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## **The design of a visual training tool for the prevention of Healthcare Associated Infections: using co-design to capture the training needs of doctors, nurses and cleaning staff**

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### *Abstract*

*Healthcare-associated infections (HAIs) cause risk to patients and have a financial impact on healthcare services due to increased length of hospital treatment, and the costs of isolating patients or closing wards. As antimicrobial resistance increases, the prevention of the spread of pathogens which cause HAIs has become of increasing importance.*

*This paper describes a new project which aims to produce a tablet-based training tool for healthcare staff using digital visualisations of data on pathogens: how they behave in the ward context and how to prevent their spread.*

*Crucial to the success of the tool will be to understand the training needs of staff, and the key preventable errors which lead to the spread of infection. The planned co-design and evaluation process for the project is described in the paper, including the different considerations for the design of the workshops to facilitate effective inputs from key hospital staff stakeholder groups – doctors, nurses and cleaning staff.*

**Keywords:** Co-design, visualisation, healthcare-associated infections

## Introduction

Healthcare associated infections (HAIs) caused by pathogens (infectious agents) such as MRSA, Norovirus, and Clostridium Difficile are a substantial global problem (Allegranzi et al, 2011). In addition to the distress and potentially fatal consequences for patients who are infected, HAIs are costly – the cost to acute services in NHS Scotland was estimated in the 2007 national prevalence survey at £183 million (Health Protection Scotland, 2007). The World Health Organisation (2014) global surveillance report on antimicrobial resistance shows that "a post-antibiotic era – in which common infections and minor injuries can kill – far from being an apocalyptic fantasy, is instead a very real possibility for the 21st Century". The prevention of the spread of HAIs in the first instance is therefore of crucial importance.

Pathogens are invisible to the naked eye - only visible through microscopy or by encouraging growth on agar in a Petri dish. This issue led the research team to ask the question: Could more HAIs be prevented if hospital staff could 'see' microscopic pathogens? Through digital visualisation, pathogens can be represented virtually, offering the potential to provide healthcare staff with improved understanding of the nature of pathogens.

In previous research by the authors (*Vis-Invis*: <http://visinvis.org>), a mixture of healthcare and cleaning staff participated in a series of exploratory workshops (Macduff et al, 2013) to inform the creation of digital visualisation concept prototypes which represented pathogens as 'visible' in the context of a virtual hospital ward (Figure 1). A key outcome of this research was the recommendation that the further development of these concept prototypes for staff training would be beneficial if they could be augmented with specific training information and scenarios around the prevention of HAIs. This paper discusses a new knowledge exchange project which will build on the experiences of working with healthcare and cleaning staff on this issue, to co-design a visual training tablet application which focuses on improving understanding of the location of pathogens; the link between specific reservoirs and survival capacities; and how they are spread.

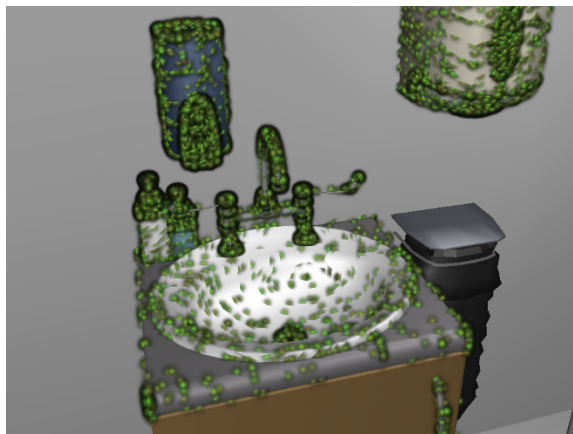


Figure 1: Screenshot from an interactive visualisation from the Vis-Invis project, informed by the perception of a participant (hospital cleaning staff) of the sink area in a ward before being cleaned

## VisionOn: a new tablet-based training tool

The knowledge exchange project 'VisionOn' will build on the previous Vis-Invis research to develop digital visualisations of pathogen data for use in staff training. Key project partners for the project include infection control leads in NHS Lanarkshire and NHS Grampian, and GAMA Healthcare Ltd., who produce an existing tablet-based training package. This partnership will be used to assist the project to meet the requirements of current NHS training programmes and to maximise the opportunities for its adoption through integration with the existing tablet application.

Currently available training materials for healthcare and cleaning staff provide clear and detailed information on the procedural aspects of HAI prevention, largely focussing on the requirements of specific job roles, e.g., procedures to minimise the transmission of infection, hand hygiene protocols, guidelines on the use of personal protective equipment, and maintenance of a clean environment and clean equipment (NHS Education for Scotland, 2014). The Gama Healthcare Clinell Training Package provides this form of information in an interactive format including: videos (e.g. showing good practice in cleaning and hand washing); games (e.g. where you swipe the screen to clean a surface); quiz sections; and textual information on the prevention of HAIs (GAMA Healthcare, 2015).

The opportunity provided by this project therefore is to complement existing staff training options by providing an alternative focus, based on the use of digital visualisations which explain the nature of pathogens and how transmission can be prevented. In order to achieve this, however, a key factor in the development of the training tool will be that the visualisations are enhanced from their exploratory concept prototype phase (Vis-Invis) to become evidence-based prototypes, and to provide relevant training information.

In order to explore the potential of this approach, three key training themes will be used to generate evidence-based visualisation prototypes. Each of these will be supported by original quantitative data from research studies involving the microbiologist on the research team:

- *Transmission of infection and hand hygiene:* This theme focuses on how different types of pathogens are spread through human error. The quantitative data for this theme includes covert observation data of what hospital staff touched and in what sequence, in an isolation ward with a patient who had acquired an infection (Smith, Young, Robertson and Dancer, 2012). The data shows that there were several instances of staff touching high-risk sites for acquiring pathogens (i.e. potential reservoirs) without using hand gel or washing hands before touching the patient.

- *The effect of cleaning on pathogen growth:* This theme focuses on the key area of what happens to pathogens during and after cleaning. The data for this theme includes measured pathogen levels in four near-patient sites in a high occupancy ward. Measurements were taken before and after cleaning over several hours, providing detailed growth rates of total microbial bioburden and incidences of specific pathogens (Bogusz *et al*, 2013).
- *Pathogen location and properties:* This theme focuses on where pathogens are found, and their longevity (survival) in different healthcare environments. The evidence for this training information will be collated from studies on key pathogens including Methicillin - resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, multi - drug resistant Gram - negative bacilli (MDRGNBs) and norovirus.

## Study design

The two key questions under investigation in the co-design and evaluation process are: what are the training opportunities which the quantitative data on pathogens could provide for hospital staff if represented in an understandable format?; and how can we represent the quantitative data on pathogens using digital visualisation to make the information meaningful for hospital staff within a training context?

In order to achieve this there will be three different events involving users during the 12 month project: 1) a co-design workshop; 2) a visualisation evaluation workshop; followed by 3) an evaluation of the final prototypes by individual staff (Figure 2).

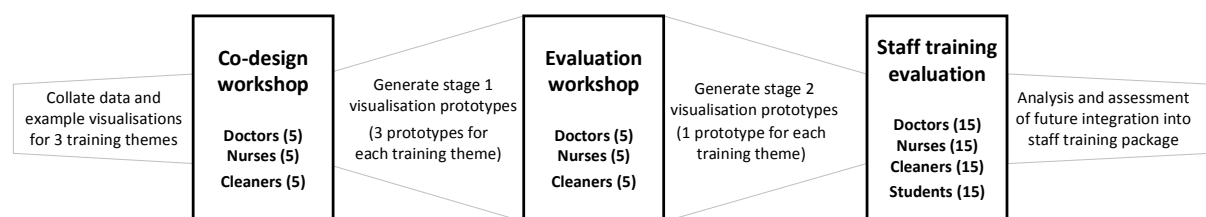


Figure 2: VisionOn co-design and evaluation process showing numbers of staff involved at each stage.

The chosen participant job roles represent the main staff who move through the ward throughout the day and are represented in the available quantitative data on the spread of pathogens. The role of patients and visitors in the spread of pathogens will be included in the discussions of scenarios in the workshop activities, but as they would not be users of the training tool no participants are included to represent these groups. While there will be informed input only from experienced staff in the first two events, nursing students, representing less experienced healthcare workers, will be involved in providing feedback on the effectiveness of the training package in the final event.

## Co-design workshop

The first event, the short-duration co-design workshop, will take place on hospital premises in NHS Lanarkshire. At the start of the workshop, the structure, nature and purpose of the activities will be clearly explained. To explore each of the three themes detailed above, the participants will be split into sub-groups by job role - each group facilitated by a member of the research team. The key outcomes of each sub-group activity will be: 1) identified training needs derived from the quantitative data; and 2) generated ideas for the visual communication of the training needs. After each sub-group activity around each of the training themes, all participants will return to the full group to compare and contrast any similarities or differences between the job roles.

The two main challenges for the design of the materials to support the sub-group activity are: to summarise the quantitative data in a way to facilitate discussion amongst the participants; and to provide appropriate prompts to explore the potential visualisation options without closing down the scope of the discussion.

### Data presentation and contextualisation

The first challenge is one which was found in the previous Vis-Invis project, when sample quantitative research data on the transmission of pathogens by touch was introduced to participants. Here, the data was presented in an 'academic-style' format which participants found difficult to interpret, particularly within the confines of a workshop with limited time to read through and comprehend the detail. An essential part of the preparation for the sub-group activities is therefore to edit, summarise and present the quantitative data in an accessible format. In order to achieve this, the data will be explained using images of common scenarios around infection control, mocked up using a small-scale model ward (Figure 3(a)). To allow the participants to adapt the scenario to explore different variations, this small-scale physical ward model will also be provided.

The second challenge relates to the role of visualisations which can seem esoteric if not contextualised using examples, shown to be essential in previous stakeholder evaluation of visualisations (Loudon *et al*, 2012; Macduff *et al*, 2013). Simple mock-up visualisations will be prepared based on the quantitative data, to be used as prompts related to the identified training scenarios (Figure 3(b)). However, a balance will need to be found between showing example visualisations on the one hand to stimulate ideas, and on the other for providing necessary focus for participants. Here, careful facilitation of the sub-group activity will be important to prompt for different ideas, and the example scenario images will be used as triggers for widening the scope of the discussion.

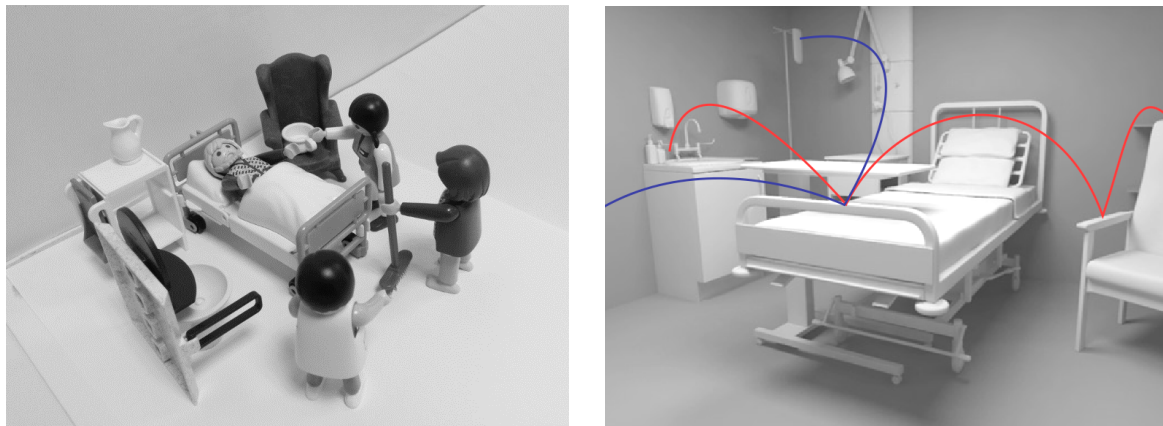


Figure 3: Examples of workshop materials: (a) image of model ward depicting a scenario of visiting time to a patient on the ward (grayscale in order to enable coloured annotation) (b) Example image based on quantitative data on sequences of hand touch in an isolation ward: the red line shows an individual who didn't use the hand gel touching the end of the bed; the blue line shows the touch points of the nurse, highlighting where there has been a risk of transmission of pathogens to the IV drip

## Prototype evaluation process

The outputs from event 1, the co-design workshop, will be analysed and used to generate a set of stage 1 visualisation prototypes (three prototypes for each of the three themes). The purpose of these visualisations will be to present a wide range of options as prompts for event 2, the evaluation workshop.

In event 2, the evaluation workshop, the same numbers and mix of job roles will participate. Where possible the same participants will be recruited for events 1 and 2, however this may not be possible due to NHS staffing pressures. The primary purpose of this second event will be for the participants to evaluate the strengths, weaknesses and issues arising from each stage 1 prototype, and to rank and prioritise the different characteristics of the prototypes. However, as the visualisations of the data will be more developed for event 2, it is anticipated that the meaning and potential for use in training of the quantitative data will become clearer to participants. Therefore, it is expected that the specification of the final stage 2 prototypes will be a mixture of the most effective components of the stage 1 prototypes, with additional ideas generated from viewing the visualisations at event 2. An additional factor however in the decision on the final specification of the stage 2 prototypes will be that, as a knowledge exchange project, the visual prototypes will need to be developed to a level to be able to be integrated into the full tablet training application in the short term, limiting the possibility for large modifications within the scope of this project.

In the final phase of the project, the stage 2 visualisation prototypes will be combined into a single training package, running on a tablet device. In an extended event 3, staff will be recruited, who were not involved in the previous stages, to use the training package on an individual basis at NHS Grampian and NHS Lanarkshire sites. An heuristic evaluation (Jones, 2013) of the visualisation



prototypes will be performed by each of the 60 participants and stored on the tablet through questionnaires before and after seeing the visualisations. The results from the evaluation will be collated and analysed to assess the effectiveness of the visual prototypes in communicating the training information identified as useful by participants through the co-design process.

## Discussion

Conventional modes of data presentation normally found in, e.g., academic or professional journals and conference papers can present barriers to their uptake and application in practice. The mode of presentation of qualitative data on pathogen incidence discussed above is a case in point: quantitative data from studies on the microscopic pathogens responsible for HAIs are not commonly used in staff training information due to the difficulties in communicating the findings in a meaningful way. Similar issues regarding data presentation and contextualisation have been identified by members of the VisionOn team in previous research, such as for biomechanical data visualised for the purposes of therapeutic rehabilitation following stroke (Loudon, Taylor & Macdonald, 2014). Here, acknowledging the manner in which data were presented, for end-users and the context in which they are to be used, i.e. in a dynamic rehabilitation setting, was key to their success. Using visuals, mock-ups and early prototypes as prompts for discussion, development, focus and refinement, rather than relying solely on verbal prompts, to assist participants in imagining and experiencing new scenarios and behaviours, is fundamental to the approach in this design-led process (Coughlan, Fulton Suri & Canales, 2007).

## Conclusion

Key challenges for the co-design process are highlighted and addressed above with the aim of achieving effective input and output from the participants. Careful facilitation of workshops will be required using visuals, mock-ups and early prototypes as prompts to both open up and focus discussion e.g., through their use in ward-based scenarios derived from the data in relation to typical infection control scenarios. The co-design and evaluation process, using the stages and tools described in the paper will inform the development of a new visual training tool which will communicate this important data on pathogens in a novel and accessible manner for use in staff training for the first time.

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## References

ALLEGIANZI, B., NEJAD, S.B., COMBESURE, C., GRAAFMANS, W., ATTAR, H., DONALDSON, L. and PITTET, D., (2011). Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *The Lancet*, 377(9761), 228–241.

BOGUSZ, A., STEWART, M., HUNTER, J., YIP, B., REID, D., ROBERTSON, C. and DANCER, S.J., (2013). How quickly do hospital surfaces become contaminated after detergent cleaning? *Healthcare Infection*, 18(1), 3–9.

COUGHLAN, P., FULTON SURI, J., and CANALES, K. (2007). Prototypes as (design) tools for behavioral and organizational change: a design-based approach to help organizations change work behaviors. *The Journal of Applied Behavioral Science*, Mar 2007;34,1, 122-134.

GAMA HEALTHCARE, (2015). Available at: <http://www.clinell.com/training-package>

HEALTH PROTECTION SCOTLAND, (2007). NHS Scotland National HAI Prevalence Survey. Available at: <http://www.documents.hps.scot.nhs.uk/hai/sshaip/publications/national-prevalence-study/report/full-report.pdf>

JONES, P., (2013). *Design for Care: Innovating Healthcare Experience*. 1st edition ed. Brooklyn, N.Y: Rosenfeld Media.

LOUDON, D., MACDONALD, A.S., CARSE, B., THIKEY, H., JONES, L., ROWE, P.J., UZOR, S., AYOADE, M. and BAILLIE, L., (2012). Developing visualisation software for rehabilitation: Investigating the requirements of patients, therapists and the rehabilitation process. *Health Informatics Journal*, 18(3), 171–180.

LOUDON, D., TAYLOR, A. and MACDONALD, A.S. (2014). The use of qualitative design methods in the design, development and evaluation of virtual technologies for healthcare: stroke case study. In Ma, M., Jain, L., A. & Anderson, P. (eds.) *Virtual and Augmented Reality in Healthcare 1*. Springer-Verlag, Berlin Heidelberg 2014. (68), 371-390.

MACDUFF, C., WOOD, F.K., HACKETT, C., MCGHEE, J., LOUDON, D., MACDONALD, A., DANCER, S. and KARCHER, A., (2013). Visualizing the invisible: applying an arts-based methodology to explore how healthcare workers and patient representatives envisage pathogens in the context of healthcare associated infections. *Arts & Health: An International Journal for Research, Policy and Practice*.

NHS EDUCATION FOR SCOTLAND, (2014). Introduction to Cleanliness Champions. [online] Available at: <http://www.nes.scot.nhs.uk/education-and-training/by-theme-initiative/healthcare-associated-infections/educational-programmes/cleanliness-champions.aspx> [Accessed 17 Oct. 2014].

SMITH, S.J., YOUNG, V., ROBERTSON, C. and DANCER, S.J., (2012). Where do hands go? An audit of sequential hand-touch events on a hospital ward. *The Journal of hospital infection*, 80(3), 206–211.

WHO, (2014). WHO | Antimicrobial resistance: global report on surveillance 2014. [online] WHO. Available at: <http://www.who.int/drugresistance/documents/surveillancereport/en/> [Accessed 28 May 2014].