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Improving handovers by learning from Scuderia Ferrari

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Introduction

It has been nearly a decade since seminal reports and associated research documenting the surprising frequency of accidental injury in healthcare were published in the UK and around the world (Vincent, Neale and Woloshynowych 2001). Around that time, complex and systemic causes of a sequence of probable accidental deaths at the Bristol Royal Infirmary were emerging, while research at Great Ormond Street Hospital was finding that small, seemingly innocuous events could accumulate to affect mortality and morbidity (de Leval et al. 2000). In these incidents, the technical challenges of complex surgery in very high risk patients meant that teams were sometimes unable to prevent errors that subsequently affected patients.

All complex systems are faced with the same problem: although humans are fallible and make mistakes, they cannot be designed out. This is not just because humans design, maintain, operate and promulgate technology, tools and tasks that allow regular systems function, but also because they keep all these disparate components together. Complex systems themselves are naturally unsafe. It is the people and teams within them that allow them to achieve high standards (Dekker 2002).

It is with this in mind that there has been much speculation on how to learn from other industries to address safety issues. We at Great Ormond Street Hospital were able to learn from the Ferrari F1 team, which comprises a complex system, and apply this knowledge to improving a critical handover process, thus developing new ways to think about safety in high risk surgical care.

High Risk Handovers

Providing continuity of care between frequently changing teams is an area of vulnerability in any complex system. With the increasing transfer of patients between clinical areas, and the reduction in working hours following the European Working Time Directive, continuity of care has vastly increased in importance in the clinical field. The transfer from the operating theatre to the intensive care unit is one of the most difficult stages in the care of a child, concluded Kennedy (2001). These children, often only days old and having had a hugely invasive surgical operation, can be extremely unstable and will require support from a wide number of inotropes, vasoactive agents, other drugs and several invasive monitoring lines. They need to be moved from safe ventilation and monitoring to portable equipment while they are transported a short distance into the ICU (in Great Ormond Street Hospital this was only 30 or 40 meters). Here they are returned to safe monitoring and ventilation. Bed space is configured around these patients, with infusion pumps placed on a stand and plugged into the power socket, and monitoring lines plugged into the monitors, which are then appropriately zeroed. During the same period, the surgeon and anaesthetist hand over to the receiving doctors and nurses in the ICU the vital information required for the care of the patient, which they have gathered during pre-operative assessments and several hours of surgery. At this point, the ICU staff may have little knowledge of the patient.

Thus, there are two critical safety tasks that occur at the same time: the transfer of the monitoring and life support equipment, and the transfer of information. Our early observations suggested that things did not always go smoothly in this risky stage of operations. Sometimes the patient was on portable monitoring and support equipment longer than they needed to be because either the teams did not know which bed space was being used; the bed space was not prepared; the correct monitoring lines or data interfaces were not immediately available; or the ICU ventilator needed configuration before the patient could be safely put onto it. Sometimes the infusion and monitoring lines were cluttered or tangled, and sometimes the infusion pumps were not plugged in and eventually ran out of battery power. Also, the receiving ICU staff may not have been aware of a patient's imminent arrival so they were not always immediately available. Another important issue was that sometimes the verbal handover was conducted at the same time as the equipment was set up, thus stretching human cognitive resources and inviting information degradation. At other times, the full set of information was not handed over.

Though it is possible to argue that these small problems were not affecting patient care, our research (Catchpole et al. 2006), and the work of others in the growing field of patient safety, was starting to suggest that the small things really do matter. The high risk of handovers was identified in the Bristol Royal Infirmary enquiry, while previous research at Great Ormond Street Hospital found problems in handovers, with several recent events and near misses identified to be partly attributable to this poor performance. We felt that these risks could relatively easily be reduced by small process changes, but we needed to understand how.

Learning From Other Industries

High risk industries usually manage to function effectively and to a high degree of safety in extremely adverse environments, with a huge literature covering the field. Nevertheless, serious accidents can be found in all these industries: Piper Alpha (Oil), Chernobyl and Three Mile Island (Nuclear), Challenger and Columbia (Space exploration), Tenerife and Kegworth (Aviation), Aryton Senna (Formula 1). The key is that in all areas, it is possible and necessary to learn from past tragedies. Rather than blame individuals, we need to understand how teams came to make the critical mistakes that they did, and build better systems of work around people to encourage the avoidance, identification and mitigation of errors before they can lead to more serious consequences.

Indeed, the notion that is conveyed through these industrial analogies is that the optimisation of human performance at the centre of every system can be approached through the application of science to the design of technology, the working environment, tasks, training, and even organisations. This approach is known as human factors, and it has helped make high- and low-risk industrial processes, and a wide range of consumer products, including cell phones, software, and even toothbrushes, more reliable, easier to operate, and safer to use. The key to learning from other industries is in translating their positive principles to the new context.

While researching ICU handovers, intensive care specialists Allan Goldman and Nick Pigott, and surgeon Martin Elliott, recognised through their shared interest in motor racing that a handover might have similarities to a pit stop. Just like a handover, a pit-stop requires a team of specialists to co-ordinate and work together under time pressure, to perform a complex technical task to a high degree of accuracy, in a changing and rapidly evolving situation.

Learning From Ferrari

I, Dr. Ken Catchpole, author of this article, joined the project team, and the two ICU doctors and I were invited to the Ferrari headquarters in Maranello, Italy to discuss pit stops with the race technical director. We showed him a video of our process and discussed at great length how Ferrari achieved the performance levels in pit stops that we sought. Upon return to the UK, we were also able to obtain the views of two British Airways pilots on approaches to structuring teamwork and communications.

Earlier, a Failure Modes and Effects Analysis had been conducted to understand where the biggest risks in the process might lie. After deliberating at some length over the lessons learned and how we might translate them into the highly technical tasks of ICU handovers, we eventually derived a process that included the entire range of elements that we had learned.

The New Handover Process

The new handover was a four stage process. First, we asked the anaesthetist to fill in a standard form that detailed the ventilator settings and bed space configuration that would be required for the patient upon arrival in the ICU. They would contact the ICU approximately 30 minutes before the patient was due to be transferred so that the receiving nurse could collect this form from theatre. This meant that the bed space, ventilation and all required monitoring interfaces could be prepared beforehand, minimising the time that the patient was off stable monitoring and ventilation. It also meant that the receiving ICU team knew exactly when to expect the patient.

Upon arrival in the ICU, the equipment was set up without any verbal handover. Each team member had been assigned a specific role, so everyone knew exactly what should be happening. The lead anaesthetist then made a safety check to ensure that all the monitoring was reading as expected, the ventilation was appropriately configured, and the infusion lines were untangled.

The third stage of the process was the verbal handover, which was given a specific order and rhythm. The outgoing surgical team and the receiving ICU team all grouped at the patient's bed to listen to the anaesthetist, followed by the surgeon, provide information. The entire team was then provided the opportunity to pose questions and discuss the situation. The receiving doctor used an information transfer aide memoire, a form or checklist specifically designed for this process, to prompt and record the transfer of the appropriate information. Once all the blanks on the form were filled (or discussed where missing), the form was placed in the patient's notes and acted as the admission note to the ICU, saving everyone time.

At this point, transfer of responsibility of the patient to the ICU team was complete, so in the fourth stage, the team (still including the surgery team) discussed the expectations for this patient. These were grouped into one of four categories of risk and further treatment, from immediate waking and extubation through six-hour and overnight reviews, to the expectation of high risk for extracorporeal membrane oxygenation (ECMO).

Importantly, and in contrast to both aviation and motor racing, the new process could be trained in 20-30 minutes. This is key, given the high turnover of staff and trainee doctors.

Formulating Change

At the time we conducted this work, the idea that the way change is made can be as important as the change itself was not as widely acknowledged as it has now become in patient safety (McGrath et al. 2008). We certainly encountered resistance from some doctors and nurses who failed to see the relevance of learning from other industries, or the need to change existing practice. Nevertheless, we were able to quickly introduce the new protocol, in part because it reflected a number of successful elements that are now more widely understood to be important for establishing new working methods. These included:

- **Recognition of the Need for Improvement.** The burning platform of the handover process was recognised following a number of incidents within the unit, as well as substantial prior research evidence. Overall, several anaesthetists were unhappy with the previous process, as handing over high risk patients without being assured of reliability made it difficult to trust receiving doctors;
- **Inspiration for Change.** Helping people to step outside their normal working pattern to see how differently things can be done can be a really valuable technique for triggering change. It helped to raise aspirations for something better. The media interest surrounding the project, though clearly not replicable, also helped
- **The Benefit of Human Factors Involvement in Solution Development.** Systems are complex and interacting, so successful change needs to occur and be understood at a variety of levels within the system to provide the opportunity for achieving the goal of behavioural change. Solutions need to be multi-dimensional and human factors science provides a far greater range of solutions than might be achieved through uni-dimensional, analytical or interventional approaches;
- **Direct Involvement of Senior Stakeholders.** Having both the senior intensive care specialists and the most senior surgeon directly involved with the process was essential. During the project, particularly in the change period, we also involved a senior anaesthetist and a senior nurse. All commented on and adapted the process so were able to feel some ownership over it; and
- **The Intervention was Multi-Dimensional.** The nature of the intervention, including checklists, defined processes, teamwork, leadership, and task allocation, meant that if one component was not reliably taken up, the entire process would not fail.

Positive Evaluation

Change without evaluation is risky. It is important to know whether the alterations have indeed helped to forge improvements. This can provide more incentive for change to those staff members who are still resistant, reducing the risk of reverting to old, less reliable processes.

Long before visiting Ferrari and developing the new process, we designed a set of observational measures based on process, teamwork and information exchange. A 16- item checklist was used to evaluate the ease of equipment transfer in the handover process, and any deviations from the optimal process were marked down. Meanwhile, teamwork was scored with a five-point anchored likert scale on four dimensions: leadership and teamwork; task management; workspace and equipment management; and situation awareness. At the same time, information transfer was scored on a 17-point scale, assessing whether there had been any omissions. Finally, the duration of each handover was measured to counter criticism that there wasn't sufficient time to conduct the new process.

Twenty three handovers were analysed before the changes were made and 27 were evaluated afterwards, with improvements noted on all dimensions measured. However, the data also revealed more differences between the old and new processes. Beforehand, poor information transfer was correlated with poor equipment transfer, but after the alterations this correlation was almost non-existent. In other words, while the new process was still not always perfect, the errors were less likely to escalate during one handover. Given that it is this 'domino' effect that increases risks to patients, our new process demonstrated the vital improvement sought.

Furthermore, by providing a structure and common way of working, we were able to help those really good teams perform exceptional handovers, while preventing the less effective teams from going too far wrong.

The final confirmation that this had been a success came in other forms. This new way of working was sustained for at least two years, after which personal reports suggested that the anaesthetist had been able to trust the process, and thus the care that the ICU doctors would provide to patients. Moreover, in discussions many months later, anaesthetists were heard to say; "This is great – but we can make it better". That signal of the desire to continually learn and improve was truly the sign of high reliability.

Conclusions

We were able to improve our vulnerable processes by translating good practice found in two industries – aviation and motor racing – into healthcare. We were able to do this by taking into account the subtle complexities of healthcare and developing a solution upon multiple dimensions, rather than a single one, while sensitively involving all the major stakeholders in the implementation of change, and conducting a detailed evaluation to show that it worked. Change in healthcare is not easy, as safety improvements are constantly threatened by organisational and financial pressures to be more efficient; however, accepting things as they are and failing to learn from mistakes is something that should not be excused. Whether that inspiration comes from fast cars or jet aircraft, it is essential for the future of healthcare.

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