This alert isn’t evidence-based**

Our research has shown that decisions about what alert(s) to include or exclude from EMM systems are driven by four main factors: (1) local governance groups, (2) vendor recommendations, (3) the perceived usefulness of alerts, and (4) evidence of alert effectiveness.13 As a researcher, I am a little worried about #2 and intrigued by #4.

I have a particular interest in drug–drug interaction (DDI) alerts, as these are the most widely implemented alert type in our EMM systems. In our survey of 26 Australian hospitals, 93% of the implementation leads indicated they believed there was evidence to show that DDI alerts improved prescribing behaviours and patient outcomes.13 But we turned to the literature and found very limited evidence of this. We identified a number of studies which showed that a single DDI alert can lead to a reduction in the concurrent ordering of two medications,14, 15 but found no research examining the impact of DDI alert sets (i.e. a suite of DDI alerts, not a single DDI alert) on DDIs or patient outcomes.

In fact, our systematic review – which attempted to bring together all the literature on DDIs in hospitalised patients16 – showed there is limited evidence to suggest that DDIs are a problem at all. Although roughly 33% of patients experience a ‘potential’ DDI during their hospital stay, we found only one study which examined what proportion of these DDIs are clinically relevant to patients, and what proportion led to patient harm. This latter proportion is likely to be somewhere around 1–2%.

With a dearth of evidence available on the prevalence of DDI-related harms in hospitalised patients and on the effectiveness of computerised alerts to prevent DDI-related harms, organisations are faced with a difficult decision – should they turn DDI alerts on? This brings to mind an interesting question: should decisions about computerised alerts – and digital health interventions more broadly – be

> For computerised alerts, there is a well-documented negative consequence of implementing too many alerts (i.e. alert fatigue), potentially putting patients at risk.
Take these steps, and the result is likely (I think very likely!) to be happier and more efficient users, more effective alerts and, ultimately, improved patient safety.

REFERENCES