How to implement 'smart' pump technology successfully to help reduce IV medication errors

A European Pharmacy Expert Panel sponsored by CareFusion concluded that standardised injections, template drug libraries, customer support and networked connectivity are all critical factors for success

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***Hospital Pharmacy Europe* recently** hosted a meeting of a panel of European expert pharmacists in Amsterdam, The Netherlands to review the implementation of 'smart' pump technology and drug libraries. The purpose of the meeting was to investigate the relatively slow uptake of 'smart' pumps in Europe and especially the use of drug libraries. Key points to be discussed included:

- Administration of injections
- Use of 'smart' pumps
- Value for money
- Barriers to use
- Improved safety

Silvia Manrique

Background

Participants identified a number of factors in the organisational climates of hospitals in Europe that could have a bearing on the uptake of 'smart' pumps. In general, healthcare organisations and regulators do not recognise that harms from intravenous (IV) injections are a problem throughout Europe – there is still a tendency to focus on 'bad products' rather than 'bad systems'. In contrast, in the US, the Joint Commission on Accreditation of Hospitals (JCAHO) recognises the problem fully and demands evidence of safe systems. As a result, nurses are not expected to prepare complex infusions at the bedside.

In some countries in Europe (France and Spain) 'reporting cultures' are poorly developed because of fear of punishment. Consequently, data about IV injection errors are sparse. In particular, hospitals do not know the actual costs of medication errors.

The importance of systems and protocols that make it easier to do the right thing was recognised by participants. It was noted that the use of treatment protocols is associated with improved patient outcomes, although in some places there is still considerable resistance to their use – in some centres adherence was estimated to be as low as 7%. Moreover, the use of safety checklists in surgery can halve mortality, but surgeons are often reluctant to use them routinely.

The introduction of safe systems, such as double-checking, and treatment protocols is often improved when accreditation inspections, for example, by JCAHO are carried out. In addition, adherence to treatment protocols is improved during trials, for example, during one trial of post-operative nausea and vomiting treatment in The Netherlands adherence by prescribers to the protocol was estimated to be 78% but after the trial this fell to 37%. Another way to improve adherence to treatment protocols is to incorporate them into computerised prescribing systems. In Mainz University Hospital there is 80-90% adherence to some protocols because of this measure. In the UK standardisation of the safest practice and most effective care is expected. In future, contracts of employment will require delivery of evidence-based care and

Case study

Implementation of 'smart' pump technology averts €162,000 in errors

The Gregorio Marañón hospital in Madrid has 886 beds that are covered by CPOE and automated dispensing systems. Studies have shown that 38% of medication errors occur at the administration stage and these are the hardest to intercept. Some of the highest risks are associated with paediatric critical care and for this reason this was identified as a priority area. The introduction of infusion pumps enabled more precise administration of intravenous doses but did not eliminate programming errors, for example morphine 90 mg/hr being given instead 9mg/hr. A 'smart' pump, which contains a drug library and safety software, can prevent this type of error. For this reason the decision was made to implement 'smart' pumps in the paediatric intensive care unit (PICU).

The 'smart' pump drug library contains the following information for each drug: the units, the concentration, the rates of infusion and the maximum and minimum doses. In addition, hard and soft limits are defined. A soft limit triggers a warning or alarm but can be overridden by the user. A hard limit also triggers an alarm but cannot be overridden and the order has to be cancelled or reprogrammed.

The implementation process, which was led by the pharmacy, was started by forming a multidisciplinary team comprising nurses, doctors, technicians and pharmacists.

'Smart' pumps have now been in use in the PICU for three years. The results show that the pumps are well accepted (98% would recommend to others) and there is 92% compliance with the drug library. A total of 92 errors have been intercepted, 49% of which were classified as moderate-catastrophic with a strong probability of causing serious adverse events had they reached the patients. Examples of these errors included a 75-fold insulin overdose and tenfold error in a loading dose of amiodarone.

The calculated cost of the 92 errors averted is €162,000, but this is probably an underestimate as it does not take into account indirect costs. Dr Manrique concluded that

- A multidisciplinary team is essential and pharmacy should take the lead
- Standardised drug concentrations must be agreed
- A drug library must be built
- Continuous evaluation of data stored in the pump can be used to educate users and to improve the technology
- 'Smart' pump technology intercepts potentially serious dose errors but other types of error could still occur

practitioners will need good evidence to justify deviations.

Participants described how pharmacy departments have introduced some measures to make the administration of IV injections safer and more economical. It was noted that errors are commonly seen in clinical areas when nurses prepare complex products – for example, the use of incorrect diluents or the mixing of drugs with total parenteral nutrition solutions causing the formation of precipitates. In the Gregorio Marañón hospital in Madrid the pharmacy prepares IV injections with the twin objectives of using the drugs more safely, by using the correct diluent, and more economically, through drug vial optimisation. Many hospitals routinely prepare all cytotoxic injections and some HIV drugs and experimental products. In one hospital in Aix-en-Provence (France) the pharmacy department prepares all IV doses, but this is exceptional. Physicians and pharmacists at the University Hospital in Mainz have agreed on 90 standardised products for anaesthetics and intensive care. Twenty of these products are now prepared in the pharmacy in 50ml ready-to-use vials. The introduction of standardised products went hand in hand with the introduction of standardised treatment protocols that have been built into the computerised physician order entry (CPOE) system. There are plans for all high-risk products to be prepared in the pharmacy. RTU products would be welcomed by anaesthetists and intensivists in the UK but the main barriers appear to be insufficient capacity in pharmacy departments to meet the needs and fear that the supply chain might not be reliable.

Barcode technology has been used in Italy to confirm correct matching of patient, drug and nurse, for cytotoxic drugs.

Standardisation of injectable drugs

There was general agreement that standardisation of injectable drugs was a critical step in the introduction of 'smart' pumps and the panel discussed the topic considering both pharmaceutical aspects such as stability, packaging and labelling, and the organisational aspects.

The main drivers for standardisation are physicians and pharmacists. Sometime the process is linked to the implementation of prescribing protocols in computerised prescribing systems.

The preferred packaging for standardised injections varies between countries. Syringes are favoured in the UK and Germany whereas infusion bags are favoured in France. In Spain, syringes are preferred for paediatric use and bags for adults. Syringe-users argue that syringes are space-saving and easier to scan for barcode identification whereas bag-users argue that bags are easier to prepare in the pharmacy.

The University Hospital in Mainz chose to prepare RTU injections in 50ml vials so that nurses draw up the entire contents of the vial into the syringe for placing in the 'smart' pump. Glass vials are easier to store and cheaper to produce than syringes, and the stability of the drug solution is better. It was noted that a transferable label that could be affixed to the syringe would be a useful improvement.

Dose-banding is another form of standardisation. It is well-developed in the UK. In Spain and Germany chemotherapy is still based on individual dosing. In France individual dosing is the norm but one hospital in Paris is dose-banding 5-FU and rituximab, because this offers the option to prepare doses in batches in advance.

One important argument for dose-banding is reduced turn-round time and prompt delivery of treatment. Another advantage is that full quality control can be carried out before a batch is released. Dose-banded treatment is just as clinically effective as individually dosed treatment.

The incorporation of a machine-readable code (barcode or datamatrix) on a product's label would be advantageous to enable easy recording of what has been given. Clinicians believe that this has proved to be useful with blood products and could be useful for opioids and other high-risk drugs. The ideal situation would be for each ready-to-administer product to bear a barcode and a peel-off label.

It was noted that in the UK a list of

commonly used injections (including standardised concentrations and volumes) has been agreed between the Intensive Care Society and the Critical Care Pharmacists' Group. This list has been published and is available at the Intensive Care Society website (www.ics.ac.uk) http://www.ics.ac.uk/professional/standards_safety_quality/standards_and_guidelines/concentration_guidance.

Although this list would cover 95% of needs, no manufacturer is so far offering barcoded versions of these products. It was noted that the products in the list would cover some 60% of needs in Germany and in The Netherlands.

There are pilot sites using 'smart' pumps that identify the drug and select the correct administration rate by reading the barcode on the RTA injection. If the CPOE software is interfaced with the 'smart' pump software, then no manual intervention is necessary

In making the business case for investment in smart pumps and drug libraries, the following points may be used:

- Reduction in costs as a result of errors averted
- Savings in nursing time (cost-improvements) as a result of electronic checks
- Achieving accreditation from bodies such as JCAHO

'Smart' pumps

Dr Silvia Manrique gave a presentation (see case study page 2) describing the implementation of 'smart' pumps in a hospital in Madrid. Panel members then discussed the essential features of 'smart' pumps, the current status of 'smart' pump technology in their hospitals and the perceived barriers to wider implementation of 'smart' pumps.

Essential features

One of the most important considerations in selecting a 'smart' pump is finding a device that nurses can use easily. For example, users reported difficulties with reading some displays because they were too small. In addition, if space on the screen is limited to a set number of characters, it is possible to select the correct drug but the wrong strength. The following points were also agreed:

- Working through dose-error reduction software (DERS) should be the default option rather than an extra
- There should be location/clinical speciality drug libraries
- There should be an option to by-pass the programme and switch to mls/hr quickly in an emergency
- Users should have to log on manually or use a biometric device – staff who have not been formally trained should not be permitted to alter or set pumps
- The reporting element of the DERS must record what would have been given had the system not alarmed and therefore what potential harm was avoided. It is particularly important to identify potential five- and tenfold overdoses
- Bi-directional networked or wireless connectivity is essential (especially for updating the drug libraries)
- The cost of implementing a DERS should be offset by the cost savings of errors prevented
- The pump should be able to identify positively the contents of the syringe or bag
- The pump software must integrate with other systems such as electronic prescribing (CPOE)

Current status

In many hospitals 'smart' pumps are only available in certain clinical areas such as operating theatres, adult and paediatric intensive care units and transplant units.

Nurses can play an important role in the introduction of 'smart' pumps because, in some ways, they have the most to gain. In the Gregorio Marañón Hospital in Madrid, nurses have been closely involved with the implementation of 'smart' pumps and feel more secure in their work as a result. If they need to administer a drug that is not included in the drug library they immediately contact the pharmacy and ask for it to be included. In general, the safety benefits of 'smart' pumps tend to be undersold – nurses should be requesting a safer environment in which to practice.

Nurses often move between clinical areas and it is important they are suitably trained in the use of the 'smart' pumps. Often the pump manufacturers provide support with initial training but it is important to have on-site champions to solve problems. One hospital has a physician and a pharmacist to do this and another has a 'hotline'. It is also important to reinforce the training regularly so that good habits are maintained.

Barriers

Important barriers to effective implementation of 'smart' pumps include failure to install drug libraries and the absence of professional or practice standards that recommend the use of 'smart' pumps.

In many hospitals 'smart' pumps are used as ordinary ('dumb') pumps because the drug library has not been uploaded or activated. This is usually because the hospital management team does not perceive this to be an important measure. Another reason is that, in some hospitals, clinicians have been unable to agree on standardised concentrations for drugs. This can be particularly problematic in paediatric units where they have been used to using 'the rule of 6' which involves varying the drug concentrations used and fixing the rate of administration. Changing to fixed concentrations and variable rates can be a major issue, although there are more arguments in favour of standardised concentrations than against. In the Gregorio Marañón hospital in Madrid a calculator to work out the rate of infusion required was built into the CPOE system and users found this helpful.

In some cases implementation is delayed because the pharmacy department is slow to respond.

At present there are no professional or practice standards or guidelines that mandate the use of 'smart' pumps. Other technologies, for example pulse oximetry, were driven by recommendations from national bodies. Professional guidelines from anaesthetists or pharmacists could be helpful. In the UK, the most helpful measure would be a recommendation from the Royal College of Nursing.

The purchase of 'smart' pumps is not always high on the medical devices committee agenda.

Drug libraries

The panel discussed the process of building drug libraries and aspects of practical working.

Some hospitals had built their own drug libraries but recognised that it was a time-consuming process. The consensus view was that it would be helpful to have a 'starter library' or 'template data set' produced by manufacturers that users could modify. It might be necessary to have such a library for each country

Most 'smart' pumps hold a master list of drugs from which subsections ('clinical profiles') can be built for different clinical areas. Ideally, the pump should detect via a network or wirelessly its location and that should fix the profile in use. There is always a risk of error if the user has to select a profile manually.

Seated at the table, left to right: Maria Cammarota, David Upton, Séverine Foucher, Theresa Saklatvala, Laurence Goldberg, Markus Hollmann, Florian Scheer, Silvia Manrique, David Cousins and Paul McAndrew

Opinions differed on the use of 'hard' and 'soft' limits. Clinicians in the UK feel that soft limits should be abandoned and only hard limits, which cannot be overridden, should be used. In contrast, clinicians in Germany and The Netherlands feel that there should only be soft limits – so that they can give higher doses if wished. The use of hard and soft limits is closely linked with the reporting systems – records of overrides can provide important information about the way the system is used and can prompt reprogramming. At the University Hospital in Mainz the reports are not used because the dose ranges are specified in the CPOE system.

Similar syringes from different manufacturers have different specifications and an important step in setting up the pump is to confirm syringe size and manufacturer – usually this requires selection from a drop-down menu.

Updating of the libraries should be done via a network or wirelessly. Usually when this is carried out the data are sent to the pump but not installed until the next time that the pump is rebooted.

Summary

The key points arising from the meeting were:

- The use of DERS is mainstream in the USA but in Europe it is with enthusiasts only.
- The first step in the implementation of 'smart' pumps and drug libraries is the introduction of standardised drug products
- Whether infusion bags or syringes are used, the pumps should look the same. The pumps used in the University Hospital in Mainz can handle both bags and syringes
- Ideally, pump manufactures should produce template drug libraries, and, if possible provide technical support to help users to customise them
- Networked connectivity for 'smart' pumps is essential

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