Ward automation: an opportunity to improve the management of medicines

There is a huge amount of learning that could be elicited from the use of ward-based automated medicines vending units in hospitals.

Chris Green, Don Hughes and Richard Baird describe how these systems could improve the management of medicines at ward level.

Literature describing ward-based automated medicines vending units (MVUs) is primarily derived from the US. In the UK, automation of the dispensing process within hospital pharmacies is now considered a standard of practice, but it is still largely embryonic at ward level and, clinically, somewhat immature.

The current situation

Current storage facilities for medicines in hospitals have changed little over the past few decades while compliance with national standards is variable. Key-controlled access to medication cupboards is a rate-limiting step in allowing timely access to medicines, particularly if staff leave wards with keys in their possession. Audit trails to determine the role of individuals in handling medicines and to reduce opportunity for theft or diversion are poor, and, in the event of a clinical or security incident, accountability is often difficult to establish.

Storage areas for medicines are generally inflexible and outmoded. Anecdotally, medicines are often stored in incorrect or inappropriate places. Product selection is subject to well recognised risks, such as identical or similar packaging and look-alike or sound-alike names. Nursing staff concede defeat in searching for a medicine because it cannot be reliably located, and pharmacy staff also become frustrated because stock cannot be found. Medicines are often reordered after the product has been exhausted from ward stocks and nurses have to spend time creating an order between top ups. As a result, patients are at risk of being administered the wrong medicine or missing doses. Also, medicines might require reordering from the pharmacy department, frustrating because stock cannot be found. Medicines are often reordered after the product has been exhausted from ward stocks and nurses have to spend time creating an order between top ups. As a result, patients are at risk of being administered the wrong medicine or missing doses. Also, medicines might require reordering from the pharmacy department, which adds to drug and drug-related costs, and leads to treatment delays for patients.

Restocking ward medicines cupboards tends to be an inefficient and protracted process, requiring manual counts of large numbers of products and checking expiry dates. Many wards are topped-up once a week on a set day, independent of the volume of being administered the wrong medicine or missing doses. Also, medicines might require reordering from the pharmacy department, which adds to drug and drug-related costs, and leads to treatment delays for patients.

Traditional cupboard-based storage systems are prone to errors and inappropriate storage of products because their design is restricted.

System design

A number of trusts are installing MVUs and, although a number of systems exist, most share a number of common features. In principle, the systems consist of a number of frames containing a number of drawers and storage cupboards that come in a range of shapes and sizes. Access is computer-controlled and, most commonly, restricted via use of a pin-number, swipe card, fingerprint scan or combination of the three. Product selection and identification is usually supported by a fixed location within the system, restrictions on how far the drawers can open, directional light technology and a visual display (possibly of a photograph of the product) on the system’s computer monitor. Barcode technology is frequently used to control the stock in the system, which is intended to minimise the likelihood of selection and replenishment errors. Medicines administration can also be supported by the on-screen option to view or print guidelines and protocols while accessing the product. Most of these systems have a refrigerator attached, which is controlled by a magnetic lock, and some have external storage options (ie, shelves or cupboards) and stock movement is monitored using barcode scanners. Similar facilities in hospital wards and departments in the US have shown a number of key benefits. These include significant reductions in time spent on nurse- and pharmacy medication-related activities, high user acceptability and significant reductions in medication errors.

Staff have observed that the system does not always recognise the drug name entered, although staff may spell medicine names incorrectly. The adoption of recommended international non-proprietary names under EU legislation has also caused problems for the more established staff who are still used to British Approved Names (eg, confusion between dosulepin and dothiepin).
Materials management

Early adopters of MVUs are redesigning work processes to take advantage of the benefits of automation. With automation, the need to visit wards to count stock is removed, which saves travel time, and, with more advanced barcodes, date checking and recording of batch numbers will eventually become automated. By not manually counting and checking stock, pharmacy staff time could be redirected to improve the storage of medicines in clinical areas. Where putting stock away was previously performed by nursing staff, the time used to do this could be redirected to patient care.

Relations with suppliers

In industrial models, use of automated vending units may be part of an arrangement with the company’s suppliers. As part of a contract with the supplier, the costs of the systems are either contributed to or covered by the supplier, who also tops up and owns the stock in the vending system, and more than one supplier may be managed through the system. Only when stock is used is it then billed to the company, using it, cutting down on the amount of capital tied up in unused stock.

Clearly, there is an opportunity for pharmaceutical wholesalers to enter into this arrangement with hospital pharmacy departments as a method of reducing costs within hospital settings. Because wholesalers receive orders from the vending systems and top-up them up, there is an opportunity for staff savings, either as part of efficiency improvement programmes or releasing staff to take on roles that have a more direct input in patient care.

Limitations

As with experience from dispensary-based automation, MVUs also have some limitations around how pack size and barcode differences, which arise from contract changes, are managed. MVUs have the advantage of storing packages efficiently with little wasted space, and efficient use of space reduces the number of drawers or frames needed for each MVU system, which, accordingly, keeps the cost of the system as low as possible.

However, when changes to pack size or barcodes are made, the ability of MVUs to cope depends on their setup or configuration and the physical requirements in moving drawers or inserts to create a new storage area if the packaging is significantly larger or smaller than the space allocated for the previous product. Therefore, when configuring MVUs, space should ideally be allocated to allow variations in pack size (within reason), and the ability to accommodate new barcodes for otherwise identical products in such a manner so that the MVU can recognise a generic pack of a particular medicine, regardless of its supplier and barcode.

The ultimate goal would be that described in Figure 1, where the only manual process involved in materials management would be restocking the MVU, and even that may eventually be automated. Each of these issues are probably being realised by a number of UK hospitals, but few will have achieved automation of the complete cycle (if any).

Models of practice

There are opportunities to use MVUs in a number of ways ranging from using them as a source to administer medicines directly to patients to using them to stock traditional ward medicines trolleys or near patient areas. The optimum method would need to be tailored to the clinical area in question and factors, such as the number of patients in the clinical area, throughput, the level of care patients require, degrees of self-medication or one-stop dispensing, should also be considered.

MVUs could be used as a central repository for all stock medicines so that products are withdrawn from the machine to stock clinical or near-patient areas, for example, drug cupboards allocated to a discrete area of the ward or medicines trolleys for use on ward rounds. Alternatively, on a general ward where one-stop dispensing is well established, smaller numbers of individual doses, for example, injectables and nebules, could be withdrawn from the system for administration to individual patients.

More direct-to-patient models of practice could include a single MVU serving a group of patients within a small area, or a mobile MVU, which could be used to support self-medication. For example, in an intensive care unit, all doses, other than those required in an emergency, could be withdrawn from a central stock holding system designated to the ICU or a section of the ICU and administered to the patient. The system would have to be flexible to allow non-stock and stock items to be held for individual patients. Similarly, in theatres, where patients’ own medicines are not routinely an issue, MVUs could be used as a central stock holding system.

For self-medication, systems have the ability to allow access based on fingerprint or password security and it would be possible to set individual patients up as system users. Access to the machine can be set up to allow patients access to some or all of their medicines at set periods of the day. The ability to set up a rationing schedule for patients could allow them access to “when required” medicines at set intervals and in set quantities by restricting access to drawers and sections of drawers.

Because products are stored in fixed locations in the MVUs, there needs to be an element of flexibility to allow movement from one pack of medicines to another. For example, if the maximum stock level of a product was one pack of 28 tablets and the minimum level was seven tablets, when a new pack of medicine is delivered to the unit, there would need to be a space to put it alongside the existing part-used pack. This creates problems in itself because staff could then use both packs partially and a reorder could be triggered before either pack is fully used. Innovative methods of managing this issue will be welcome developments.

This latter problem may not be an issue in other European countries, where the packaging of medicines may differ significantly from that in the UK. For example, in the Netherlands, many medicines come as unit-dose blister packs, each blister having the product details and, importantly, its own barcode. There may be opportunities for this method of packaging medicines to be used in the UK with automated systems checking the preparation of self-medication supplies or unit-dose dispensing linked to electronic...
prescribing. Because of the design of these systems, and should uptake of unit-dose blisters may increase, particularly if the use of electronic prescribing in combination with barcode-led administration of medicines to patients increases. Whether unit-dose blisters come into practice or the traditional original pack dispensing models currently used in the UK persist depends on evaluative work, which needs to be carried out in the UK health system.

Clinical decision support

Most systems have the opportunity to interface with hospital intranets, computer network systems and the internet, allowing the user to access a wide range of information linked to the product being selected. Although the increasing importance of clinical governance and risk management, the volume of policies and guidelines is growing at a substantial rate and accessing information quickly is becoming increasingly important. Simple challenges when medicines are selected, for example, confirming compliance with antimicrobial prescribing policies, may also be used to improve practice.

Ward level dispensing

Ward level dispensing by pharmacy staff is a possibility with MVUs and it could be delivered in a number of ways. First, over-labelled prepacks could be withdrawn and issued to patients once their details had been added by hand. Alternatively, the system could be connected to a label printer to generate a patient-specific label and issue the appropriate pack. This could be done in partnership with pharmacy software, MVU software, the trust's patient information or, with an appropriate interface, any permutation of the three. It would be an ideal setup for commonly used medicines, for example, analgesics or laxatives in surgical wards. However, for less commonly used medicines, the cost and logistics of holding appropriate and adequate stock may prevent this. How these systems link in with the main pharmacy automation system, assuming there is one, would also need to be considered.

Security and audit trails

Withdrawn items can be linked to patient unit numbers or barcodes to ensure that use of products is linked to a patient's prescription. MVUs can generally record and report on which members of staff have accessed the system, when they accessed it, which drawers or cupboards they have accessed and even which part of the drawer they have accessed. Thus, staff become more accountable for individual actions in handling medicines.

Medicines use support

It is envisaged that provision of advice to the person withdrawing products could facilitate the use of a medicine and reduce the risk of medication errors. Most systems would allow the system administrator to set up preferences for individual medicines that direct the user to answer decision-support questions or access information or other products. For example, with regards to the National Patient Safety Agency's alert on methotrexate, decision support could require the user to confirm that a weekly (not daily) dose had been prescribed, or to check the patient's white blood cell count. Similarly, with regards to the NPSA alert on opiates, the intent to withdraw 30mg of diamorphine could be met with the prompt “this is a high strength opiate, are you sure you wish to continue?”

Another example would be if a member of staff withdrew amiodarone infusion: the system might be able to either link the amiodarone to a particular infusion bag stored in the same system, for example, a 500ml bag of glucose. Alternatively, the system might flag up a message “only mix this medicine with glucose, please confirm” and require the user to verify that he or she has noted the information provided.

Systems are generally able to direct staff to remove items as part of a kit in such an order that all parts of the kit must be removed before the last item is made available. For example, for staff preparing a phenytoin infusion, the system would direct them to remove a filter line first, a bag of either 50ml or 100ml 0.9 per cent sodium chloride infusion and then withdraw the phenytoin injection. The order in which the products are withdrawn could be deliberately ordered to ensure compliance with the “kitting” arrangement or local policy.

Missed doses

The risk of missed doses because medicines are not available or cannot be located could be reduced by these systems because of their functionality but evidence to support this in the UK is lacking. Where stockouts occur, most systems have a communication function, which allows systems in different wards or clinics to interrogate each other in order to locate stock. Instances where patients have died because of a lack of availability of a medication because the system fails to perform the function, or have had seizures because of a lack of availability of antiepileptics could be reduced or even prevented and, although manual systems should be in place, automation may produce more reliable results in practice.

A further benefit of these systems is that restocking units is driven by the use of products (ie, there is a clinical and patient need). Under manual systems, the traditional pharmacy top up is usually done on a specific day of the week, with nursing staff ordering additional supplies usually when stocks are critically low or have run out. Automation prevents or reduces the risks of stockouts, creates automatic reorder and provides better data with which more useful predictions of stock usage can be obtained.

Closed-loop barcode systems

The ultimate goal is the use of barcodes to link patients, prescriptions and products within a closed-loop barcode system. This is already a reality and work at the Hammersmith Hospital, where it showed that it is possible to link mobile vending units, an electronic prescribing system and a barcoded patient in a closed-loop system in which it will be more difficult to make medication errors. The study reported that medicines administration took longer for nurses to complete, which may be a barrier to its wider adoption, although a reduction in use of resources to deal with the sequelae of medication errors would be an issue. The cost of these systems may also be an issue, however, experience with dispensary automation suggests that the cost of these systems will fall as use grows over time possibly fuelled by competition between manufacturers. Furthermore, as the evidence for their use increases both academically and experimentally, there may be a drive by bodies, such as the Healthcare Commission, for organisations to adopt them in a similar manner to that of dispensary automation.

Safer management of Controlled Drugs

The physical structure and security of most MVUs makes them suitable for the management of Controlled Drugs, including the maintenance of an electronic register, which could include biometric data. The information that can be made available from the use of automated systems makes the monitoring and audit of CDs more accurate and far more accessible than traditional paper-based systems, which do not need to be used to access the drugs and could be filled in incorrectly.

Opening a traditional CD cabinet allows the user to access the entire contents of it. MVUs can be designed to have compartments with locking lids in some drawers that restrict access to individual drugs and doses, which allows a more specific audit trial. The identification of who has accessed (or possibly accessed) individual products, when they accessed them, and what was accessed could be managed from the accountable officer's desktop computer and provide the full audit when required. Where staff are suspected of working together to misappropriate CDs, it would also be simple to produce a report looking at witnessed transactions where both parties have been involved.

Building a business case

The benefits described are not easy to quantify, measure or justify financially. The likely cost of setting up a medium-sized district general hospital with a fully automated ward and theatre arrangement would be significant depending on the products and config-
mates in differing studies varying between similarly difficult to determine, with estimation. The cost of adverse drug events is to cover ongoing costs and the cost of de-
be expected that resources identified from may be identified easily and allocated to duration. Although, for some trusts, capital systems allows rapid and robust identification of products is a problem and automation of sys-
does not need to be intact, and they may be mechanical picking actions, their packaging these systems tend not to rely on robotic or pensaries will have problems handling. Since the service mean that medicines are more prone to errors and inappropriate storage of products because their design is restricted. Storage areas should have prevented it from...
aking or not returning them using the correct procedure. This leads to the system generating another for more stock but, when staff ar-rive to load the system, the product is already in the allocated space.

Staff being unable to load the system using unrecognised barcodes

Staff not being able to locate medicines because they were using the incorrect spelling for the drug when searching

Staff having problems accessing the unit when their fingerprints are faint or indis-
tinguishable

Staff having a stash of medicines in a drawer or box that they cannot or do not want to return to the approved storage area

Conclusion

There has been a significant need to modernise and introduce innovative solutions for clinical storage of medicines for a number of years. There is a huge amount of learning that can be elicited from the use of these systems and it is important that this learning happens and that the system is probably cost, and robust models of practice that demonstrate cost savings and improvements in efficiency are essential to realise the potential of these systems. There is a massive opportunity to improve the man-
agement of medicines at ward level and improve services and accessibility of medicines to patients by developing the materials management and clinical applications of these systems.

References


