ICU MANAGEMENT & PRACTICE

# ICU Volume 12 - Issue 1 - Spring 2012 - Cover Story

## New Ambulance Concepts to Improve Care in the ICU?

**The Helen Hamlyn Centre for Design at the Royal College of Art in London has a focus on people- centred and inclusive design. From its origins, researching and designing for an ageing population, its work has grown over the past 20 years to encompass better healthcare and better workplaces, because many people now live and work longer despite age-related changes in their abilities. To focus on these increasingly important matters, the centre has developed three research labs: the Age & Ability Lab, the Work & City Lab and the Health & Patient Safety Lab.**

#### Introduction

The Health & Patient Safety Lab has made a significant impact through research and design projects, having reduced medical errors through better infection control; better labelling and packaging of medication; improved infusion pump interfaces; better surgical instruments; and safer and more effective resuscitation trolleys and neck immobilisation collars. It has also designed products with patients' self-esteem in mind, and used design to reduce violence and aggression in accident and emergency (A&E) departments.

This article focuses on Helen Hamlyn Centre for Design's work on ambulance design since 2005. It is relevant here because there are many similarities with ICU design, and the same methodology could probably deliver worthwhile improvements in ICU settings. The UK's ambulances are sometimes referred to as A&E vehicles, because that is almost always their field of application; however, from time to time they serve temporarily as the nearest thing to the ICU for critically unwell patients.

The ambulance dates back to horse-carts used in the Crimean War to transport wounded soldiers back from the battle line, and they have only developed incrementally since then. Clinical science has meanwhile progressed, and the need to design a treatment space fit for purpose within that clinical reach is long overdue. This paper considers whether the ICU has also developed only incrementally while clinical science and available technology has progressed, and would also benefit from a fresh design approach.

#### Project History: Innovative Ambulance Design

In 2005 we at Helen Hamlyn Centre for Design studied adverse incidents in ambulances for the UK National Patient Safety Agency, which had gathered incident reports indicating a significant sense of unease with regard to ambulance design. We quantified and analysed the data and identified ten design areas that could be improved with a better design. This work fed into the ongoing ambulance standardisation programme in the UK, as well as into a proposal to the UK Engineering & Physical Sciences Research Council to fund the Smart Pods project, which looks at opportunities to develop an integrated system of mobile healthcare, involving more treatment in the community, using the skills of more highly trained paramedics. Existing research at the time showed that about 60% of 999 calls in the UK did not require admission to hospital, and could be better and more cost-effectively treated or managed externally.

By 2009, the Smart Pods research project successfully outlined an integrated pre-hospital healthcare system – a combination of improved emergency ambulances, small responder vehicles, mobile kiosks, standardised treatment spaces, consumables packs and equipment – brought together under an operations management umbrella. In the absence of resources to do everything in parallel, a project to improve the conventional ambulance treatment space that could potentially be developed with limited funding, offered a finite package. Redesigning the ambulance treatment space was considered a key element of the whole system, since ultimately there needs to be a means of treating, stabilising and transporting those patients who need to go to hospital.

#### Methodology for People-Centred Design

Since the Helen Hamlyn Centre for Design was set up in 1991, we have brought designers and users together to analyse user needs and to develop and agree on an evidence-based design brief. The term users in this case refers to clinicians; patients; crews who maintain, clean and stock the vehicles; fleet managers; procurement teams; health service officials; and others who have a responsibility for the ambulance over its life. The next step is to create a mock up of the design, and to build test rigs to evaluate them. The findings of the evaluation feed back into the research, and the process is reiterated until the solution is robust enough to be physically prototyped and validated.

The process for developing the new ambulance interior was research led from its inception and is an example of co-design, where our role was to facilitate collaboration among the broad spectrum of ambulance users described above throughout the project's development. Adopting a co-design process had two main advantages: firstly, it ensured that the stated and unstated needs of the users were met as far as practicable, and secondly, it encouraged the different stakeholders in the project to engage, own and accept some design compromises.

The initial objectives set for the redesigned ambulance aimed to improve patient safety, enhance clinical functionality and reduce costs for the

NHS. We employed a multidisciplinary approach, partnering with university and hospital-based emergency care specialists, ambulance service managers, front-line paramedics and crews, as well as engineers and industrial designers, and went through three reiterative design cycles, each consisting of four stages: learn, design, evaluate and analyse.

Research began by accompanying ambulance crews on 12-hour shifts in order to document, observe and understand the complexity of their work at first-hand. These rich experiences, paired with having an advanced paramedic on the project team from day one, accelerated the flow of ideas and the gathering of insights.

In parallel to our empirical observations, a 1:1 cardboard representation of the current ambulance was developed in our purpose- built ambulance research lab where we invited clinicians to talk about and demonstrate some of the current practices carried out in ambulances. Typical ambulance modes of use were then mapped to understand the needs and limitations that crews and patients face every day, and a thorough audit of current ambulance equipment and consumables was completed. We then correlated the equipment and consumables data with the identified modes of use to come to decisions that utilised the minimum amount of space in light of requirements.

This gave us a solid base to begin exploring ideas through sketches and rough cardboard models. Paramedics were invited to the ambulance lab to discuss and critique the rough proposals and aid in the refinement and development of the ideas. Eventually the rough ideas became 3D computer data, which were soon transformed into full-size test rigs constructed in wood, cardboard and foam. Again, paramedics and patients were invited to evaluate and help to expand some of the concepts.

Once an ergonomic layout was agreed upon a more robust test rig was produced along a 1:1 appearance model. Teams of paramedics and patients were invited to perform outlined clinical scenarios on the testing rig, as well as thematic evaluations on the appearance model and DDC system. In addition, a virtual immersion model developed in a stereoscopic simulation space at the Royal College of Art was used to review several variations of interior layouts without the need to physically build them.

Data generated from the evaluation process was analysed by an independent team, and the results were fed back to us and translated into new learning that kick-started the reiterative cycle once again. Proposals and evaluation methods in every recurring cycle became more sophisticated as the project evolved.

The project resulted in a full-size demonstrator unit for all UK ambulance services to assess. This has created a fundamental building block of the new system, as envisaged by the Smart Pods research, and opened the way for further investment that will enable the whole system to be designed. The new treatment space features:

• A centrally positioned stretcher, to allow clinicians 360° access to the patient, facilitating safer, more efficient treatment. A large stretcher is used to manage bigger patients in response to the trend towards increasing obesity;

• All equipment and supplies located on one side of the vehicle on a simple, ergonomically designed ‘working wall’. A simple but effective addition is a small foldout table for the attendant to use as a lay-down space for items in use, instead of having to rest them on the patient;

•Modular treatment packs, which are loaded into the vehicle before each shift by the ‘make ready’ team. This way the crew can be confident that the vehicle is fully stocked for the shift. Among other necessary items, the pack contains dressings, cannulas, an airways and oxygen kit, and a maternity pack;

• A collaboration of technologies that are used daily in our phones and cars. A Digital Diagnostics and Communication (DDC) system unfolded, providing enhanced road navigation, enabling video links and discussion with hospital colleagues and specialists, and providing remote access to patient records. It also sends vital signs and handover information directly to the hospital while en route.

This is more efficient and less prone to error than transcribed notes;

• An easy-clean interior, designed to avoid corners and crevices where dirt can collect. The evaluations have demonstrated significant improvements in infection control as a result. The interior is also better lit, has a better ambience and is less intimidating;

• Simple additional features, including handcleaning facilities, which, contradictory to patient safety advice, are not currently available. Storage facilities and a cooler box are also provided, with the latter expected to reduce food poisoning among staff, who had reported their sandwiches going off during a 12-hour shift in hot weather.

Evaluations of paramedic performance in the new ambulance design have demonstrated that these features significantly reduce the time taken to complete treatment stages and infections, while improving staff technical skills through better ergonomics, and impacting positively on patient outcomes. Estimated UK-wide cost savings of 35 million pounds could be achieved through reduced emergency department and hospital admissions, with more patient treatment carried out closer to home, a clear patient preference (Darzi, 2008).

This ambulance interior is the result of an evidence-based design brief derived from first principles research, which could be applied to ICU design. The starting point was to consider several issues:

• How to reconfigure and design a standardised treatment space to improve clinical effectiveness and safety for patients and clinicians: The design responds to this concern by providing a logical layout and standardised working environment, which contains all equipment and materials needed during the work shift, with better infection control (see Figure 1).

• How to reduce staff injuries: The design’s central stretcher position and seating layout eliminates reaching over the patient to access equipment and consumables;

• How to improve stock control and standardise equipment: Prior to a work shift, the ‘make-ready’ crew loads all items in required quantities through use of modular packs. UKwide adoption of the design reduces errors through consistency;

• How to improve patient experience, treatment capabilities, working environment and infection control: A clean, uncluttered, reassuring interior, with better lighting and easier clinician workflow, all improve patient and staff experiences; and

• How to improve diagnostics, communications and data transfer through digital technologies: The DDC unit combines state of the art technologies in a mobile overhead unit, wirelessly linked to a paramedic workstation and the driver's navigation console.

**Key Message**

Our co-design approach has not only worked for the ambulance, but also in other medical contexts, most notable in advancing the resuscitation trolley and the neck brace. Our questions is this: Could a collaborative approach between people-centred designers and clinicians, using a process of research, co-design and evaluation, and focused on the ICU, lead to a better adapted design, ergonomically laid out to support evolving clinical thinking and improvements in kit and technology, which delivers better patient outcomes? We hope you agree it is a question worth asking.

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