# Using Multimedia Technology to Help Combat the Negative Effects of Protective Isolation on Patients: The Open Window Project - An Engineering Challenge

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**The Open Window project was established with the aim of creating a "virtual window" for each patient who is confined to protective isolation due to treatment for illness. This virtual window as developed provides a range of media or experiences. This paper describes the approach taken to the system design and discusses initial experiences with implementing such a system in a critical care setting. The system design was predicated on two guiding principles. Firstly it should be intuitive to use and the technology used to create the virtual window hidden from patient view. Secondly the system must be able to be installed at the point of care in a way that delivers the experience under the patient's control, without compromising the function or safety of the clinical environment. Patient acceptance of the system is being measured as part of an on-going trial and at this interim phase of data analysis 100% (n=55) of participants in the intervention group have reported that the technology was easy to use. We conclude that the system as designed and installed is an effective, robust and reliable system upon which to base a multimedia interventions in a critical care room.**

## INTRODUCTION

St. James's Hospital, Dublin, houses the National Stem Cell Transplant Unit (adults) and carries out approximately 100 stem cell transplants annually. Patients undergoing stem cell or bone marrow transplantation for the treatment of haematological malignancies are required to be kept in protective isolation. This means that they are confined to single isolation rooms for many weeks, having only limited contact with family or friends. Protective isolation is necessary where a patient's immune system is compromised, either directly due to their illness or, the nature of their treatment. The project was established with the aim of reducing the sense of isolation which patients experience while in protective isolation.

At the start of the project we conducted a series of interviews with patients who had been in protective isolation. From those interviews we concluded that during the period of isolation, patients wished to be connected to familiar places and people, and to be able to view scenes from the outside world. They felt that to do so would help them to stay "connected" with their normal life and also provide an aesthetic contrast to the clinical environment. Furthermore, patients expressed in vague terms the desire to view something relaxing and healing, which would provide an opportunity for personal reflection.

While in protective isolation they were acutely aware of the fact that they were living in an environment dominated by technology and clinical practices which were alien and unsettling. Many expressed feelings of loss of control over their lives since everything that happened in the protective isolation room was in some way governed by their disease or treatment. From these interviews it became clear that patients had little interest in engaging with another layer of technology, particularly if it was difficult to control. We concluded that patients were looking for a personal and meaningful experience that was ambient, easily accessed, under their control and individualised.

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The Open Window project was established with the aim of creating a "virtual window" for each patient which was unique and which they could control personally. This window would open onto a number of "virtual places" which would provide a range of media or experiences (*Figure 1*). The project team developed a system which is built on a computer network consisting of a server, network hardware and a PC for each of the patients' rooms. The 'window' was created using a video projector and audio speakers. By connecting the system to the internet, images from the patients' families could be sent to the virtual window in each patient's room. Similarly, patients could request to have an internet-enabled camera placed in a location of personal significance. Artists are commissioned to make new multimedia artworks specifically for this project and are aware of the nature of the viewer and the context in which the art will be shown. Content includes live video and still images from visually dynamic locations chosen by the artist, family and friends if the patient wishes. These are accompanied by a choice of music and sound. Some content is abstract but content primarily relates to scenes of nature and people and places that are meaningful to the patient. This facility opened up a new form of dialogue between the artist and the patient. (*Figures 2-4*)

Figure 1. The Open Window system as it appears in the Patient's Room.

It was central to the success of the project that the patients would not be aware that they were using a computer, therefore the system design had to take account of this. Furthermore, it could not be assumed that the patient was familiar with using computers or a graphical user interface, so a custom-user interface was developed. The fact that the system was to operate at the point of care in the isolation room brought more challenges. These rooms are highly-controlled environments designed to be kept clean to a very high standard. They are HEPA (High Efficiency Particulate Air) -filtered positive pressure rooms. Access to the rooms is through an air-lock. Any device being placed within the rooms must comply with strict infection control guidelines and other clinical requirements to ensure that the integrity of the room design and its clinical function is not compromised. The system design was, therefore, predicated on two guiding principles. Firstly, the technology should be transparent. By that it is meant that it should be intuitive in use and while it should be a significant visual presence in the room, the technology used to create it should be hidden. Secondly, the system must be capable of being installed at the point of care in a way that delivers the experience while remaining under the patient's control, but without compromising the function or safety of the environment.

Figures 2 – 4. Examples of images shown on Open Window.

## USER INTERFACE

The user interface design was central to the success of the project and can be considered from two perspectives - hardware and software. Images courtesy of Open Window.

Early prototypes highlighted that use of a wireless mouse and keyboard was unacceptable to both patients and members of the infection control team. Keyboards are notoriously difficult to keep clean because of the crevices between the keys. Some patients also resisted using the keyboard as *"it felt like using a computer."* Many patients were not familiar with computer use. A wireless mouse was acceptable to the infection control team as it can be wiped clean as part of routine cleaning and, if there is a need to perform a deep clean in the room, the mouse is inexpensive and can be replaced. Many patients were resistant to using the wireless mouse because, again, it felt like using a computer. Interestingly, the remote control used to turn on the projector (and another remote control for the TV in the room) posed no problem to users.

In conversation with patients during the prototyping phase it became clear that it was the Graphical User Interface (GUI) concept that users were mainly reacting against. The user interface chosen was therefore a remote control device similar to that used for a TV. The remote control and associated software was designed so that each button had one function and was independent of what was displayed on the screen, i.e., no on-screen menus were used. It emulated a TV remote control rather than that of a DVD, which has elements of a GUI in its design. The remote controls were custom-designed and manufactured and proved easy to clean (*Figure 5*). Where there was a requirement for a deep clean in the room, the remote control could be discarded and replaced. The infra-red signals from the remote control were picked up in the room by a small sensor mounted on the projector, which was connected over USB to the PC. The operation of the projector in the room was controlled by connecting its serial-interface port to the computer. This allowed all functions of the virtual window to be controlled from one remote control. The remote control worked through the glass observation windows into the room, so the system could be operated by an engineer from outside the isolation room.

At the software layer the user interface was also conceived to emulate a TV with a number of channels, each of which delivered a different virtual window into the patient's room. Using a single remote control


Figure 5. Custom designed Remote-Control for operating Open Window.

the patient could turn the window on or off, choose a channel and adjust the volume of audio. The user did not see the operating system projected onto the wall. Thus the virtual window appeared with content and was controlled without the user being aware that they were using a PC. The system provides an overview page where users can disable channels they do not wish to see. This provides the user with another way of personalising the system.

## SYSTEM COMPONENTS AND SAFETY

The system was designed to minimise the hardware elements in the patient's room. This reduced the need to re-engineer components to meet infection control and other safety requirements. The patient environment is usually considered to be any area whose boundary is 1.5 metres from the patient in any direction. When dealing with patients who may be mobile within an isolation room, this becomes in practice the whole room except for the ceiling and upper parts of the walls.

Electrical safety of the system was achieved by ensuring that there was no physical connection between the patient or a member of staff and the system. The use of a battery-powered remote control which communicated with the PC using infra-red provided a solution to the electrical safety challenge as well as meeting infection control guidelines and being acceptable to and intuitive for patients. The multimedia experience was provided by a projector and stereo speakers which were installed on the ceiling and upper walls of the patient's room. All were powered from a mains supply routed through a 1:1 separation transformer to bring the normal earth leakage currents of these non-medical devices to within the tolerances expected for medical devices (*Figure 6*).

Initial fears that Infection Control staff would have difficulty with the projector fans were unfounded. In these environments, during treatment, there are no airborne hazards. Rather, infection control requirements were focused on the ability to adequately clean devices regularly and rigorously between patients. Consequently, the equipment needed to have smooth enclosures that could be easily wiped clean and which could be disinfected with Clorasept or a similar solution. Like all devices used in a critical care environment,

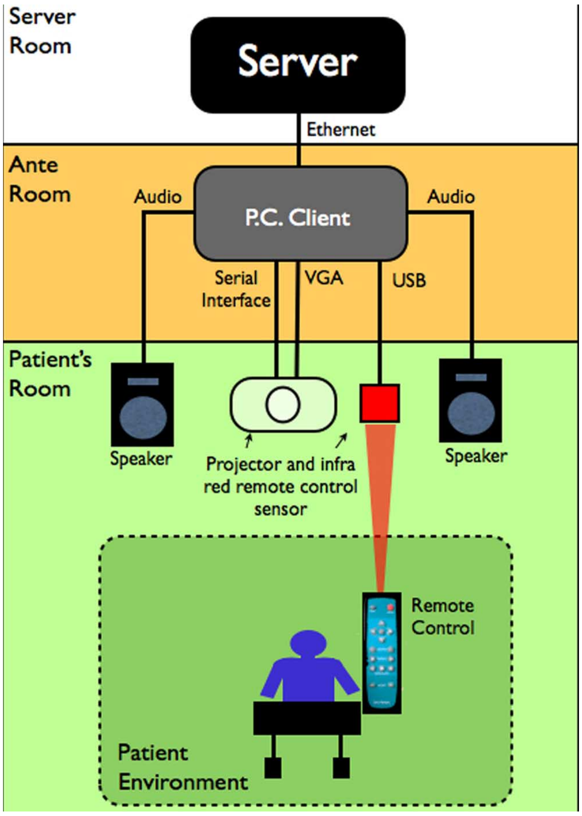


Figure 6. Schematic Diagram of technology used to create Open Window.

the system needed to be robust. Within the room the projector and speakers were most at risk of being damaged by accident or by the cleaning régime.

However, by careful choice of device and placement these risks were reduced to acceptable levels and there have been no failures to date. We chose Genelec-powered studio monitors which have a metal enclosure and speaker grill. These have proved to be robust enough to stand up to regular hospital cleaning and the occasional close encounter with an I-V stand! An NEC projector chosen for its smooth contours and extremely low fan noise was installed on the ceiling. To minimize dust catchers all cables to these devices were run inside the walls or ceilings and services bought out on flush plates. This had the secondary advantage of reducing the visual effect of placing the devices, as no trailing wiring can be seen (*Figure 7*).

The system's "back end" is built on a computer network consisting of a central server, associated network hardware and a PC for each of the patients' rooms. The PC which delivered the content to the speakers and projector in each room was placed outside the patient's room. This dealt with electrical safety and infection control issues. If necessary it could be accessed for maintenance without having to enter the protective isolation environment. The same was true for the servers and network hardware which were placed in an IT room nearby. All the PCs and servers were extensively tested before installation. All devices were set up to auto-boot into the application and establish connectivity with other elements of the system. In the event of a power failure the system automatically comes back on line when power is re-established.

## EXPERIENCE IN PRACTICE

The system has been installed in eight rooms in the Denis Burkitt Unit (the stem cell transplant unit at St. James's Hospital) and a randomised controlled trial which began in 2007 is currently under way. The purpose of the trial is to measure the psychological effect and experiences of Open Window on patients undergoing stem cell or bone marrow transplantation. Findings at the interim phase of data analysis suggest that Open Window has a positive effect on participants' experiences; however, final results will not be avail-

Figure 7. Photograph showing the projector and speakers used to create Open Window.

able until January 2010. Also at this interim phase of data analysis 100% (n=55) of participants in the intervention group have reported that the technology was easy to use.

Participants in the study use the remote control system readily and in a way that allows them to control and tailor their experience according to personal preferences. All participants used the remote control to manipulate the system by removing content that they did not like and focusing on the images they preferred. The system and its design have achieved their primary aim of being intuitive and easy to use.

The system has not created any electrical safety or infection control risks. The speakers and projectors in the patients' rooms were not designed to be cleaned as often as medical devices. We feared that they would not stand up to a medical room cleaning régime. However, experience to date has shown that they are robust and there have been no negative outcomes from their use or failures of these devices. The system as a whole has proved to be remarkably reliable. The fact that all system components are programmed to autoboot into the Open Window application and automatically establish communications with other elements of the system has reduced the number of requests for system support. The only downtime recorded was due to hardware failures – in one case the failure of a hard disk on a PC, and in the second, failure of a network patch cable. The system has achieved an effective uptime of 99.8% over the two-year period to date.

We conclude that the system as designed and installed is an effective, robust and reliable system upon which to base multimedia interventions within a critical care room. The advantage of implementing such a system is that it allows for the ongoing development of new content without the need to change the infrastructure. Work is continuing with the artistic community to develop content that is specific to patients who must spend time in this environment.