

Personas and scenarios (infusion devices)



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Overview

There is a concern that during the design, development and deployment of medical equipment, the reality of who will use a device, and how they will use it, is not communicated. A potential way to address this problem is through application of relatively simple, lightweight and adaptable techniques that allow those from different professional backgrounds to share views on who will use a device and how. This document provides illustrative examples relating to the application of two such techniques (personas and scenarios). The techniques have been advocated as a way to avoid design in isolation by encouraging consideration of design possibilities and discussion of what products should do and why. They do this in a way that is commonly accessible. The examples in the document relate to a class of device, frequently used in UK hospitals (infusion pumps). The set of personas and scenarios, while being empirically grounded, are not comprehensive, being based on data from a limited set of UK hospitals.

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This content is available online at <http://tinyurl.com/n2stptx>

MARY

Age: 24, Staff Nurse, Oncology Services

Personal Background and Profile

Mary has been working for the health service for two years. Mary normally works alongside 4 nurses and one nurse manager. Mary takes blood samples, delivers anticancer therapies, in addition to providing supportive therapy. As well as setting up and delivering infusions, Mary is responsible for caring for patients, educating them about their treatment, reviewing, checking and updating records and liaising with other healthcare professionals. Mary works as part of a multidisciplinary team, which is often short staffed. Mary normally gets her colleagues to double check any calculations prior to acting on them, however when the unit is short of staff this isn't always easy.

“Even coming to the hospital can be stressful, emotional and a worry to patients”

Likes / Dislikes

Mary likes R&B music and goes out with her colleagues, to local clubs on a Friday night. In her spare time she is a member of a local running club and periodically runs charity 10k races. Despite being in the job for a while, Mary finds it difficult when treatment is not successful. In some cases, Mary will get to know the patient and family quite well, although her colleagues tell her she needs to keep detached. Mary tends to focus on the positive and works hard to make sure that patients receive the best possible experience given the potential negative emotions associated with terminal illness.

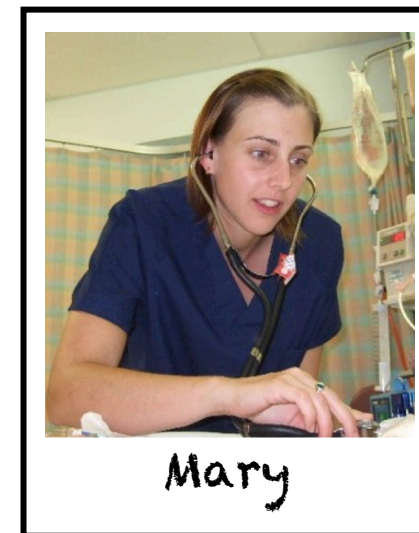
Attitude to Equipment

When equipment fails or doesn't work as intended, Mary gets cross and frustrated as she worries that patient care is being compromised. She tends not to show her emotions. Mary doesn't care about device functionality other than that used to program the infusion. If pumps are alarming frequently or configured inappropriately then Mary lets the nurse manager know. Mary is familiar with IT packages such as Word and Outlook and has a degree in nursing. Before using the infusion pumps, Mary completed a 40-minute training session with a Trust trainer, covering the process of identifying the giving set, loading the pump and programming the infusion. Mary hasn't read the device manual, but has been on a day long training course relating to the clinical aspects of IV therapy.

Goals and Needs

When using infusion pumps, Mary aims to quickly and reliably program the pump, whilst making sure that the patient is comfortable. Pumps alarm frequently and Mary is sometimes distracted when attending to a device. During a given day, Mary will need to program several infusions, sometimes using multiple devices simultaneously. Mary may program the device when wearing clinical gloves and look away or leave the

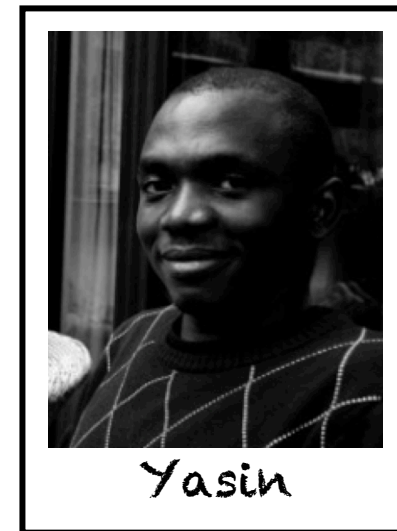
device unattended during the programming sequence.



Picture from: <http://tinyurl.com/7eopuca>

YASIN

Age: 40, Nurse Manager, Oncology Services



“Check, check, check”

Likes / Dislikes

Yasin likes watching and playing football and is an avid follower of the local club. He is married and has two children, Habib (4) and Tahir (2). Yasin always gets to work at least an hour before the rest of the team, but insists on leaving on time so, if at all possible, he can see his children. Yasin doesn't like dealing with what he calls “nasty substances”. These may be radioactive, volatile, flammable or toxic. Yasin has a very cheerful character and is always positive and helpful. He dislikes paperwork and doesn't like audits.

Attitude to Equipment

Yasin has seen it all in terms of good and bad practice, and understands a lot about the way that medical equipment can be used to help make things better. Yasin remembers the time when all treatments were delivered via syringes or drips – the great thing about the use of infusion pumps is that people don't have to wait so long for the treatment and nurses can prioritize time more effectively. Speaking to nursing colleagues, Yasin thinks that the manual use of a syringe or drip is better than a pump in some cases. That way you can watch how the patient reacts, vary flow subtly and deal with occlusions immediately. The recent set of volumetric pumps was purchased using money raised by a charity. He speaks warmly of them, but the introduction was not without problems. Yasin is proud of the time he used six pumps to deal with a particularly complicated protocol and works hard to identify ways in which things can be done better.

Goals and Needs

If the team is happy, Yasin is happy. Within the team, Yasin needs to know what is going on, when and why. He doesn't want to watch over his staff but also doesn't want the team making mistakes. He has to mediate between senior management and his staff. He gets frequent requests for data regarding quality and efficiency.

Personal Background and Profile

Yasin has been working for the health service for ten years. Yasin grew up in another part of the country, but has since moved to the local area when the job of nurse manager came up (two years ago). Yasin has responsibility for a team of nine nurses but shares the nurse manager role with two others (there is only ever one manager per shift). Yasin likes to keep up to date with basic IV therapy and nursing skills, as he finds himself performing many of the nursing duties. Although he doesn't admit it, he quite likes doing this, as the rest of his job involves dealing with what he often thinks are tangential issues associated with health and safety / quality improvement. Yasin also has to allocate responsibilities to the nurses, for example changing roles if a patient condition deteriorates, or team members are sick or late. Yasin has been on an eight hour “train the trainer” course provided by the infusion pump manufacturer.

FRANK

Age: 40, Clinical Engineer / Device Trainer

Personal Background and Profile

Frank joined the NHS as a clinical engineer, but recently took up a post as a medical device training officer. Frank has been working for the local NHS trust for ten years and has been involved in a variety of roles relating to the provision, servicing and training of a varied range of equipment types. In a previous role, Frank supported quality assurance. He worked predominately on monitoring equipment and infusion devices. Frank has a wealth of technical knowledge, but tends not to share it on account of no one being interested. Despite missing out on a university education, Frank has learnt a great deal “on the job” and is a member of a local online EBME support forum. He rides a Harley Davidson to work and has a lathe in his garage.

has had to contact the manufacturer when a pump was found with a cigarette burn in the casing and never knows what to do when someone tells him that they dropped a pump.

“Hi spec pumps are wasted in general use – we give them a Ferrari and they drive it like a Metro”

Likes / Dislikes

Frank is an engineer at heart and spent his early career in the hospital workshops, employed on a variety of projects, making custom made fixtures for ambulances. Despite a wealth of technical knowledge about how the extremely advanced and accurate pumps work, most of the functionality is disabled and the users rarely ask questions about anything other than basic functionality. Frank finds this disappointing.

Attitude to Equipment

Frank was involved in the staged upgrade from the legacy Infusomint device to the new Quantomax. Frank worked with the manufacturer and clinical staff to establish a servicing regime including battery maintenance (the NiMH batteries are fully discharged periodically) and calibration. He also helped implement a device tracking system. Since completing the upgrade program, Frank has had a bit of spare time. Therefore, six months ago, Frank took up an additional responsibility, training clinical staff on basic set up and programming of volumetric pumps and syringe drivers. Frank works closely with the clinical trainer sponsored by the equipment manufacturer. Frank tends to be primarily focused on the safety and set up of the devices, rather than clinical aspects relating to infusion therapy.

Goals and Needs

Frank rarely has any issues with the 40-minute training sessions and can effortlessly take users through the set up process. One of the main problems that Frank gets contacted over is how to clean the devices (for example the drop sensors). Frank helps people where he can, but doesn't really see it as his responsibility. Frank can download logs and diagnose minor faults. There is rarely a need to do this. When Frank does need to access the logs, he uses the servicing software “Quantoserve”. Finding the correct lead to attach the infusion device to the laptop and password to access the program always takes a while and the program isn't that easy to use. It needs to be run on a specific operating system and Frank keeps a dedicated laptop. Frank



JIM

Age: 67, Patient, Haematology/Oncology

Personal Background and Profile

Jim is a cheerful guy. He is a grandfather to four and spent most of his life working in a printing factory, setting up machinery and checking on the quality of the print. He has a relaxed, generous character. Shortly after retiring, Jim got diagnosed with chronic lymphatic leukaemia. This has recently got to an advanced stage. Jim has got used to visiting his local hospital and normally goes along with his wife Helen. He is currently receiving a course of IV chemotherapy. Jim has got to know the nurses and enjoys sharing a laugh with the staff and other patients. Last time Jim received chemo, he wasn't too well afterwards. Helen found this distressing.

“Just as long as it cures me, I don't really care”

Likes / Dislikes

Jim has a great sense of humour and likes playing practical jokes. Prior to his condition getting worse, Jim enjoyed having a Chinese meal on a Friday night and accompanying his children and grandchildren to the local park at the weekend. He likes the view he gets from the hospital ward / day care unit.

Attitude to Equipment

Jim tends to receive his chemotherapy sitting down, but other patients move around and sometimes even leave the hospital. Jim knows that if he moves his arm too much, the pump will stop, which may interfere with his treatment. He tries not to do this, but it isn't always easy when he is trying to read a book. He has seen other patients using heat pads and blankets during the treatment but he doesn't feel the need for them. Jim trusts the nurses implicitly. He thinks the infusion pumps look quite “space age”. They were obviously designed by “youngsters”.

Goals and Needs

Jim stays positive and doesn't want to be reminded that he is ill. That said, recently it has become a lot harder to ignore what is going on. Following the diagnosis and during the early stages of his condition, he kept himself busy and tried to keep the fact he had leukaemia in the background. Now it is getting to the point where he needs a wheel chair and pre-arranged transport to get to / from the hospital. Jim wants to make sure that Helen isn't put through too much distress but needs her help for an increasing number of day to day tasks. Jim has to stay free from infection. This means avoiding people who are ill, washing hands frequently and not eating certain foods. Helen keeps people informed of the progress of the chemotherapy, but really both Jim and Helen want it to interfere with their lives as little as possible. When the current round of chemotherapy started Jim was yearning after a holiday, he has always wanted to visit the Amalfi coast, unfortunately, it is looking likely that he is too sick to go.

SURESH

Age: 38, Hospital Pharmacist (Clinical), Oncology Services

Personal Background and Profile

Suresh always wanted to be a pharmacist. Suresh excelled during his education, receiving four grade As in Advanced level Chemistry, Biology, Maths and Physics. He went on to gain a Masters of Pharmacy before taking up a position as a hospital pharmacist. Suresh is a clinical pharmacist, meaning that he'll join ward rounds, give advice on treatment options, review medication in the event of undesirable side-effects, double check that medication is appropriate and advise patients and staff on treatment options. He aims to make sure that treatments are delivered safely and effectively. Suresh worked with a multidisciplinary team to define a standardized drug library for use throughout the hospital, but found it very difficult due to the unique circumstances associated with the administration of chemotherapy treatments.

"I enjoy talking to the patients"

Likes / Dislikes

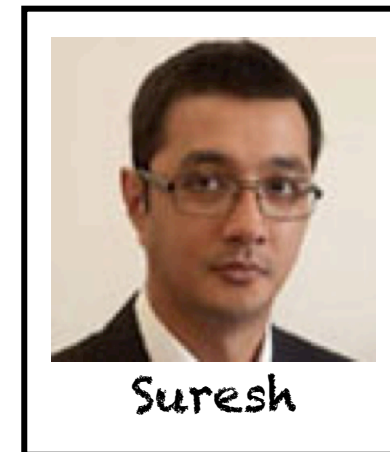
Suresh is quiet, unassuming, has an eye for detail and is very neat and orderly. He maintains focus on the task at hand and requires accuracy at every point of the process. Suresh likes paperwork (prescription charts) to be complete, correct and in the right order. He likes controlled drugs to be accounted for and any drugs stored on the ward to be in the right place. He doesn't like unlabelled drugs or preparations, or anything that might cause a mix up between drugs, patients, administration time or route. He likes the drugs fridge to be ordered so that people don't get confused. He doesn't like to see drugs intended for different routes of administration in the same tray. He hates people putting drugs back in the wrong place or in the wrong packaging. He is also on the lookout for pilferage, but hasn't ever had a problem with it. Controlled drugs are kept under lock and key for many reasons, although this can present a big problem when people can't find the keys. He doesn't like working out of hours and finds the hospital IT systems burdensome. He recently resorted to faxing paperwork around the hospital to get around a constrained and unreliable prescribing system.

Attitude to Equipment

Suresh likes infusion pumps, but sees them as inconsequential compared with the substances that are being delivered. His main interest lies in a pump configuration that may reduce the potential for unintended harm, or reduce the number of steps in the prescribing process. He has enjoyed using his British National Formulary (BNF) mobile phone "app" to get advice on drug management, including information relating to doses, side-effects, cautions, relative costs and contra-indications.

Goals and Needs

Suresh needs people to recognize that, when it comes to intravenous therapy, no two drugs or treatments are the same. Many of the treatments are individually mixed in the basement of the hospital. This is a complicated process. Although sometimes patients have to wait, he sees the most important thing as ensuring that the treatment is correct, the patient is in a condition to receive it and the protocol is appropriate.



Personal Background and Profile

Fred has been an anaesthetist for a long time. Fred started his health service career in A&E (as a Junior House Officer). He then moved into anaesthesia (as a Senior House Officer and then registrar). After seven years he became a consultant and has provided anaesthesia for many surgical disciplines, including neurosurgery, trauma, obstetrics, cardiac, orthopaedics and neonatal. He has provided hospital wide cover for pain relief (when necessary) and teaches medical students. He has co-authored in the region of 100 peer-reviewed papers and has been on several editorial boards. Fred has written a couple of textbooks and is interested in modelling the interplay between physiology and anaesthesia. Part of this relates to his interest in "Target Controlled Infusion" (TCI). This involves incorporating models into equipment that can alter the rate based upon the need for anaesthesia.

FRED Age: 55, Consultant Anaesthetist, Surgery

"The pumps are probably specifically designed to be awkward"

Likes / Dislikes

Fred used to be a keen tennis player but has moved over to tennis coaching due to a recurrent back problem. He likes writing papers, delivering lectures and attending international conferences. He doesn't like the current design of equipment and the fact that getting anything changed seems to take a number of years. He really hates it when the hospital runs out of certain types of drug, or he feels he isn't doing the best possible job due to a paperwork hold up.

Attitude to Equipment

Fred is a bit of a geek. He uses a laptop, two tablet computers, a smart phone and desktop PC (provided by the hospital). During his time in the job, he has seen advances in the technology surrounding anaesthetics. Patients recover faster and experience fewer side effects. There is a move towards more subtle, effective anaesthetics. Fred has experienced a few close shaves. These have involved the wrong drug being administered via the wrong route, drugs been accidentally administered twice, or in another case, drugs being mixed up. None of these situations involved an infusion device. Fred constantly reiterates how important safety is. Fred and the surgical team play Jazz music in theatre and try to keep the atmosphere as light as possible.

Goals and Needs

Fred would laugh at the idea of summarizing his goals and needs in a paragraph but is committed to the helping the next generation of anaesthetists excel in their work and pushing the discipline forward to his best possible ability. Fred wants to set up a centre of best practice for anaesthetists, including simulation facilities, R&D labs, trials units and teaching facilities. He wants the unit to be world leading. As part of this, he would like to see his ideas regarding TCI developed and put into wider use. To test his models and develop his ideas, he needs access to a range of drug types that may not be licensed in the UK. He also needs to navigate a complicated and lengthy technology approvals process if he wants to see anything adopted or standardized across the health service. Fred would like to think that when he retires he has made a difference and contributed to the history of anaesthetic practice. He'd also like to dispel the image of the isolated anaesthetist, hidden away at the end of the operating theatre.



MIRIAM

Age: 30, Agency Nurse, Various

Personal Background and Profile

Miriam has ten years of nursing experience and an “adult nursing” degree. She has found that being a temporary worker suits her needs and pays well. She also likes the variety. Miriam finds that she gets called to address staff shortages and does her best to fill the gap to the upmost of her ability. Most of the wards she works in are extremely busy. Although in most cases the team is glad to get some support, she has had a few problems working with people she has only just met. She often has to ask a lot of questions. The agency provides training on skills such as cannulation, but Miriam is already very competent. When she works on a ward, the main problem is knowing whom she needs to contact when problems arise. Miriam has a very young child, cared for by her mother.

“As an agency nurse you get left with the dull, dirty or difficult jobs that other people don’t want”

Likes / Dislikes

Miriam likes to think that she is doing a good job and wants to blend in. She likes it when short, concise and clear summaries of the procedures are available. She doesn’t really want the patients (or other staff) seeing that she is referring to them. She knows what to do, and when, but different hospitals have variations in practice and so she likes to check. Miriam likes it when equipment storage is labelled and also when descriptions of procedures or protocols are available. Miriam doesn’t like feeling out of her depth. At the same time she recognizes the need to get on with things. Miriam doesn’t like it when patients or relatives shout her at. She feels that she often gets put into some of the more difficult situations that arise. She isn’t always sure about the boundaries of her responsibility and gets concerned when she sees things that don’t constitute good practice.

Attitude to Equipment

Miriam doesn’t always know much about the equipment that is being used to administer treatment. Although she gets told where everything is, she sometimes finds it hard to locate the items that she needs. In some cases it is because the hospital uses an alternative make or brand and in other cases the item doesn’t exist. She cares about infection control, sterility and hygiene, but different hospitals have different ways of doing things so she isn’t always sure what is necessary. She has used a range of infusion devices and tends to prefer the modern ones as they give a bit more support and guidance when it comes to programming. That said, she likes the Hosponox device that she trained on.

Goals and Needs

She is very intelligent but sometimes has problems communicating. She needs to win the confidence of those around her quickly and finds that having problems interacting with equipment undermines this very quickly.



Background and Context

Mary is working in the oncology day care unit. She has responsibility for three patients. One of these is Jim. She has a buddy assigned but won't be able to rely on her as things are busy. She has been told about a potentially disruptive patient and warned about a potential mix up as two of the patients have similar names. Jim is receiving a course of IV chemotherapy. He needs his bloods checked, then, assuming the results are within limits, administration of hydration / mineral supplements and chemotherapy. The air conditioning is broken and to make matters worse, it is taking her a long time to log onto the hospital computer. The hospital uses a "chemo-safe" IT system that has an integrated formulary and protocol library. Jim's details are entered on the system, the pharmacy has prepared most of the treatments and the prescription paperwork has been printed out. Multiple individuals have checked the prescription and treatments.

SCENARIO 1: *Mary is administering a sequence of treatments*

"It is all about safety and speed... We normally give a drug, flush it through, give another and flush it through"

Criteria for Success

Mary needs to deliver multiple treatments in the right sequence safely and efficiently. There are lots of things to watch out for, for example making sure that Jim is able to receive the treatment, his weight hasn't changed, the treatment is correct, she has the drugs and equipment prepared, the paperwork is completed, Jim has given consent and the infusion is set up correctly.

The Story

Mary is about to start administering the chemotherapy for Jim. She has already checked that his weight corresponds to that on the prescription and the results of blood sample are in range. She has assembled most of the items



that she needs and double checked that the chemo is available and the labels on the chemotherapy bags (name, date, drug, dose and route) match the details on the prescription. She has a few other bags ready with no label attached. This usually means the bag contains saline or glucose. She also has some supportive treatments (for example antibiotics) and a range of accessories such as syringes, the giving set and antiseptic wipes. She checks the expiry dates and then the sequence of the drug administration. The form that she is looking at contains the drug name, dose, route, method of administration, time of administration and notes regarding the treatment. Mary wants the whole procedure to go as quickly and efficiently as possible, but, they only have one pump and it isn't possible to set up and program a sequence of infusions. Mary sets up the cannula (this isn't always easy but today it isn't proving too difficult as Jim has "good" veins). Each treatment is set up separately. Mary starts with the hydration therapy. The hydration bag needs a magnesium supplement adding to it, but Mary can't find it. Mary stops what she is doing and goes to get the magnesium, mixes it with the hydration pack and carries on with the set up. Mary spikes the bag, she primes the line manually and then checks the line for air bubbles. She finds one of these and "chases it" back up the line. She turns on the pump, inserts the line, programs the pump, she sets the VTBI to 1000 mL and time to 1 hour. Sometimes people use a rate, sometimes a time, but the pump always calculates the remaining value for you. Mary also knows she needs time to get the chemotherapy treatment ready. She knows the pump is set to pre-alarm a few minutes before the hydration therapy is complete and this should provide sufficient time. In that way, the alarm is a good thing as it reminds her to do something. In the remaining period she can go and start "prepping" some of the other patients, but she has to be careful that she doesn't get to the point where everything needs to be done at once.

Picture from Joseph E. Lake, Jr. and Farah J. Mendelsohn

Background and Context

Yasin is substituting for one of his staff who is away sick. He is about to tend to a patient in an isolation room. The patient is receiving chemotherapy. During chemotherapy a reduced immune system means that it may be best to use an isolation room to minimize the chance of infection. They don't have that many isolation rooms available and they require preparation prior to entry, for example the use of gloves, apron, removal of watches etc., washing of hands and in some circumstances use of a mask and/or gown. The rooms use differential pressure to minimize the chances of infection. Yasin wants to avoid having to enter and exit the room on multiple occasions and so is doing what he can to set up a series of long running infusions. The patient has knocked over a commode, so Yasin gets Miriam to arrange for the area to be cleaned and disinfected. Yasin knows that the patient is ready to receive the treatment but needs to get the OK from the doctor.

SCENARIO 2: *Yasin is setting up treatments in an isolation room*

"I know these numbers, after so many years... the pump backs up my maths"

Criteria for Success

Yasin needs to manage the set up and programming of multiple pumps, making sure the right pump is delivering the right treatment and programmed with the correct parameters. He wants to minimise the number of times he has to subsequently visit the pumps.



The Story

Yasin has entered the isolation room. He has everything he needs prepared in a blue tray; this has been cleaned and disinfected to provide a "clean field". It only contains clean items. Yasin is using three volumetric infusion pumps,

attached to a pole. He has hung multiple bags of chemotherapy on the pole after checking all of the details. There are already a couple of additional bags containing saline and potassium. Two of the three pumps are being set up simultaneously. The third pump is already running, delivering a potassium treatment. Yasin uses the prescription chart to check and double-check the treatments and order of treatments. Unfortunately, it isn't always that straight forward, as in this case the doctor wants to check on the patient to see if they need any supplementary antibiotics beforehand. This is indicated on a post-it note affixed to the prescription chart. Yasin decides to set up anyway as the doctor should be here shortly. Yasin primes the lines using saline and then spikes the chemo bags. He clamps to stop any chance of free flow, or accidental release. He sets up the drip chambers and attaches yellow "cytotoxic" tape to the lines. He turns the pumps on and then opens the pump doors. As he is part way through setting up the first pump, the second pump (with the open door) starts alarming. Yasin stops setting up the first pump and starts working with the second pump. The patient then asks Yasin to have a look at his cannula. Yasin does this and then loads the giving set in the second pump. He then goes back to the first pump to finish programming the rate and VTBI. He knows that if he leaves either device for too long it will start alarming. Despite the pumps telling him to release the roller clamp, he leaves them in place. He finishes the programming but doesn't press start on either. Yasin then looks at the battery indication on the pumps. He can see that the second pump isn't fully charged. In this case he would rather use the pumps on "battery power" as it is better to avoid trailing leads. He would also have to track down a power adaptor and these have been in short supply due to a few of them breaking.

Picture from: <http://tinyurl.com/ck9odjo>

Flickr user: arlingtonva

Background and Context

Jim is staying overnight in the oncology ward. At the beginning of his treatment he could receive chemotherapy in the Day Care Unit (DCU). As he has begun to get sick there is a need to keep him on a ward. Jim has had a recent bout of diarrhoea and the staff must get fluids into him promptly. He is hooked up to an infusion pump that is delivering fluids. He is lying down, in a bed. The ward is quite dark (it is late at night) and most of the patients are asleep, although a few are sitting up, reading books. His current infusion was set up about an hour ago. He doesn't know how long it will go on for, he just hopes that he doesn't need to go to the toilet again and he is being really careful to not move his arm too much. The nurses have put a bandage over the access point (cannula) so it shouldn't get caught in anything. Jim knows that if he bends his arm too much then the device will alarm. Last time this happened the pump created a terrible racket and the nurses took a while to come over and sort it out. For some reason they wouldn't make it quiet until they had had a good look at his arm.

is not very comfortable. Jim wishes he knew how long he was going to have to stay like this for. He is also worried that the nurse might not hear the alarm. Earlier in the day, Jim could see that the nurses were being put under pressure by having to deal with all of the alarms on different equipment. He doesn't want to upset them. He wonders what the alarm sound means and how long it will be until he can be disconnected from the equipment. He also worries that he might have broken the pump. What does the amber light mean? Jim thinks back to a nurse using another piece of equipment. He was taking his pulse. That thing made a racket as well. The nurse didn't seem to be benefiting much from the blips and bleeps and tried to follow the instructions to shut it up. Just when they thought they had sorted it, the thing started chirping again. Jim and the nurse had a laugh about this, but he could see that the nurse was a bit embarrassed. Jim thinks back to his home and his wife Helen and wishes he wasn't in hospital. He wonders if Helen is asleep, how she is, and how the children and grandchildren are? He hopes that his current condition isn't going to influence the chemotherapy and wonders if he will ever get to leave the hospital.

SCENARIO 3: *Jim can't sleep*

"Its amazing anyone gets any sleep around here"

Criteria for Success

Jim needs to sleep.

The Story

Jim is tired, gaunt and pale. The doctors are beginning to get concerned about Jim and the way that he is responding to the chemotherapy. It is late at night and not much is happening on the dimly lit ward. About an hour ago a nurse set up an infusion pump next to Jim. Although the infusion pump screen and buttons were backlit, she used the light of her mobile phone to check the line and make sure that everything was set up correctly. Jim is very anxious about the fact that his infusion pump might alarm and disturb the other patients. The last time this happened was when he moved his arm slightly, although on a few other occasions he hadn't got the foggiest as to why the pump was alarming. His arm is rigid and tense and he



Background and Context

Fred is providing anaesthesia during a liver replacement operation. It is a complicated procedure and the operating theatre is busy. Prior to the operation, Fred met with the patient and talked about the anaesthetic procedure, the risks involved and what the potential side effects were likely to be. Having done this, Fred is in the process of inducing anaesthesia, which due to the length and complexity of the operation requires a combination of different drugs to provide hypnosis, analgesia and muscle relaxation. Delivery of the drugs can be performed manually, through the use of infusion devices, vaporizers or ventilation of medical gases. The theatre contains a number of different types of medical equipment including volumetric infusion pumps, syringe drivers, monitors, anaesthetic machines and ventilators. There are a number of accessories including a patient warming device and various barriers and drapes between the surgeons and the anaesthetists.

adjustments a code is required. Most of the people who use the pump can't remember this code and so keep a copy of it in their smart phones. A spare battery is kept next to the pump as it isn't unusual for the pump to run out of power mid operation. If this happens, it needs to be changed quickly. Fred has got around to setting up the device, putting a new battery in, connecting the bag, attaching a cassette (the part that drives the drug down the line), attaching the sets, air sensor and reviewing the configuration settings. Fred responds to the on-screen prompts. Now let me see, he mumbles, set up a new delivery, YES, lock the pump, YES, set attached, set latched, sensor on, YES, drug bag to 240 mL, YES, prime tubing, YES. Fred gets impatient. I hate this bit, I have to hold the YES button for two minutes, (two minutes pass), continue priming, NO! The pump screen now displays "Epidural Stopped" and asks the user to press VIEW to continue. Fred presses VIEW and then sets a rate using up and down arrows. He pushes the buttons until the screen reads 6 mL/hr. Fred knows from experience that this is the right value for the size and weight of patient. He also knows from experience that to get the pump to do anything you have to press "ENTER". There is nothing on the screen to indicate this. The pump then asks for a dose. This is because, when the pump is in use on an ICU, patients can self-administer a small dose or bolus of pain relief. Fred enters 0 mL/hr and presses ENTER. He then enters the volume of the bag and presses ENTER. That way, the pump should know when the bag is empty. The pump provides a prompt to remind him that an air detector is required. Fred reviews the values using the VIEW button and then locks the case. He presses START and the pump asks if Fred wants to start the infusion, YES or NO. Fred presses YES. This locks the keypad and the pump starts delivering the drug.

SCENARIO 4: Fred is setting up an epidural pump

"If you go through the whole menu from the start it is okay - but adjustment is chaos"

Criteria for Success

Getting the epidural pump to deliver a drug to provide analgesia.

The Story

The patient has been prepped and moved to the operating theatre. Whilst the patient was awake a catheter was inserted into the epidural space in their back. An analgesic was delivered manually and the epidural pump will be used to maintain the level of analgesia. The pump will move with the patient after the operation, so that analgesia can be continued. It is placed inside a locked clear plastic box. The pump buttons and screen can be accessed through a hole in the box but the rest of the device is inaccessible without the key. For some



Background and Context

The medical equipment library is a centralized store run by nurses, equipment coordinators and technicians. Members of staff collect and deliver equipment on the request of clinical staff. The equipment library is responsible for the cleaning, maintenance, repair, decontamination, testing, checking, storage and record keeping associated with medical equipment. The library staff maintain a database of equipment types including details relating to usage, service (due) dates, repairs, purchase dates, planned disposal, location, availability, risk rating, type, asset number, owner, manufacturer, model, make and value of equipment. The staff receive requests from wards using a paper based form containing information regarding the name and ward of the requester, date and time of removal, estimated return date and necessary details about the patient (for example weight or condition). A similar online form can be submitted. They also have a card index system ("T-cards"). The system can be used to show where equipment is loaned. The library has also been trialling the use of RFID technology to assist in the location of medical equipment. This is because smaller items often go missing as a result of being hidden away in cupboards or moved to other parts of the hospital. Sometimes equipment is also moved away from the hospital.

the battery life. Some of the users have been complaining that the pumps are running out of power mid-infusion. Frank waits for the pumps to be returned and then intercepts them before they become available, placing the red T-card under the "out of service" section on the T card Panel. This now has nine volumetric pumps listed as "out of service". Something is not right, because he knows there are three on his workbench, three have recently gone back to the manufacturer and three are nowhere to be found. As it happens, Frank knows where the pumps are, as he went looking for them at the end of last week. A set of the pumps that were on loan became contaminated. They needed to be returned to the equipment library for, cleaning, decontamination, checks and possible repairs. The nurses were concerned that the equipment library staff would not be aware that the pumps were contaminated. They placed them in yellow "clinical waste" bags. These were accidentally collected and incinerated.

SCENARIO 5: *The equipment library has run out of volumetric pumps*

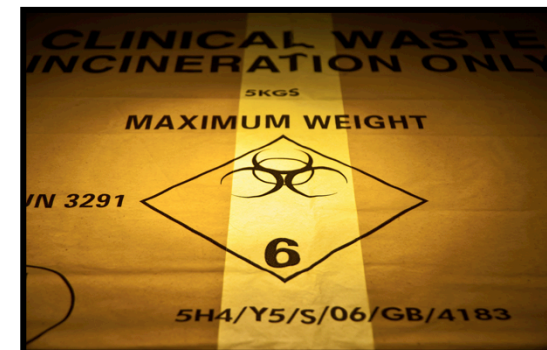
"If you hadn't put the pumps in clinical waste bags, they wouldn't have got incinerated"

Criteria for Success

Finding out where the missing volumetric infusion pumps are.

The Story

It is Monday morning. The medical equipment library manager has called up Frank. The equipment library is next door to his office so he goes around. The phone is ringing and the manager is scribbling on loan requests and shouting instructions. "I need two D1s for the ICU". There are multiple requests for volumetric pumps that are coming in, but very few remaining in the library "clean area". The right hand side of the "T card panel" has a red strip, under the "out of service" heading. The "T card panel" is a large board showing the numbers and types of equipment allocated to the various wards in the hospital. Red cards indicate volumetric infusion pumps. The equipment library manager turns to Frank and shouts, "Where are all my pumps?" Frank thinks back to the previous week. He has been spending the last couple of months taking the volumetric pumps out of service so that he can check up on



Background and Context

The Intensive Care Unit (ICU) has received a patient from surgery (via the recovery room). The ICU contains five bays, each with a dedicated nurse and series of equipment types. These include volumetric pumps, syringe drivers, life support systems (ventilators), medical supplies and a computer terminal. The computer terminal provides access to the Electronic Patient Record (EPR). The ICU staff (nurses and doctors) are working with the surgical team to review the surgical/anaesthetic notes prior to entering them onto the EPR. The ICU doctor will then prescribe additional treatments as necessary, which will also be entered into the EPR. Nurses prepare and administer treatments by reading the prescription from the EPR and extracting the necessary drug, dose and rate, taking into account patient weight and condition. Nurses prepare the medication, for immediate use, making sure that the syringe or bag contains the required medication at the required concentration. They then program infusion devices to deliver the medication at an appropriate rate. In some cases they may also program the device to deliver a set amount (Volume To Be Infused - VTBI). Care needs to be taken, because if a VTBI is provided and the syringe changed, then the device will stop after the specified volume has been administered, not when the contents of the syringe has been delivered.

option, read the volume infused and reset the counter to zero. This takes eight key presses. If the nurse decides to read the value from the syringe then they need to open the device door. In some cases the scale on the syringe or the yellow label indicating the drug name is obscured. They have to displace the syringe to access this information. In this case, the situation has been complicated by the fact that the patient is receiving adrenaline to keep their blood pressure in an acceptable range. The nurse is flicking her gaze back and forth between the monitors that are located on the other side of the patient. This is because she needs to keep an eye on the vital signs and, if necessary, adjust the rate of drug delivery on the other devices.

SCENARIO 6: *Members of the ICU are providing postoperative care*

“With all the monitors, ventilators and infusion pumps, the whole thing is a bit like an aircraft cockpit”

Criteria for Success

Delivering postoperative care, managing pain, getting the patient to the point where they can be discharged from the ICU.

The Story

It is late in the evening and members of the have taken responsibility for a patient, post surgery. An array of monitors and medical equipment surrounds the patient who is receiving multiple solutions via IV lines. The ICU nurses need to check the volume of fluid delivered by the infusion devices at regular intervals and enter this value into the electronic record. They don't want to stop the pump in order to do this, as unintended fluctuations in the rate are not good for the patient. There are various ways to find out how much fluid has been delivered, for example, through checking the contents of the syringe or bag. Alternatively they can check the value recorded by the infusion device. If the nurse gets the value from the device, they need to navigate the menu structure in order to take a reading of the amount of fluid delivered since the last reading was taken (an hour ago). They press a button to bring the menu up, select the “status” option, navigate to the “intermediate parameters”



Picture from: <http://tinyurl.com/c8uz6rk>

Flickr user: alinssite

Background and Context

Suresh is sitting in a meeting involving a range of professionals from different backgrounds. They are tasked with implementing a standardized infusion device management policy across the hospital. The aim is to reduce the potential for medical error. The meeting includes representatives from manufacturers, hospital procurement, infection control, training, nursing, clinical and pharmaceutical organisations. The team wants to implement controls (either via the configuration of the pumps or wider policy) to reduce the potential for medication error. One way to do this is to get the pumps to block input that would result in over or under infusion. Although this sounds simple, it isn't easy because different drugs are used in different ways in different wards. The group are increasingly finding that there is no "one size fits all" solution. They need advice from the pharmacy about what constitutes a "safe" dose. The group are frequently referring to an injectable medicines administration guide which provides details of the title, formulation, method of administration, risk, dilution, rate, licensing, compatibility and other considerations associated with commonly used drugs.

the hospital as a whole. For example, a paediatric setting may require different limitations in usage when compared to the Intensive Care Unit (ICU). Added to that, they know that some device types are more or less accurate than others. For example, devices vary in terms of short and long-term accuracy, the accuracy of the bolus and potential to bolus on release from occlusion. There may also be a tendency to bolus during device actions such as closing the door. When it comes to alarms, different devices are more or less responsive when it comes to the time to alarm following occlusion, the pressure increase at which they will alarm and ability to detect air. All of these factors feed into the appropriateness of a device for a given context. They also inform the estimation of appropriate limits when implementing, for example, constraints on the way in which drugs can be delivered. Irrespective of the difficulty of standardizing the drugs that are used across the hospital as whole, Suresh has the additional problem that many of the chemotherapy treatments are custom made and may be administered as part of clinical trials, or tailored for a given patient or patient condition. In this case, it is unlikely that any form of standardized drug library will help.

SCENARIO 7: Suresh is helping to implement a hospital wide policy relating to infusion device use

"Patient safety is our primary concern"

Criteria for Success

Reducing the potential for medication error during infusion device usage.

The Story

It is Friday afternoon and Suresh is finding it hard to contribute to the meeting that he is in. The group are examining the risk factors in intravenous infusion and developing a standardized drug library and equipment management policy. Suresh and the team need to address several issues, for example, how to assemble a list of the drugs commonly in use around the hospital or make sure that a list provided by an external body is suitable for adoption. Although Suresh finds this interesting, the people he is working with are concerned with a much wider risk based classification system to make sure that the right pumps are being used in the right place, within the right constraints, across



Picture from: <http://tinyurl.com/caghq53>

Flickr user tipstimes

Background and Context

The HEMS (Helicopter Emergency Services) is an air ambulance that can provide pre-hospital trauma care, during the day, within a pre-defined geographical area. The air ambulance is used to deliver trauma care to individuals who have been involved in a range of accidents/incidents. These include road traffic accidents, falls from height, assaults, stabbings and shootings. The helicopter normally cruises at 1'500 ft at around 130 kts. It can fly for about an hour. A doctor is carried to the patient in order to perform procedures that would normally occur in a hospital. The helicopter is well equipped and can support (for example) blood transfusions (a range of blood types are stocked on the helicopter). In this case, the air ambulance saves lives, because without it, patients would bleed to death prior to medical support arriving, or en route to the hospital. More lives would be saved if there was another helicopter, as if two accidents / incidents happen at once, then one helicopter is not sufficient.

that the movement, forces and vibration exerted by the helicopter do not break the pumps or influence the accuracy of fluid delivery. If the air ambulance was flying at a higher than usual altitude, changes in pressure could influence the pump behaviour or components of the pump. It might be colder than a normal operating environment. They need to be careful that the devices don't pose a fire risk, or influence the operation of the helicopter in any way. They also need to make sure that the pumps are safely stored / attached so that they stay in place as the helicopter banks and turns. They can't modify the helicopter, as it could influence the flight worthiness, however need to find ways of fixing the device. There is also the unlikely possibility that the device will somehow interfere with the helicopter electronic systems. Frank has been working with both the helicopter and medical device manufacturer to make sure that these concerns don't pose a problem. He has also worked with a local university to draw up an assurance case providing the rationale regarding why integration of the device is safe. This is partly because the pumps are being used in such a unique context. All the paperwork has been signed off and Frank is about to install the device. He climbs into the back of the helicopter and pauses. Now are the medics going to use their left hand or right hand to operate the infusion pump?

SCENARIO 8: *Frank is installing an infusion pump on an air ambulance*

"Put simply, the helicopter saves lives"

Criteria for Success

Installing an infusion pump in an unusual context.

The Story

Frank is in a good mood. It isn't that often that you get to install equipment on an air ambulance. The air ambulance service want to trial the use of infusion pumps, on-board, for use during flight. Frank is working with the medical equipment manufacturer and air ambulance service to find a way of getting infusion pumps onto the helicopter. There are quite a few complications in doing this, as the power supply on the helicopter requires conversion, they also need to make sure



Picture from: <http://tinyurl.com/cg9w6th>

Nick Chipchase

Background and Context

It is the beginning of the morning shift in Accident and Emergency (A&E). The department has about 45 admissions per weekday and between 50 and 60 per day during weekends. They have an emergency theatre and areas for paediatric admissions, minor injuries, major injuries and resuscitation. The unit has been designed to reduce the potential for violence, but during a Saturday evening it is not uncommon for aggressive behaviour to occur. The unit is normally staffed with 6 staff nurses and 2 sisters. A triage nurse will assess the majority of admissions and then allocate them to an appropriate area. Patients arriving by ambulance will have had information about their condition relayed to the department so that preparation can occur. Staff are conforming to standard asepsis procedures.

patient is conscious but pale. The paramedics have already cannulated to create a venous access point. The patient has abnormally low blood pressure and is bleeding heavily. On arrival, paperwork will be handed over by the ambulance service, and a paper based system used to record all of the treatments that are being administered. The team is dealing with a massive haemorrhage. This requires a quick and focused approach. The team plans to perform a rapid blood transfusion. Delays will result in the patient dying. The team immediately request blood and start to set up the necessary equipment. A nurse is tasked with bringing in the blood bags and loading the equipment used to deliver the blood. Electronic infusion devices have the potential to damage blood cells, but the devices that they are working with are known not to do this. The blood has been warmed. In setting up the device, the nurse takes the blood set and primes it. This is achieved by closing the clamp on the blood set, spiking the bag, squeezing blood through into the chambers, slowly opening the clamp and running the blood through the giving set. The nurse then needs to insert the set into the pump. She opens the pump door and then aligns the plastic guides contained within the giving set with the mechanism in the pump. There are three of these, the first two go in easily, but the third seems to be stuck. Something is not right and she feels like she is forcing the clip into the pump mechanism. She takes out the giving set and looks at it. The hospital has a number of different giving set types and lengths. These sometimes get confused but it is quite rare. This one is definitely a blood set so she continues. The pump has the direction of fluid flow indicated and the bag is definitely located on the correct side of the pump so she wonders if she is trying to insert the clip in the right way. She hastily looks at the quick reference guide that is supplied next to the pump to see a picture. She is getting concerned. She continues and has another attempt and pushes the clip into the device hard. She then forces the door shut quickly. They need to get the blood in as quickly as possible.

SCENARIO 9: *The A&E trauma team need to rapidly infuse blood*

“In this situation we have to work quickly and reliably”

Criteria for Success

Getting substances into the patient quickly.

The Story

An elderly patient has been brought into A&E. A car travelling at about 40mph hit them. The paramedics bring in the patient on a spine board and



Background and Context

Miriam is on an IV therapy training day. The trust has recently rationalized training sessions so that all training occurs on a single site. There is a question as to the degree to which this type of training should be mandatory for agency / bank staff. Miriam has decided to attend. She is hoping that by attending the course, she will also be allowed to do a bit more on the ward, because despite her extensive background, she is often dissuaded from working with infusion devices.

therapy calculations. Attendees are required to fill in a worksheet, going through multiple examples relating to typical conversions and calculations. Miriam is getting confused, partly because different types of equipment are programmed in different ways and partly because some of the calculations are tricky. It has been a long day and the course is packed full of facts and figures relating to what should and should not be done. Miriam is working on one of the examples where an infusion of dopamine has been prescribed in the following way: 200 mg of dopamine in 50 mL of 5% glucose to run at 3.5 mcg/kg/min. The patient weighs 70 kg and Miriam needs to work out the rate that the pump should be running at in mL/hr. mg stands for milligram, mcg for microgram, mL for millilitre, kg for kilogram and min for minute. Miriam remembers the formulae they were taught at the beginning of the course, you take the dose that you want (3.5 mcg/kg/min) multiple by weight (70 kg) and then multiple by time (60 minutes). You divide the resultant value by the amount of drug that you have got (200'000 mcg) and then multiply the resultant value by the value of the solution that it is in (50 mL). That gives 3.675 mL/hr. Miriam is glad that the infusion device they use performs many of the calculations for them, but can see why it is a good idea that they are able to perform calculations in their head. Miriam can see the potential for things to go wrong for example when converting between milligrams and micrograms, hours and minutes and getting the right numerator and denominator. The next example involves working out the rate for a gravity infusion. It relates to a situation where nurses count the drops falling into the burette in order to work out the rate of the infusion. A giving set will have a predefined drop factor, indicating the number of drops required to dispense one mL of fluid. By increasing or decreasing the number of drops per minute, nurses can alter the rate a solution is delivered at. This can be achieved by moving the roller clamp up and down the tubing. Miriam needs to work out what to set the drop rate to in order to deliver a litre of saline over 10 hours. The giving set has a drop factor of 20 drops per mL. There are 1000 mL in a litre, and the delivery needs to be over 10 hours. That means 100 mL per hour, or 2000 drops per hour (drop factor multiplied by volume required per hour). Miriam wouldn't want to count 2000 drops, so she divides by 60 to give a drop count per minute (33 and one third). She then rounds down to 33 (you can't have a third of a drop). Miriam thinks back to the days when everything had to be administered using gravity fed equipment and gives thanks to the fact that these days, modern equipment can perform some of the calculations for you.

SCENARIO 10: *Miriam is practicing some tricky calculations*

"Maths has never been my strong point"

Criteria for Success

Being able to perform calculations and reach the correct answer.

The Story

Miriam is on an IV therapy training day. As part of the course there is a section on intravenous

