Infusing Confidence in Today's Technology

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DOSE-ERROR REDUCTION SYSTEMS (DERS): PREVENTING PATIENT HARM

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1. In a study of infusion pumps with similar features, Wong CA, Ratliff JT, Sullivan JT, Scavone BM, Toledo P, Mccarthy RJ. A Randomized Comparison of Programmed Intermittent Epidural Bolus with Continuous Epidural Infusion for Labor Analgesia. Anesthesia & Analgesia. 2006;102(3):904-909.

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CONTENTS

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Medication errors: what happens when things go wrong? The impact on patients, hospitals and NHS costs

Jackie Nicholson, Nurse Consultant in Vascular Access, St George's University Hospitals. **Andrew Barton**, NIVAS Chair, Advanced Nurse Practitioner in Vascular Access and IV Therapy, Frimley Health.

On 30th October 2019, Smiths Medical and the British Journal of Nursing (BJN) held the conference 'Infusing Confidence in Today's Technology' in Birmingham, UK. Jackie Nicholson and Andrew Barton chaired the event, which was attended by intravenous (IV) nurses, pharmacists and medication safety officers.

Jackie Nicholson, Nurse Consultant in Vascular Access at St George's University Hospitals, opened the morning sessions by highlighting two alarming figures: there are 237 million medication errors (ME) in the NHS per year and 12,000 estimated deaths, or the equivalent of 27 jumbo jets. 'We would never stand for 27 jumbo jets crashing every year. But somehow, we are allowing this number of deaths per year from ME,' she stressed.

The World Health Organization (WHO) has recognised this issue, and is committed to reduce patient harm from ME by 50% in 2022. Intravenous (IV) medications are at higher risk than other types of medication, as they are more complex to prepare and administer. An estimated 10.1% of IV medication administration is associated with error, and is often down to the wrong drug selection, wrong diluent or wrong rate. To illustrate the impact this has in practice, Nicholson presented two case studies: one that led to newborn death, and another that caused hearing loss—both as a result of overdose.

She also highlighted the risk of errors with patient-controlled analgesia (PCA) pumps, which is 3.5 times the risk from any other medication administration error. Patients who are not monitored closely are at risk of respiratory depression, she warned. In fact, the Institute for Safe Medication Practices (ISMP) in the US recommends smart PCA pumps containing dose-error reduction systems (DERS).

Nicholson finished her presentation with a testimonial of a mother describing how she lost her son to PCA and ME. 'As health professionals or scientists, we are used to looking at what we do in a non-emotional way. That story brings home the human impact of ME,' she stated.

Next came Andrew Barton, NIVAS Chair and Advanced Nurse Practitioner in Vascular Access and IV Therapy at Frimley Health. He began his talk by defining ME as 'any error in the prescribing, dispensing or administration of a drug, irrespective of whether such errors lead to adverse consequences or not.' He then emphasised: 'Drug errors are the single most preventable cause of patient harm.'

ME cost the NHS £1.6bn every year. Such errors start with prescribing (done mostly by junior doctors), dispensing the drug (pharmacists) and administering them (nurses). Therefore, all stages involve some form of human factor. These errors cause clinical impact, which include increased length of stay; increased cost; patient injury and litigations; patient disability; psychological impact; nurses' personal and professional status, confidence and practice; and death.

To improve safety, he suggested using electronic prescribing systems, checking IV drugs (single checking), applying pre-programmed infusion pumps that offer a check of rate and dose ('smart' pumps), using DERS to help reduce pump programming errors by encouraging the use of standard drug concentrations via customisable drug libraries, providing ready-to-administer drug formulations, following the Medusa electronic injectable medicines guide, and labelling IV lines and bolus syringes. Automation using electronic prescribing, and dispensing and safe systems to deliver medications are safer than relying on human factors alone. 'That's where we are going in the future,' he closed.

A brief history of dose-error reduction systems (DERS): how did we get here and what has stopped us going further?

David Upton, former Medication Safety Pharmacist.

In the 90s, significant advances were made in the design and functionality of IV infusion devices. David Upton explained how these evolved into dose-error reduction systems (DERS), when they were first introduced in the UK, and why their uptake has been so slow—until now.

The next speaker was David Upton, former Medication Safety Pharmacist. His presentation described the advances seen in the design and functionality of IV infusion devices during the 90s, when pumps first became able to infuse with a higher degree of accuracy. This meant they were also capable of infusing any drug at any rate; therefore, mistakes done by the person in charge of programming the pump could result in life-threatening medication error.

In the US, this led to a series of overdose fatalities, involving 10 or even 100 times overdoses of opiate infusions, which resulted in calls for the infusion devices industry to mitigate the outcomes of pump programming errors.

Smart pumps were then introduced. These were equipped with a dose-error reduction system (DERS), which uploaded a drug library to the pumps based on best clinical practice. They also had the ability to calculate infusion rates, and contained an events capture log to record every programme interaction with staff and pump, as well as any attempt to infuse a drug aside of the library dose limits.

The system became widely adopted across the US, being credited with saving several lives through IV medication error avoidance. 'In an ideal world, no patient should receive an IV infusion without the safety protection of DERS,' said Upton.

The use of DERS in the UK

The rapid adoption of DERS in the US contrasts with the slow uptake in the UK, often being restricted to clinical settings where they are championed by individuals with particular enthusiasm for the technology. Smart pumps incorporating DERS were first introduced in the UK on volumetric devices in 2003, followed by a version for syringe pumps a year later. But progress in the past 17 years has been patchy, due to a number of reasons:

- Lack of equipment standardisation: most pumps in the US had DERS. In the UK, the industry was selling pumps with and without DERS, so people would normally choose the less expensive option (ie, no DERS)
- Low investment: there was a lack of evidence to show investing in DERS was worthwhile
- Resistance to change in IV practice (eg, change to standardised concentrations)
- Poor evidence of effectiveness: there was a lack of research on how many medical errors or how much money could be saved by incorporating DERS
- Low promotion by the manufacturers: there was no great launch, nor publicity splash. This has been an ongoing issue
- Poor pharmacist involvement.

'Where do we go from here?' asked Upton. Standardisation of IV practice (especially, drug concentrations) is not an easy thing to do, but it is possible, he stressed. A key challenge, though, is the availability of template drug libraries—in fact, the audience admitted none of them had accessed such library, as it can be time-consuming for these to be uploaded. Enhanced customer support from manufacturers and networked connectivity of infusion devices came up as two other major barriers, considered critical to the successful implementation of smart pumps with DERS.

Get a SMART business case, know your team players and analyse the data

Janine Clark, Pharmacy Manager, Princess Elizabeth Hospital, Guernsey. **Andrew Dimech**, Deputy Chief Nurse, Lead Cancer Nurse, The Royal Marsden. **Paul Lee**, Medical Devices Training Manager, Swansea Bay University Health Board. **Chris Remmington**, Lead Pharmacist, Critical Care, Royal Brompton and Harefield.

A strong business case and staff engagement are crucial to achieve DERS implementation. So is being able to interpret the data that can improve patient safety, agreed Janine Clark, Andrew Dimech, Paul Lee and Chris Remmington.

In the UK, 90% of pumps have DERS capability but only 60% are able to use DERS, emphasised Janine Clark, Pharmacy Manager at Princess Elizabeth Hospital in Guernsey. A robust business case is the first step in DERS implementation, she explained, and shared five aspects that must be taken into account when building a SMART business case (Table 1):

- **S**pecific: do not assume the target audience knows what DERS is. Provide enough information on where DERS fits into practice and how it can improve patient safety
- **M**easurable: set out key objectives, so that everybody knows what DERS will aim to achieve. These should be measurable (eg, number of medication errors that could be avoided by introducing DERS)
- **A**chievable: show the potential cost-effectiveness of using DERS (decreased length of hospital stays due to medication errors, fewer litigations, etc.). Also, involve diverse departments, such as pharmacy, nursing, medication safety officers, procurement and IT, to ensure all key actors will support the initiative
- **R**elevant: identify where DERS sits within the organisation's strategy, for example, in avoiding unnecessary harm and improving patient safety. Provide a SWOT analysis illustrating the strengths, weaknesses, opportunities and threats of adopting different pumps
- **T**imely: start with the intensive care unit (ICU), where the vast majority of infusions are carried out. Then, analyse the information from ICU and use it to improve other areas in the organisation.

'Implementing DERS is doable. It takes medium effort to create quite a high impact, but it's an ongoing process—you need to build that into your governance procedures,' stressed Clark.

When developing a business case for DERS, it is crucial to focus on the 'achievable' aspect of it, which consists of involving as many departments as possible to ensure multidisciplinary engagement before implementation. Paul Lee, Medical Devices Training Manager at Swansea Bay University Health Board and Chairman at the National Association of Medical Device Educators and Trainers (NAMDET), shared a project plan that involves medical equipment management, pharmacy, nurses, doctors, medical staff, anaesthetics, risk and governance, and IT (Figure 1). This collaborative approach starts by gathering a project team, assigning local groups, agreeing on a drug library, creating a pilot, testing, and implementing and reviewing feedback. 'Everybody that's involved in the organisation links into the project. So, there's due diligence, governance and assurance right throughout the processes,' he said.

How to implement DERS and measure outcomes

Once the business case is approved, the next step is putting it into practice. Andrew Dimech, Deputy Chief Nurse and Lead Cancer Nurse at The Royal Marsden, mentioned some of the challenges to implement DERS in an organisation. In addition to financial barriers, there can be resistance to change. 'It's important to have your key stakeholders

on board to be able to champion that for you and get you through to the next stage,' he said. Dimech also explained that fomenting collaboration between different departments from an early stage can help get the business case right from the start, and ensure a seamless adoption of DERS (eg, by making sure that drug libraries are designed in a way that meets both pharmacists' and nurses' needs).This team effor will require:

- Strong leadership to drive change
- A culture of collaboration
- Setting the scene to achieve the desired objectives
- Multiprofessional engagement and pre-planning
- Defining stakeholders' needs
- Being flexible and responsive
- Checking, testing and getting permanent feedback.

After implementation, a mechanism needs to be in place to measure outcomes: how successful is the organisation being at using the drug library, what errors are being avoided, how can this be extrapolated to other areas of the organisation, etc. Among the benefits of effectively implementing DERS, Dimech highlighted a reduction in patient safety incidence and in drug errors where nearly 3000 potential infusion errors were prevented in his organisation. 'DERS is a useful tool to reduce infusion errors and has been proven to limit significant drug issues,' he concluded.

Analysing the uptake of DERS

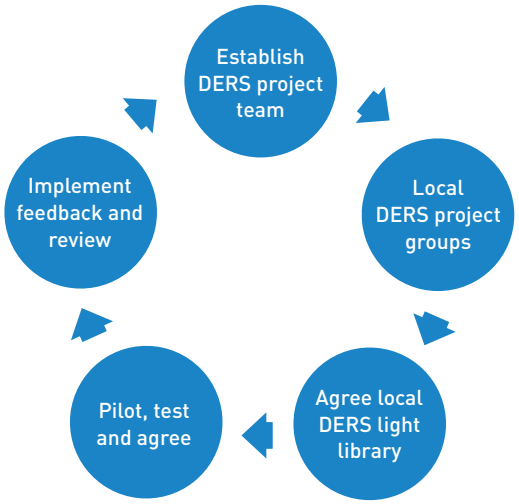
A key aspect when adopting DERS is launching, checking and updating the drug library. Chris Remmington, Lead Pharmacist in Critical Care at Royal Brompton and Harefield, discussed the importance of using Continuous Quality Improvement (CQI) data to identify how people are using the drug library, what difference it is making in practice, and what aspects need improvement.

Remmington analysed the outcomes after one year of DERS implementation at his hospital. He found that the use of smart software increased from 60% to an average of 80%; error rates were 1 in 50 infusions set up and 1 hard limit in 550 infusions; 82% of the hard limits were reprogrammed, indicating 'true errors' recognised by the user; and 23% of infusion rate errors involved rates at least two times the hard maximum limit. His team also identified that periodical changes to the clinically important safety limits are crucial. 'Once you've released the drug library, it doesn't stop there. You need to take into account its maintenance, which should take between six to 12 months,' he stressed. In line with this, some companies provide annual refresher training.

DERS will not prevent every error, as there is still a human factor involved—for example, if the wrong patient weight is entered, the wrong dose will be provided. However, DERS can prevent the wrong standard concentration being selected and it will provide safe limits for infusion rates, said Remmington.

Table 1. How to create a SMART business case for implementing DERS in your organisation

Specific: explain how the plan fits into practice
Measurable: set out key objectives (eg, avoid harm)
Achievable: ensure all departments are on board
Relevant: show how the plan links into the wider strategy
Timely: identify when the results will be achieved



Team players
Medical equipment management
Pharmacy
Nursing
Medical staff
Anaesthetics
Risk and governance
IT department (WiFi)
Supplier

Figure 1. Know your team players

Continuous Quality Improvement (CQI): data usage, reporting and limitations

Emma Weston, Lead Pharmacist Critical Care and Theatres, Basingstoke and North Hampshire Hospitals. **Stephen Squire**, Clinical Engineering Consultant, ESQ Clinical Technology Ltd. **Tiffany Holland**, Smiths Medical.

After DERS has been implemented and data is being recorded, the next step is to identify key indicators that will help improve patient safety by avoiding preventable harm. Emma Weston, Stephen Squire and Tiffany Holland discuss what the future of DERS will look like and the savings it can generate.

Data gathered using DERS can help identify common errors and design staff training programmes to help tackle these issues. Emma Weston, Lead Pharmacist in Critical Care and Theatres at Basingstoke and North Hampshire Hospitals, produces annual reports by clinical area (surgery, oncology, outpatient) that show diverse indicators, such as how many infusions were started within profile and what they were, what the alerts for hard limit breaches or soft limit breaches were, and what was carried out on the pump before and after the alert.

Not all alerts are errors. 'They might be soft alerts, or the pump might be configured slightly wrong,' she explained. Data can then be manipulated to identify a particular time of the day where alerts go off, evaluate whether weekdays or weekends are specifically more problematic, and look at what the number of agency staff is at that time. The reports can also identify if any drugs are redundant and need removing from the library. These data are then presented at operation meetings to discuss potential changes, said Weston.

Analysing such reports can help identify potential patient safety improvements. According to Weston, the alerts helped avoid preventable harm in her trust. Following scrutiny of 2017 data:

- DERS prevented 1 potential error for every 183 infusions
- It acted as an extra check for the most high-risk infusions within her trust
- It also acted as a safety net and calculation double check
- It helped identify training needs if particular drugs alert were more frequent than others.

Drug databases were tailored for individual speciality. This took about six years to take it to where her trust wanted it to be, she added.

There are, however, limitations. 'Data is not updated as regularly as we might want to, so it's not real-time. You also have to wait for new drugs to go on profile, as this is updated once a year,' warned Weston.

Exploiting the power of DERS

Stephen Squire, Clinical Engineering Consultant at ESQ Clinical Technology Ltd., discussed two pump systems: DERS installed in non-networked pumps, and infusion management software (Table 2).

DERS in non-networked pumps requires drug libraries and safety limits to be updated manually. It uses limited IT infrastructure but does not provide ideal continuous quality improvement (CQI) data, as the information is not 'fresh,' said Squire.

The other alternative, infusion management software, allows organisations to manage their pumps, infusions, and drug libraries over a network, which is essential for

Table 2. Deciding on the most appropriate DERS system
DERS in non-networked pumps: manual updates, small scale implementation and outdated CQI data
Infusion management software: fast updates to the drug library and relevant CQI data. Requires a network connection

large DERS implementations over several wards or sites. This system provides fast updates to the drug library and up-to-date CQI data. But it does require network connection to each pump (WiFi or cable). 'With infusion management software, the pharmacy and the clinical engineering departments can manage those pumps together. There is a change and release process where the pharmacy department creates a dataset and gets it validated, and the clinical engineering department presses a button and sends the data over the network to make sure that the pumps are getting the current update,' explained Squire.

Looking into the future, he discussed fully integrated pumps. Once hospitals have fully integrated pumps interfaced to an electronic prescribing and medicines administrations (EPMA) or clinical information system, everything that happens in the hospital will be electronically captured, he said. This would help generate records of care. 'Where we would all expect to be in 10 years' time, is actually possible to do now. Buy your system with this potential in mind,' he suggested.

Savings and benefits

When discussing Smiths Medical's configurable software platform (PharmGuard), Tiffany Holland, Senior Global Sales Training Manager at Smiths Medical, focused on four distinctive characteristics: it is safe, both in terms of cybersecurity and for those using it; simple, which means it is user-friendly; smart, because it delivers actionable insights to help improve processes in the organisation, and secure, as it protects the organisation's assets (Table 3).

Hospitals using PharmGuard software have shown a significant reduction in man hours when uploading medication libraries onto the pumps. 'Ten minutes is all it takes with a wireless software system to update medication libraries on 195 devices, when originally it would take about 112 man hours,' emphasised Holland. This generated savings of around $100,000 per year, she added. 'Instead of spending time finding all the pumps to then update the library, they can now deploy it wirelessly.'

Left to right: Janine Clark, Paul Lee and David Upton

Left to right: Andrew Dimech, Chris Remmington and Stephen Squire

At the end of the conference, delegates were asked about their learning outcomes and take-home messages. Their answers are illustrated in the next section.

Table 3. Benefits of implementing PharmGuard's configurable software platform

Safe: helps prevent medication programming errors with medication safety software. Provides informed care decisions through monitoring of real-time patient data, and tracks compliance to medication library usage by facility and care area
Simple: provides actionable reports to help inform infusion management decisions. Allows for easy assessment of medication library compliance by clinical environment. Tracks infusion pumps throughout facilities by integrating with their real-time location system (RTLS)
Smart: removes manual programming steps with smart pump programming and manual documentation steps with auto documentation. Deploys medication libraries and device software wirelessly
Secure: complies with FDA's guidance for cyber security recommendations with the PharmGuard system. Engages with government agencies on threat assessment and vulnerability scoring

Delegate feedback

The British Journal of Nursing (BJN) spoke to a number of delegates at the Infusing Confidence in Today's Technology conference. Below is a summary of their learning outcomes, best educational sessions and key take-home messages.

"I'm a junior pharmacist, so for me, coming to this conference was all about learning. It's been a big eye-opener for me. I will go back to work and share with my team everything about DERS and how we're using it."

Amrita Garcha, pharmacist

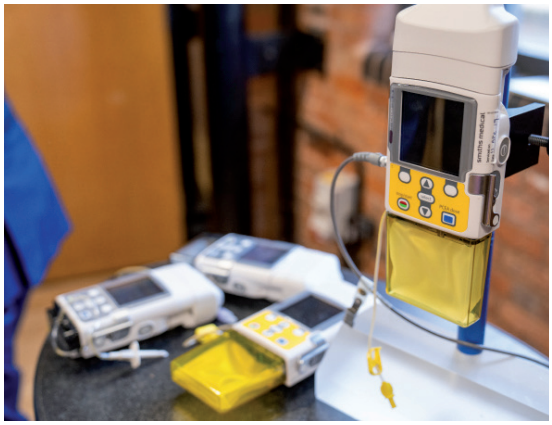
"It's very interesting to see the different case studies from the speakers. Also, to learn about who they had to involve in their teams to implement DERS. We don't use DERS at all; coming here was thought-provoking."

Delegate

Delegates at the Smiths Medical/BJN conference

Speaker Paul Lee answers questions on his presentation

Chair Jackie Nicholson discusses medication errors



Smiths Medical infusion system

"I'm from Ireland. It's interesting to compare our progress with how other people are doing. I think we're doing very well! I can identify with many of the challenges and issues discussed in the morning sessions."

Mary Crowley, Clinical Nurse Manager

"The conference was very good. We need more nurses and doctors here, though. It would be good to hear more from the primary end users of DERS. I liked that the speakers were very open about the barriers and challenges to implement DERS. One approach will not fit all."

Delegate

"We're implementing DERS in 2020, so this conference was very timely. The business case presented by Janine Clark was extremely helpful. We have a drug library, so it's good to know what else is available there."

Scott Barkley and Paul Malone

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Intelligence Meets Infusion

Are you Ready?