Empathetic Research and Design of the Nurse Handover

Improving nurse shift handovers using interactive data visualization

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ABSTRACT

Data Visualisation is prolific across business and science but is less utilised in healthcare settings. Poor usability is cited as the major prohibitor within digital healthcare systems and is particularly evident in patient documentation and nurse handover processes (Khan, Mukhtar, Ahmad, Gondal, Ilyas, 2017). This pictorial documents the empathetic research and design of the nurse shift handover using a user-centred design process. Grounded in discovery research, the pictorial demonstrates the pitfalls of current shift handover methods. The pictorial illustrates how the use of a digital data visualisation dashboard to view, record and store patient information will improve communication, efficiency and overall satisfaction in nurse shift handovers.

Authors Keywords

Data Visualisation, Healthcare Informatics, Interactive, Dashboards, Usability, Nursing, Shift Handover, EHR

INTRODUCTION

Clinical dashboards gather summary data to provide the necessary information to healthcare management to make key decisions as well as informing day-to-day clinical activities (Maktoobi & Melchiori, 2016). When compared to other disciplines, healthcare data visualisation is not as advanced in its application with poor usability cited as a blocker in the use of electronic healthcare systems over the common paper-based approaches (Khan et al. 2017). Information visualisation can help health care professionals, support services and patients to interpret diagnoses and medical decisions while sharing background information that could include guidelines, clinical evidence and patient data. Attempts to use data visualisation in healthcare include patient cohort analysis, dashboard design of an electronic health record (EHR) and the use of digital cognitive maps to enable clinical handovers (Sharma, Stranieri, Firmin, Mays, Burstein, 2018). Clinical handovers between nurses are key to ensuring good communication, a high standard of care and patient safety. The use of data visualisation to present EHRs to nursing staff can support the process and knowledge needs of nurses (Matney, Maddox, Staggers, 2014).

DATA VISUALISATION IN HEALTHCARE

Data visualisation in Healthcare supports the exploration and discovery of insights in healthcare data for patients, clinicians and policy makers allowing them to make better decisions (Shortliffe & Cimino, 2014). Clinical health information is increasingly available in the form of an EHR which when used alongside visualisation can provide insight on treatments. (Shneiderman, Plaisant, Hesse, 2013).

Khan et al. (2017) developed an electronic health record for obstetrics that focused on improving usability and patient healthcare. Using visualisations to oversee progress, inconsistencies in data, and risks to patient health, the dashboard enabled a physician to monitor a patient's healthcare record over a period of time. By using visualization techniques, their system received higher levels of usability and user satisfaction to perform healthcare data analysis tasks over the existing system.

An investigation into the use of EHRs by nurses was undertaken by Chetta, Carrington, Forbes (2015). They state that the use of EHRs in clinical settings presents new opportunities for data analytics to be introduced into the practice of nurses. Access to the records is of benefit to nurses but the recording, retrieving and analysing the data is difficult with issues around the communication and validation of the data (Carrington & Tiase, 2013).

Often nursing staff are unable to sort through the vast data available in an EHR to find the information they need (Rind et al., 2013). The interactive visualisation tools developed by Chetta et al. (2015) enable nurses to communicate and reason more clearly about patient health.

STUDY APPROACH

To carry out the study there was a requirement to research and design an interactive data visualisation prototype tool for nurses to use during clinical handovers. The tool functions as a series of interactive dashboards accessed by tablet, laptop or desktop device. A user-centered design thinking process (empathise, define, ideate, prototype, test) as advocated by the Stanford d.school and David Kelley (Gibbons, 2016) was utilised throughout the study. Three hypotheses were created to focus the design on the communication, efficiency and satisfaction of the nurse shift handover.

ISBAR - Clinical Handover Sheet				
Identify (I) Situation (S) Background (B) Assessment (A) Recommendation (R)				
Identify	Situation	Background	Assessment/ADLs	Recommendations Goal/Risk/Read Back

In order to validate the hypotheses an analogue paper prototype was also designed which was be based on the ISBAR (Incident, Situation, Background, Assessment, Recommendation) method used by the HSE (HSE Ireland, 2017).

Communication: Nurses that use an interactive dashboard to perform a shift handover communicate essential patient information more effectively than when using a paper method.

Efficiency: Nurses that use an interactive dashboard perform a shift handover more effectively than when using a paper method.

Satisfaction: Nurses that use an interactive dashboard to perform a shift handover are more satisfied than when using a paper method.

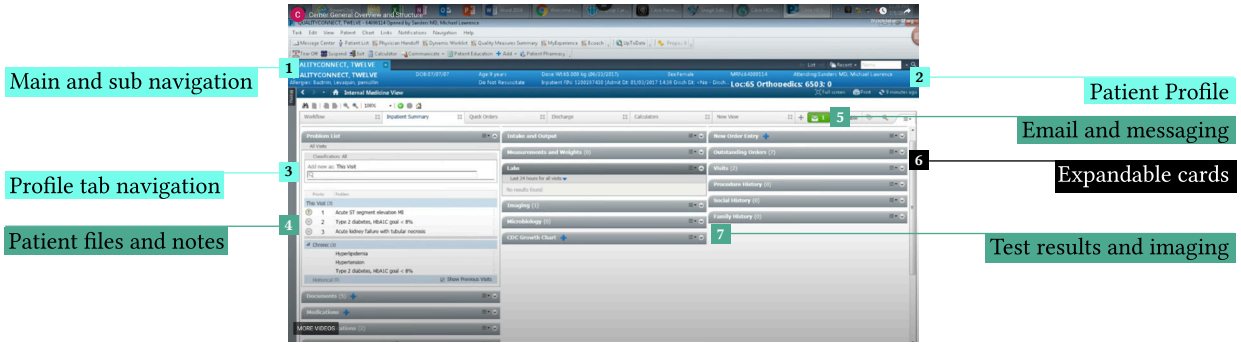
Secondary research was conducted to inform the design process in the form of a Literature Review and Competitor Analysis. Primary research in the form of Discovery Interviews and an Online Survey provided first hand accounts of nurses' interaction with shift handover processes. The insights gained from these research activities informed the creation of user journey maps, personas, empathy maps and storyboards which helped to make the characteristics of the users ie. nurses, more memorable for making key design decisions (Harley, 2015). Using the data collected, a lo-fi paper prototype of the interactive data visualisation tool was prototyped for guerilla testing with participants. Paper prototyping and testing early help identify the biggest improvements in the user experience of the design (Nielsen, 2003). At this stage of the design a card sorting exercise with participants was undertaken to help refine the architecture by exposing the participants' mental model (Rohrer, 2014). Following this test and review of findings, the design of an iterated mid-fi digital prototype with further guerilla testing on two more participants was conducted (Moran, 2019). The feedback from this mid-fi testing informed a final hi-fi design of the digital dashboard prototype. Following a pilot test, the digital dashboard was A/B tested alongside the paper prototype. A talk aloud protocol (Nielsen, 2012) enabled a content analysis (Cavanagh, 1997) to measure communication while time on task (Nielsen, 2001) and a NASA TLX (Task Load Index) (Laubheimer, 2018) was used to measure handover effectiveness. The SUS (System Usability Scale) (Brooke, 1996) was used to measure satisfaction with both prototypes.

DISCOVERY RESEARCH

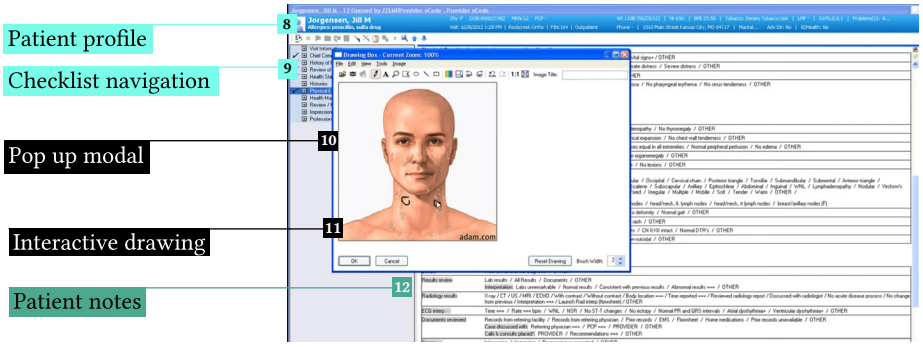
Competitor Analysis

A competitor analysis was undertaken to gain an insight into the area of EHRs and electronic patient records (EPRs) nationally and internationally in order to identify any gaps in the market (White, 2019). Annotation of the product interfaces found that they lacked a user-friendly experience and UI with complicated layouts and crowding of information.

	Cerner Millenium	Epic	Allscripts Professional	Athenahealth	Kainos Evolve
Platform					
Cloud	✓	✓	✓	✓	✓
On-premise	✗	✗	✓	✗	✗
App version	✗	✗	✓	✓	✗
Software features					
Clinical workflow	✓	✓	✓	✓	✓
Document management	✓	✓	✗	✓	✓
Lab integration	✓	✓	✓	✓	✓
Patient demographics	✓	✓	✓	✗	✓
Patient history	✓	✓	✓	✓	✓
Patient portal	✗	✓	✓	✓	✓
Reporting and analytics	✓	✓	✓	✓	✓
Voice recognition	✓	✓	✓	✓	✓
Medical templates	✓	✓	✓	✓	✓
Scheduling	✓	✓	✓	✓	✓
Customised specialities	✓	✓	✗	✗	✗



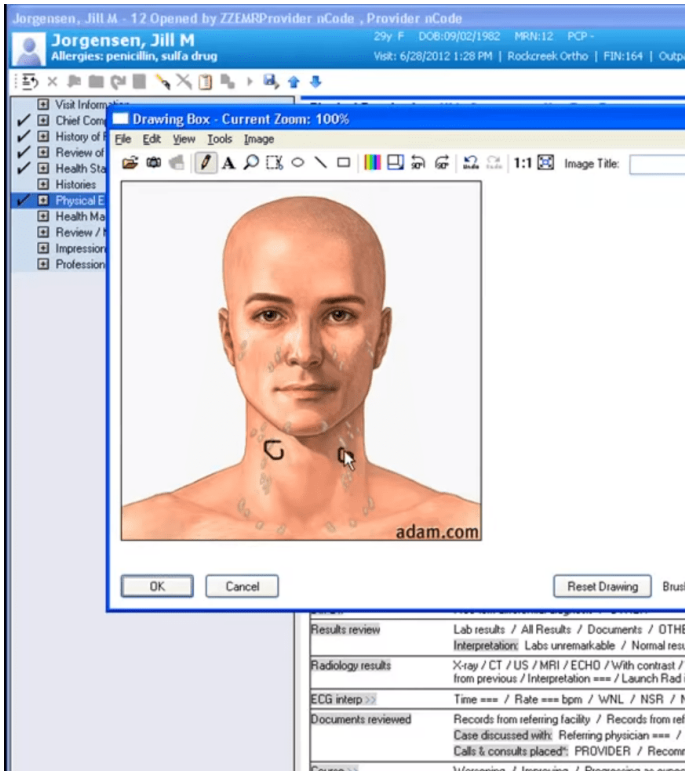
Cerner Millennium System – Inpatient Summary (Cerner Training, 2017)



Cerner PowerChart – Patient View (Software Connect, 2020)

Features

- Navigation
- Documentation
- Interaction



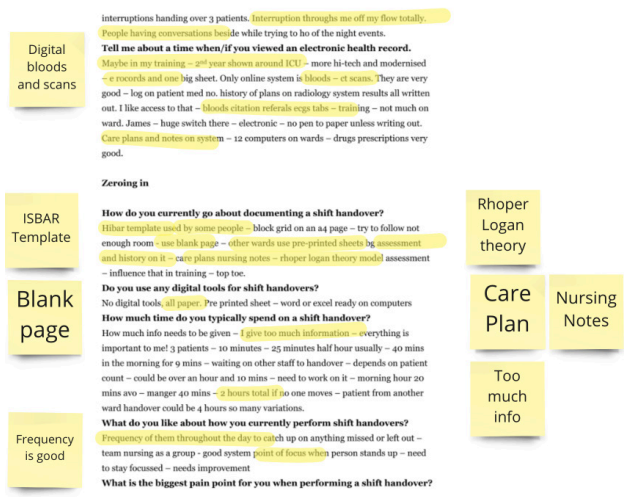
> **“If a handover goes past 8.30am I am catching up all day often missing my breaks.”**
>
> Nurse B

Discovery Interviews

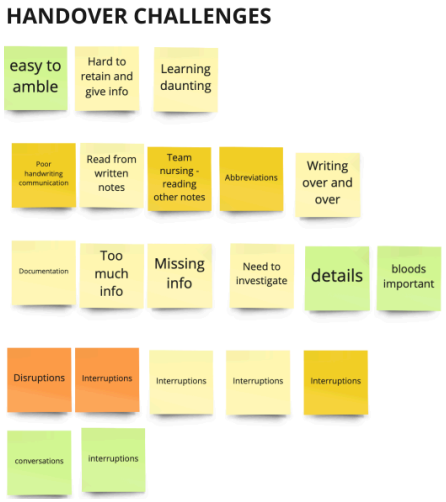
Remote qualitative discovery interviews took place with 5 nurses who were recruited by word of mouth. Their roles varied from junior to senior roles across a number of wards. Discovery interviews were used in the early stages to provide insight into what nurses think about the current handover process and the challenges that they face (Pernice, 2018). Studies by Abraham, Kannampallil, Patel (2014) and Stevenson, Nilsson, Petersson, Johansson (2010) were referenced to inform the questions asked regarding a handover’s support of everyday clinical practice and it’s user-friendliness. The interviews lasted approximately 30 minutes with the questions focusing on stories of their daily routine, with particular focus on their current handover process and in a perfect world how the process would work. Informed consent was signed digitally before each interview with details being kept strictly confidential.

All of the nurses interviewed said they used written methods of recording patient information for handover. Some digital records were accessed for bloods, imaging and bed allocation but no EHRs were used. Notes are documented in their nursing notes and patient care plans and in the most cases an ISBAR template is used for handover along with a ward occupancy white board with patient details documented.

Thematic analysis was used to group responses into themes related to the research questions (Braun & Clarke, 2006). The responses for each question were read through in detail for each participant with interesting statements highlighted in the online tool Miro. The key themes were tabulated for relevancy across the 3 areas the hypotheses focus on, communication, efficiency and satisfaction.



Coding of a Nurse statements Interview Script



Grouping of coded statements into relevant themes

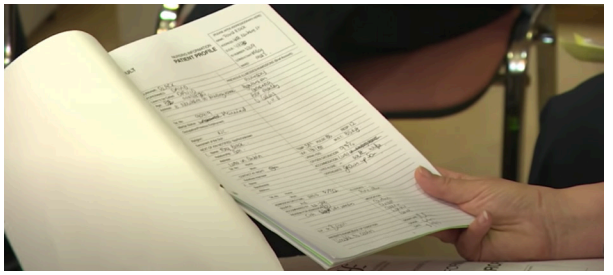
> **“I tend to give too much information which can make handovers lengthy – it’s hard to summarise all the key details.”**
>
> Nurse D

	Communication	Efficiency	Satisfaction
Handover length		✓	✓
Staff shortages		✓	
Summarised information	✓	✓	✓
Pre-populated templates	✓	✓	✓
Interruption management	✓	✓	
Standardisation of handovers	✓	✓	
Less documentation and writing		✓	✓
Missing information	✓		✓

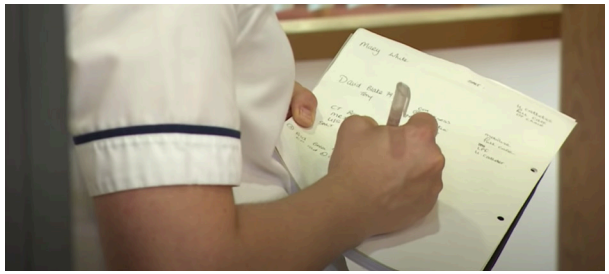
Current Practice

Findings from the Discovery Interviews show that nurses had their own individual methods of documenting, delivering and receiving shift handovers and there is a need for a standardised format. The nurses interviewed used a combination of nursing notes, care plans, templates and blank paper for shift handover. Confidentiality means handover notes and templates are destroyed at the end of a shift. There is training material publicly available online from the HSE Ireland in the form of Youtube videos and facilitator guides (HSE Ireland, 2015 & 2017). The following images are taken from that training material. *Images courtesy of the HSE, NMPDU and the ONMSD.*

1. Nurses interviewed said shift handover takes place mornings at 7.30am and evenings at 7.30pm with shorter huddles throughout the day. Handover takes place in a team setting with no prior collaboration occurring.



2. Nurses will refer to nursing notes and care plans when delivering the handover.



3. Some templates exist but the nurses spoken to used blank pages to scribe patient information, usually following an ISBAR or Rhoper Logan Tierney heading structure.

"My nurse in training can find handovers hard to understand – English is not her first language."

Nurse B

"Handwriting can be hard to make out sometimes "

Nurse C

4. Interruptions were a major grievance from the nurses interviewed, delaying the handover and interrupting the flow of the nurse delivering and those receiving.

5. Phone calls are constantly incoming throughout the handover causing interruption.

6. Further interruptions from patients and other departments were reported.

"There are constant interruptions from patients needing meds, doctors doing rounds, theatres ringing for patients."

Nurse D

Online Survey

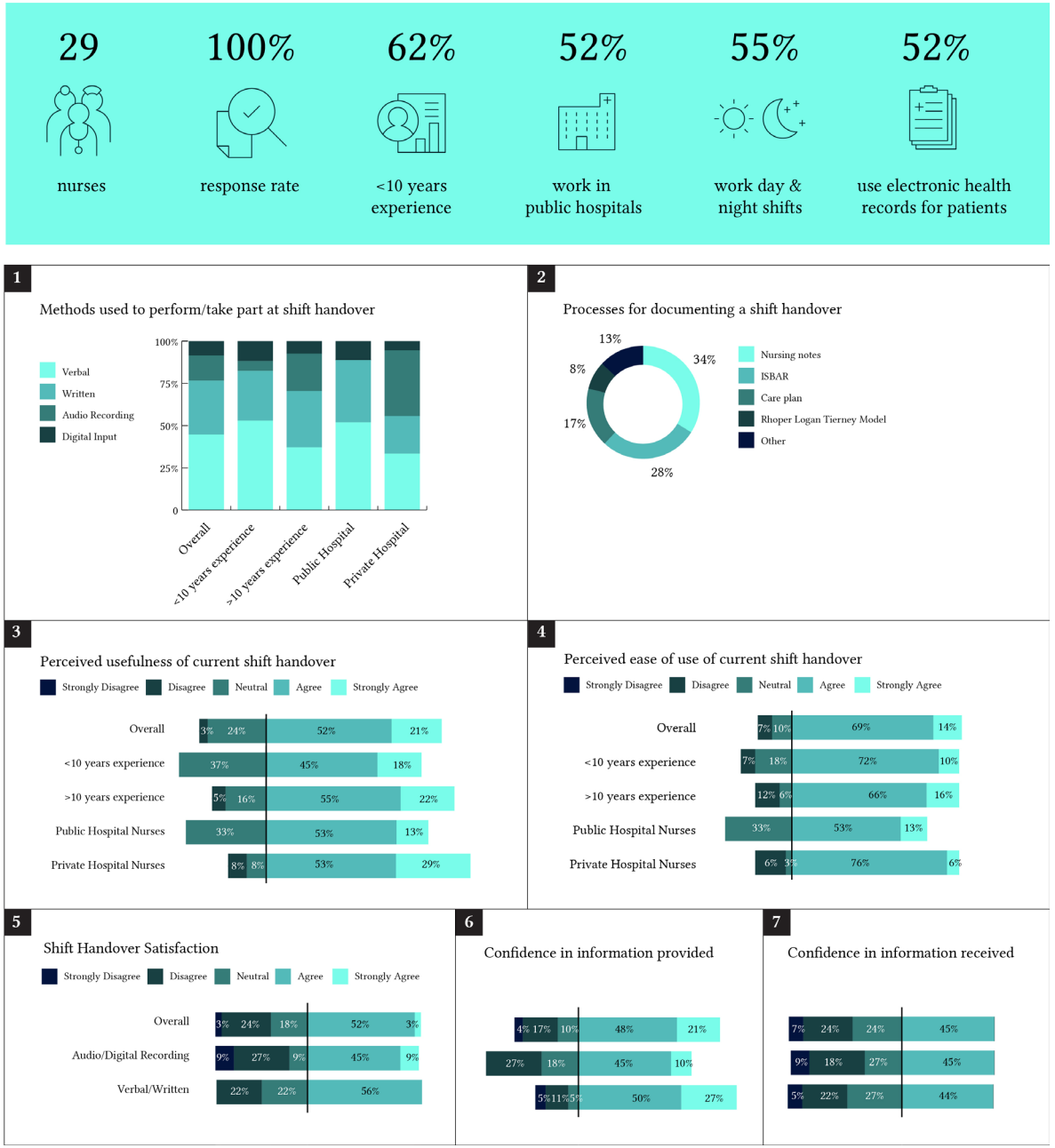
A Quantitative/Qualitative survey was created and distributed online to gain attitudinal insight.

Mixed method questions were used in the survey in order to get adequate information on current processes, reduce potential for measurement and non-response error and to tailor the methods to the target sample (Ponto, 2015).

Quantitative questions were based on the Technology Acceptance Model (TAM) which uses two scales, perceived usefulness and perceived ease of use, as fundamental determinants of user acceptance (Davis, 1989). A third scale for satisfaction was also included in the survey to gauge satisfaction with current handover processes. A Likert Scale was used to measure responses on a scale of 1 to 5 from 'Strongly Disagree' to 'Strongly Agree'. The Likert Scale measures attitude in a scientifically accepted and validated manner (Joshi, Kale, Chandel, Pal, 2015).

Qualitative questions were asked that mirrored the questions in the discovery interviews which provided the richest feedback, based on Thematic Analysis. Further Thematic Analysis of the responses from surveys identified areas for investigation and development as did the analytic study of the quantitative measures.

The survey results show that verbal and written methods are used mostly for shift handover in public hospitals while 53% of respondents in private hospitals use audio recordings. Nursing notes and the ISBAR method are the most common processes for documenting a handover. Perceived usefulness and ease of use scores were high for current handover processes. Interestingly, 83% of overall respondents find current methods easy to use while 27% of overall respondents don't find the methods useful. 55% of respondents were satisfied with their current process. Of concern is that only 55% of respondents have confidence in the information they provide while just 45% have confidence in the information they receive. Notably, respondents that used audio/digital recordings had less confidence in the information they provide over those that used verbal/written methods.

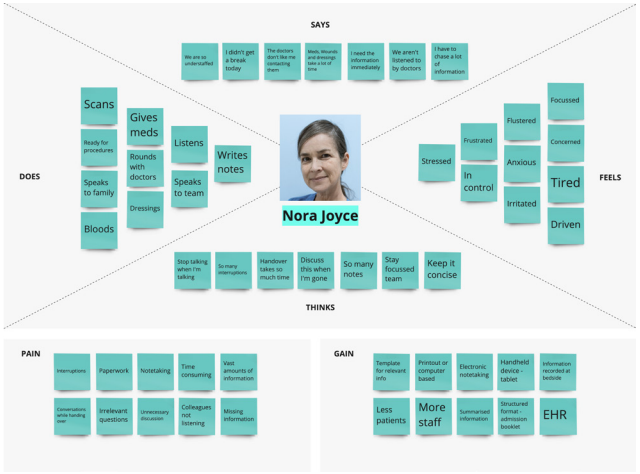


DESIGN

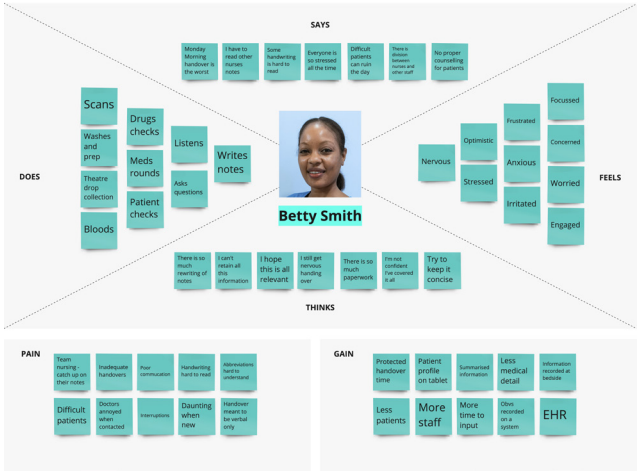
Personas and Empathy Maps

The interviews and online questionnaire allowed for the creation of Empathy Maps to visualise the user needs. Personas were created to represent two of the key user demographics, senior nurses with over 10 years experience and junior nurses with less experience.

Nora (Senior Nurse) – Empathy Map



Betty (Junior Nurse) – Empathy Map



Nora (Senior Nurse) – Persona

"There is so much information, it is hard to keep a shift handover succinct and to the point..."

ABOUT

Nora is a senior nurse from Dublin. She currently works in a Dublin hospital on a surgery ward. She will work day and night shifts depending on the roster. On average she will spend 1.5 hours on handovers each shift, 45 minutes to start, two separate 15 minute updates during the shift with a 15 minute handover at the end. Nora feels confident handing over as she has done it for over 10 years now. She takes written notes throughout her shift and refers to them at handover.

Staffing is a big issue for Nora with not enough nurses and care assistants compromising patient care. When handing over interruptions from doctors, patients and phones ringing are a real pain point for Nora. Nora would like a template with the key patient information recorded that can then be updated with key information from the previous shift.

GOALS

- Ensure a high standard of patient care
- Needs to deliver and receive summarised patient content
- Needs to keep the information relevant

CURRENT FEELINGS

STRESSED | ACTIVE | BUSY | CONCERNED

FRUSTRATIONS

- Constant interruptions during handover
- Verbose handovers from other staff
- Irrelevant questions and discussions
- Constant scribing of patient information

MOTIVATION

- Advocating for the patients, getting doctors to listen to them
- Providing the best care for patients

TECHNOLOGY EXPERTISE

Internet and IT

Software

Mobile Apps

USE OF TECHNOLOGY

- Desktop computer and mobile
- Mobile browsing and social media
- Bloods and Imaging databases

Betty (Junior Nurse)– Persona

"I get nervous handing over because it is important I include all crucial information..."

ABOUT

Betty qualified two years ago as a nurse and has been on the same surgical ward since. On average Betty spends two hours on handovers during her shift. 45 minutes at the beginning and end and two 15 minute updates during the shift. Betty still gets nervous handing over to senior nurses and managers, she wants to be confident in the information she is handing over. There is so much to account for and retain that she finds it hard to decipher the most relevant information for handover.

More staff are required on the ward to maintain high standard of patient care. Interruptions during handover are an issue and a protected time to handover would be of benefit to Betty and her team. A digital patient profile would improve handovers for Betty rather than stacks of pages on patients.

GOALS

- Ensure patients are alive and well
- Deliver a concise and accurate handover
- Provide training to her adaption nurse

CURRENT FEELINGS

ANXIOUS | TIRED | BUSY | CONCERNED

FRUSTRATIONS

- Constant interruptions during handover
- Too much information to retain
- Constant scribing of patient information
- Missing patient information
- Shorthand and nurse handwriting legibility

MOTIVATION

- Providing the best care for patients
- Helping the families of patients

TECHNOLOGY EXPERTISE

Internet and IT

Software

Mobile Apps

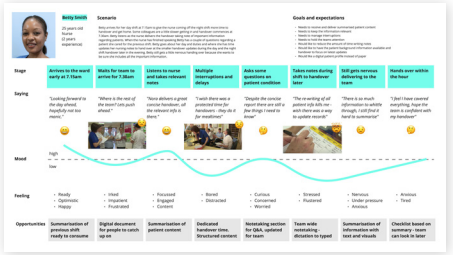
USE OF TECHNOLOGY

- Desktop computer, tablet and mobile
- Social media, online shopping, streaming
- Bloods and Imaging databases

Journey Maps

Journey maps show the 'As-Is' scenario our personas currently face. Based on the accounts provided by the nurses interviewed, a scenario was created for the senior and junior nurse personas.

Betty – 'As-Is' Journey Map



Nora – 'As-Is' Journey Map

Nora Joyce

40 years old
Nurse
(12 years experience)

Scenario

Nora is coming off a night shift of 12 hours and is handing over to the next morning shift at 7.30am. Some of the team have arrived early but she needs to wait for all the nursing team to arrive. The morning handover is the longest accounting for all patient activity during the night. 15 patients would usually take her 45 minutes to handover but it can take longer. Nora documents the handover in her nursing notes using a heading structure for patient, history, condition and current stats. When all the team have gathered round Nora delivers her handover verbally while the team take their own notes. Despite interruptions from doctors on call, phones ringing and patients she delivers her handover and manages to leave by 8.30am. She can't wait to get home to sleep!

Goals and expectations

- Needs to deliver and receive summarised patient content
- Needs to keep the information relevant
- Needs to manage interruptions
- Needs to hold the teams attention
- Would like to reduce the amount of time writing notes
- Would like to have the patient background information available and handover to focus on latest updates
- Would like prewritten and printable templates available for handover

Stage	Spends hours writing notes through night shift	Waits for team to arrive for 7.30am	Greets team and begins talking through handover	Multiple interruptions and delays	Finishes speaking and answers questions	Questions divert off on tangent	Conversations delay Nora answering questions	Nora finishes up and leaves the team at 8.30am
Saying	*"This takes up so much time"*	*"I can't wait to finish up now, where is the rest of the team?"*	*"Right, down to business. I need to remind the team of patient X bloods."*	*"10 interruptions and I've only gotten through 1 patient!"*	*"Good questions from nurse A. I wish nurse B and C would stop talking"*	*"Focus people!"*	*"Do you have to discuss this now, I've delivered my part let me go home"*	*"Happy with that handover, patient X will be in safe hands. I'm wrecked"*
Feeling	• Tired • Fed up • Concerned	• Stressed • Anxious • Tired	• In control • Focussed	• Stressed • Anxious • Irritated	• Part of the team • Concerned • Anxious	• Flustered • Irritated • Stressed	• Flustered • Irritated • Stressed	• Content • Happy • Tired
Opportunities	**Note taking EHR**	**Digital document for people to catch up on**	**Summarisation of content**	**Dedicated handover time. Structured content**	**Notetaking section for Q&A, updated for team**	**Structured format will help align team**	**Notes section can be updated with questions**	**Updates on shift when Nora logs back in**

Mood: high / low

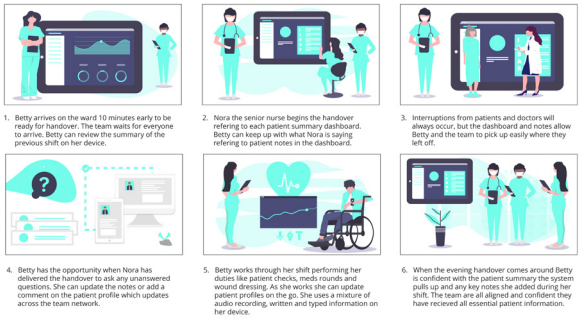
Storyboards

Storyboards show the 'To-Be' scenario both personas would ideally encounter at the end of a shift and the beginning of a new shift. A storyboard was created for each persona based on the wants and needs of the nurses interviewed and responses in the online questionnaire.

Problem Statement

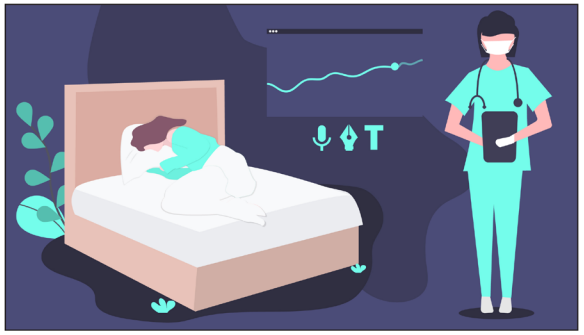
(*Who*) Nora, a Senior Nurse working the night shift, **(*What*)** can use a digital device to record patient information which she can refer to at handover, **(*Wow*)** providing a concise and efficient handover with all key patient information and tasks communicated.

Betty – Day Shift to Night Shift Handover

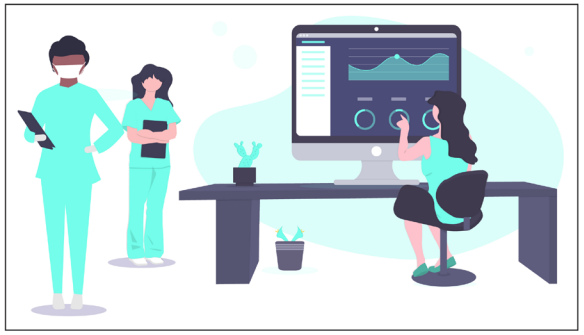


1. Betty arrives on the ward 10 minutes early to be ready for handover. The team waits for everyone to arrive. Betty can review the summary of the previous shift on her device.
2. Nora the senior nurse begins the handover refering to each patient summary dashboard. Betty can keep up with what Nora is saying refering to patient notes in the dashboard.
3. Interruptions from patients and doctors will always occur, but the dashboard and notes allow Betty and the team to pick up easily where they left off.
4. Betty has the opportunity when Nora has delivered the handover to ask any unanswered questions. She can update the notes or add a comment on the patient profile which updates across the team network.
5. Betty works through her shift performing her duties like patient checks, meds rounds and wound dressing. As she works she can update patient profiles on the go. She uses a mixture of audio recording, written and typed information on her device.
6. When the evening handover comes around Betty is confident with the patient summary the system pulls up and any key notes she added during her shift. The team are all aligned and confident they have recieved all essential patient information.

Nora – Night Shift to Day Shift Handover



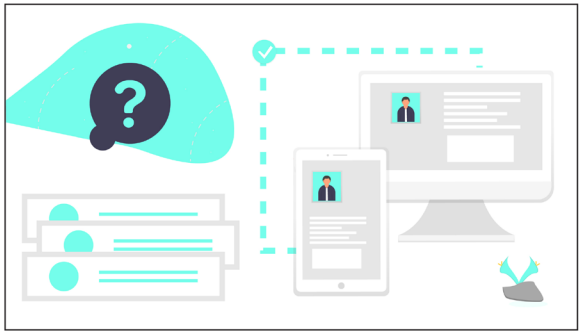
1. Nora takes notes on her patients at their bedside with her digital device as she works through the night. She uses a mixture of audio recording, written and typed information on her device.



2. Next morning her team arrive a few minutes early and when they log into their digital device they are presented with a dashboard summary for the ward and all patients.

3. Nora talks the team through the handover refering to the dashboard summary for each patient. Despite interruptions, Nora can keep her train of thought refering to the dashboard.

4. Each patient is documented and discussed using the ISBAR (Introduction, Situation, Background, Assessment, Recommendation) structure documented in the patient dashboard.



5. Nora takes any questions at the end and can update the patient summary by editing or leaving comments. These edits and comments update across the team network.

6. Nora is able to head home confident she gave a thorough handover and the team have all the necessary information on their device should anything arise.

Paper and Mid-Fi Prototyping

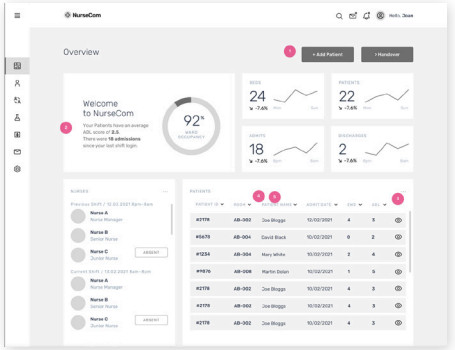
Paper prototypes were designed based on the persona needs and those expressed by nurses in interviews and the online questionnaire. The paper prototype consisted of a Ward Overview, Handover Patient List and Handover Patient Profile. Paper prototypes were guerilla tested remotely with a number of nurses for feedback on the work in progress designs. The feedback was taken and implemented in a mid-fi iteration of the design.

Ward Overview

The overview screens work in a similar way to the Patient Communication Board showing ward occupancy, staff and patient status.

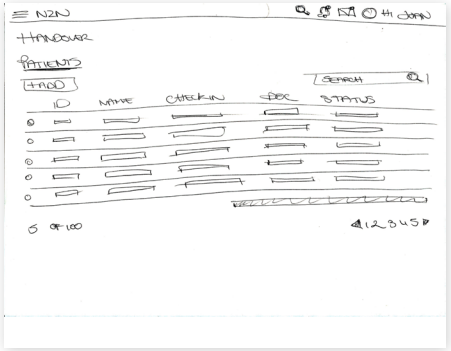
> **"We use a similar overview but it is spread across multiple tools"**
>
> Nurse A

> **"Care plans need to be included in nursing notes - could be 20 per patient"**
>
> Nurse B



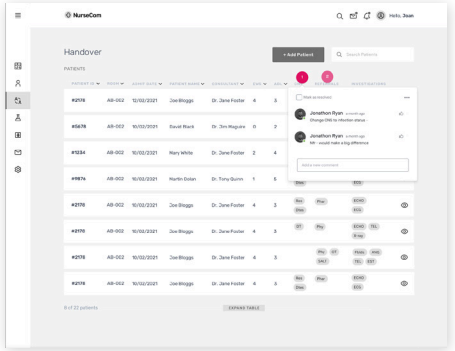
Handover

The handover screen gives a list of patients on the ward. Nurses can view each patient profile in an editable digital ISBAR template.



> **"I need to be able to audio record, type and write into the notes"**
>
> Nurse B

> **"I need to know the infection status for a patient and if they are not for recuss"**
>
> Nurse A

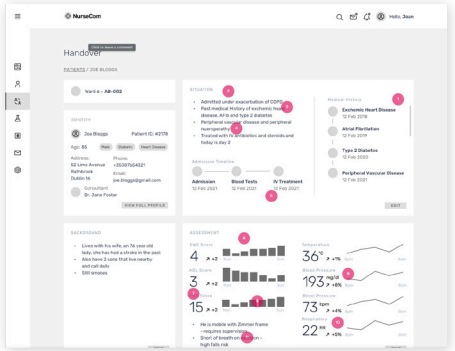


Patient Profiles

Patients are displayed in a list of all patients. A patient profile can be selected and viewed displaying patient information, history, stats, nursing notes and care plan.

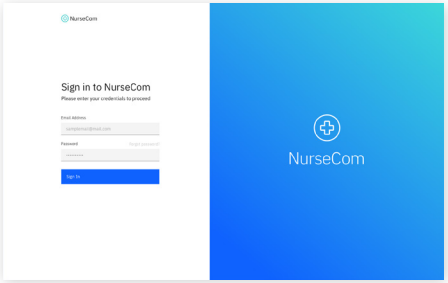
> **"Vitals can be summarised in an EWS (Early Warning Score) - I would drill through for detail then"**
>
> Nurse A

> **"We would need to know what drugs have been administered in the patient timeline"**
>
> Nurse A

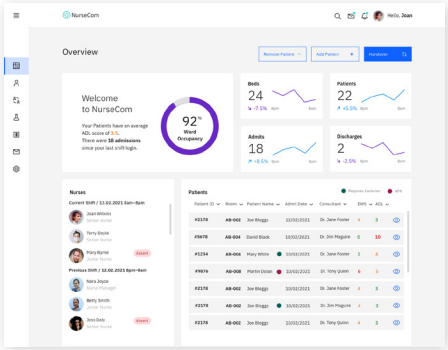


Hi-Fi Prototyping

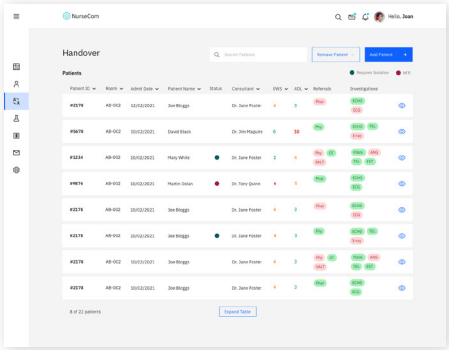
The feedback provided from guerilla testing the mid-fi prototype with participants was used to iterate a hi-fi design of the dashboard experience. The prototype enabled a user to log in, review a ward overview dashboard, navigate to individual patient handover and view patient profiles. During the patient handover the nurse could review patient history and observations, take notes and update patient information in the patient profile.



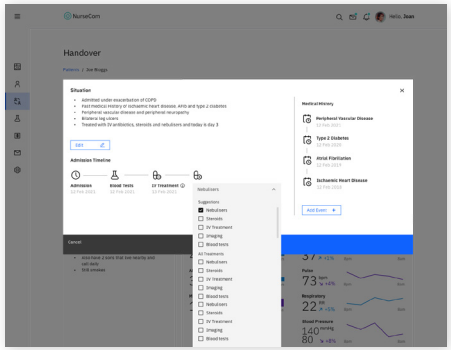
1. NurseCom Login - Nursecom was decided on the name of the digital prototype as a play on the words ‘Nurse’ and ‘Communication’.



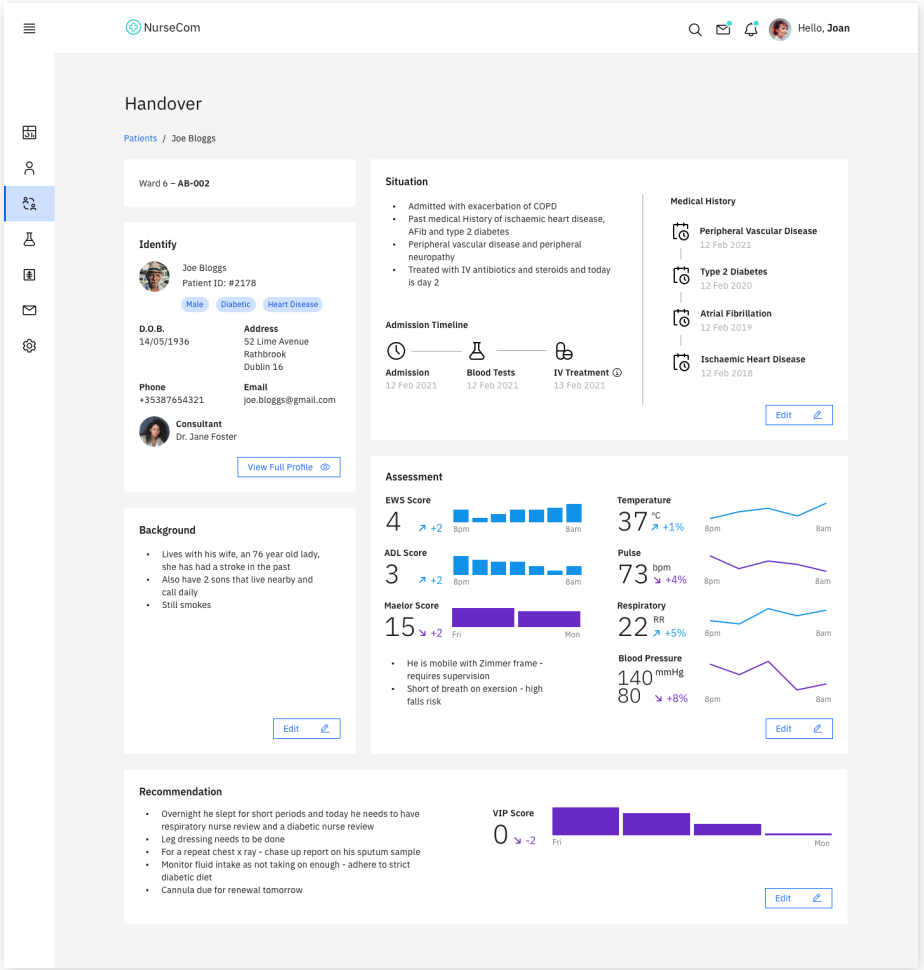
2. Ward overview - Data visualization with ward stats, key actions, nurses on ward and patient profiles. Based on testing feedback, the ‘Remove Patient’ button was introduced along with colour coding for scores, status and the addition of consultants on the Patients section.



3. Handover - All Patients Overview was colour coded with scores, tags and status based on testing feedback. A search for patient function was also included.



4. Situation Card and Timeline - Options in the edit view enable the user to voice record, capture a photo or freehand draw on the screen. Adding the medication through a dropdown menu was included as a feature based on testing feedback.



5. Handover Patient Profile - Editable fields, history and admission timeline, patient details, records, scores and statistics. As a result of testing feedback, timelines were changed on some scores to 12 hour shift to track the frequency of recording.

CONCLUSION AND FUTURE WORK

The discovery research undertaken provided the insight to inform primary research activities. The design of UX artefacts grounded in this discovery research helped to identify the needs of nurses and act as shorthand for the full set of attributes, desires and behaviours that need to be considered when making design decisions (Harley, 2015). The study illustrated how current shift handover methods are primarily paper based, lack standardisation and are time consuming with excessive documentation and interruptions on the ward. The research outputs enabled the identification of key areas of the nurse shift handover where a digital dashboard can help to improve communication, efficiency and satisfaction while validating the 3 hypotheses for the full study.

Testing of the paper prototypes allowed for early feedback and first-hand experience of viewing and interacting with a digital tool that nurses can use at shift handover. The overview was highlighted by nurses as something they do currently but across multiple tools and formats so one consolidated view is of benefit. Nurse responses indicate that, to allow for accurate recording of patient information, the functionality of the tool must allow for audio recording, typing and writing information on screen. The scores around ADL (Activities of Daily Living) and EWS (Early Warning Score) were highlighted by nurses as key measures of patient health that have been represented with data visualisation.

The iteration and guerilla testing of the paper prototypes and mid-fidelity designs resulted in the design of a high fidelity prototype. The final phase of the study saw the recruitment of 16 participants for a final A/B test of the hi-fi digital prototype alongside the paper prototype. This test was a within-subjects test design where each participant was tested under each condition to maximise the available participant feedback. The A and B of each test was alternated with participants to prevent any learning effects (Creswell, 2018). Two fictional patient handovers were created based on the HSE Ireland's available training material that were read aloud during the test to simulate a handover. The test consisted of 3 tasks for each prototype. A post test interview was conducted to gain further insight on each prototype.

Results from the quantitative analysis of the post-test interview show that 94% of participants reported that the digital prototype communicated essential patient information more effectively than the paper prototype. The Qualitative Content Analysis highlighted several areas in which nurses found the digital prototype enhanced the communication of essential patient information with nurses indicating higher levels of accuracy, detailed summarised patient content and clear layout that resulted in a better user experience.

Quantitative analysis for the Time on Task indicated that there was no improvement in time taken for the digital prototype over the paper prototype, with some of the tasks taking significantly longer on digital. Remarkably, despite this increase in time taken, 82% of participants stated in the post-test interview that the digital prototype was more efficient to use than the paper prototype with many participants stating that the digital prototype was faster to use. This view may be due to the novelty factor of the digital prototype as experienced by Tay (2016) in their longitudinal study on the impact of iPad use on teaching and learning.

Quantitative analysis for the NASA TLX indicated that there was an overall improvement in mental workload of 114% based on the geometric mean of the 3 tasks. Quantitative analysis for the SUS indicated that there was an overall improvement in satisfaction of 23% when using the digital prototype. 100% of participants stated in the post-test interview that they were more satisfied with the digital prototype than the paper prototype.

In short, the study has illustrated that the use of a digital data visualisation dashboard to view, record and store patient information can improve nurse shift handovers in the communication of essential information, the efficiency of a handover and the overall satisfaction with the shift handover process.

Future research would involve the iteration of the digital prototype based on the feedback provided by nurses during testing. Key feedback involved removing some of the manager level ward overview charts while providing more emphasis on the patient overview section including additional measures like diet, falls risk and blood results on the timeline. Additionally, further research in the form of a longitudinal study over a period of months would potentially find more reliable data for the metrics used in this study.

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