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CONTEXT AND POLICY ISSUES:

Automated medication dispensing systems (AMDS) have evolved since the 1960’s with increased technology (computer memory, wireless networking, improved computer interfaces), integration with other information systems in health care settings, and changes in policy regarding safe medication use.1-3 Essentially, the AMDS consist of locked medication storage compartments with an internal computer to control access and record medication removal. The systems may be stationary or mobile, and have been used in various settings, including acute care hospitals as a tool in medication distribution.1,4

Unit dose medication dosage forms (oral, liquid, injection) are accessed from the AMDS after input of the staff identification and password, and specific medication and quantity.1 The AMDS allows access to the area where the medication is stored, and records the removal with staff identification. Increased productivity with automation of technical tasks and 24-hour availability of the system are potential advantages.2 Medication inventory and restocking AMDS processes may introduce new sources of error that require attention.1 Variations are available that include a record of the patient for whom the medication was dispensed, which limit access to drugs on a patient’s medication profile or by prescribing physician.4 With more control built into the AMDS, the cost and complexity are higher.4 Benefits described for unit dose distribution systems over ward stock medication distribution systems include decreased costs due to medication errors, reduced nursing time preparing medication, and possibly medication inventory reduction.1,5 Efficiency in the use of AMDS may be enhanced through integration with the pharmacy inventory system for billing and replenishment, integration with computer provider order entry (CPOE), barcode-enabled point-of-care (BPOC), and electronic medication administration records (eMAR).4

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The aim of the decentralized AMDS is to safely decrease the lag time between prescription writing and medication administration. Implementation of an AMDS requires workflow adjustments for all users. Patient safety may be improved with pharmacist collaboration with patients, nurses, and physicians. The cost of one preventable adverse drug event has been reported as $6000.

A 2003 survey of 15 technologies used in 100 Canadian hospitals to influence medication safety found automated dispensing in 56% of responding hospitals servicing a mean of 35% of patient beds. Details about whether the automated dispensing systems were centralized or decentralized, and specific products used were not provided. One third (33%) of hospitals’ pharmacy directors identified automated dispensing as the next investment. This report reviews the clinical effectiveness, cost-effectiveness, and guidelines for use of the Pyxis® and medDISPENSE® AMDS.

RESEARCH QUESTIONS:

1. What are the clinical benefits and harms of Pyxis® and medDISPENSE® Automated Medication Dispensing Systems in acute care settings in hospitals?

2. What is the cost-effectiveness of Pyxis® and medDISPENSE® Automated Medication Dispensing Systems in acute care settings in hospitals?

3. What are the guidelines associated with use of Pyxis® and medDISPENSE® Automated Medication Dispensing Systems in acute care settings in hospitals?

METHODS:

A limited literature search was conducted on key health technology assessment resources, including PubMed, the Cochrane Library (Issue 4, 2008), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international health technology agencies, and a focused Internet search. Results include articles published between 2003 and January 2009, and are limited to English language publications only. Filters were applied to limit the retrieval to systematic reviews, health technology assessments, meta-analyses, guidelines, economic studies, randomized controlled trials (RCTs), and observational studies.

SUMMARY OF FINDINGS:

Our literature search identified the recommendations of one systematic review on the use of AMDS in hospitals and two observational studies with limited applicability to the research questions within the search time frame. No other systematic reviews, health technology assessments, meta-analyses, guidelines, economic evaluations, or randomized controlled trials were found. No studies specifically assessing the Pyxis® and medDISPENSE® AMDS were identified.

Health technology assessments, systematic reviews and meta-analyses

The 2003 recommendations from the systematic review of the literature and expert panel from the Committee for Evaluation and Diffusion of Innovative Technologies (CEDIT) in France summarized the organizational and regulatory, technological, medical, and economic findings for the use of AMDS in French hospitals where the most common drug distribution system is the ward stock system. The recommendations include recognition that AMDS may be important in
the implementation of a unit dose drug distribution system. CEDIT suggested that this would comply with regulatory practice standards and reduce the time lag between prescription and drug administration within clinical constraints and limited pharmacy resources. The AMDS systems for unit dose drug distribution systems are expensive to implement, and require computerized prescriptions for optimal use. Unit dose systems have been shown to reduce medication errors; AMDS may not reduce errors further, and may introduce other types of medication errors. Economic benefits in favour of unit dose over ward stock systems relate to reduced medication errors, reduced nursing time handling medications and possible streamlining of drug inventory. The CEDIT recommendations state that there is no published evidence for the two to five year write-off period for AMDS acquisition. In the absence of evaluation of actual manpower and drug expenditure gains, CEDIT recommends restricted use of AMDS in long and medium-term care hospitals in France due to the prevalence of computerized prescription systems.

Observational studies

The first study from a socio-technical perspective was undertaken as part of a larger research project in 2003 involving the introduction of decentralized AMDS with the opening of a new building in a Canadian hospital. Daily observations and interviews of staff were completed for 2 months after building opening and introduction of AMDS (by Omnicell Inc.), with follow-up visits over the next 16 months. The goal was to improve work practices by understanding differences between planned work practices and actual work practices with the introduction of AMDS. Observations identified new medication-related difficulties (e.g., tracking of narcotic medications) and uncovered previously unrecognized medication-related difficulties (e.g., tablet splitting). The authors provided an extensive review of the literature questioning the benefits of AMDS, and suggested system-wide planning and implementation to allow optimal use of a technology like AMDS.

The second study was a pre and post analysis of prescribing errors and medication administration errors after implementation of electronic prescribing, AMDS, bar-coded patient identification, and electronic medication administration record. Secondary data was collected to measure physician, pharmacist, and nursing time spent on medication-related activities before and after the pilot implementation of these changes on the 28-bed surgical ward in a UK hospital in 2003. Before the changes to medication prescribing and administration, drugs were prescribed on paper charts, stored on drug trolleys and stock cupboards, and given on nursing drug rounds. Outcomes were measured 3 to 6 months before and 6 to 12 months after the changes. Prescribing error results showed significant reduction (3.8% before and 2.0% after; p<0.001) with no difference in severity of errors and more error resolution before patient doses were given (48% before and 67% after; not significant). Medication administration error results showed a significant reduction (8.6% before and 4.4% after; p=0.0003) with improved checking of patient identity before drug administration (17.4% before and 81.1% after; p<0.001). Secondary outcome results showed significant increase in physician time (mean of 15 seconds per medication prescribed before and 39 seconds after; p=0.03) and pharmacist time spent on the patient ward (68 minutes per weekday before and 98 minutes after; p=0.001). Results of nursing time spent on drug rounds and in medication-related activities outside of drug rounds showed reduced drug round time (50 minutes per week before and 40 minutes after; p=0.006) and increased time spent outside of drug rounds for medications (110 minutes per week before and 154 minutes after; p=0.006). The system implemented was ServeRx® by MDG Medical. Noteworthy limitations in applicability of these results to use of AMDS relate not only to the implementation of multiple technologies at once, but also to changes in physician, pharmacist, and nursing time spent with medication-related activities and fewer medication orders per patient in the period after the changes. As well, applicability to other patient wards at the same hospital or other hospitals is uncertain. Another
publication of the structural, process, and outcome results from a socio-technical perspective was reported for this pilot. In light of the limited literature regarding use of AMDS and similar technologies, these publications provide a description of a pilot implementation in one setting.

Limitations

The literature search resulted in very little evidence of low quality assessing the clinical harms and benefits, cost-effectiveness and guidelines for use of AMDS in the acute care hospital setting. The observational studies demonstrated AMDS as an evolving technology which is currently used in combination with other technologies in a changing medical environment. Their applicability in other hospitals is uncertain. The results provide information for centralized and decentralized AMDS, as opposed to Pyxis® and medDISPENSE® AMDS specifically. Other options that may be available in Canada are Acu-Dose Rx® by McKesson, MedSelect® and OmniRx Medication System® by Omnicell.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING:

Despite current use or planned implementation of AMDS in many Canadian hospitals, the evidence supporting the clinical harms and benefits, and cost-effectiveness is lacking. Use of AMDS, along with other medication strategies including unit dose drug distribution systems, computerized prescription systems, bar-coding, and computerized medication administration records, has evolved over several decades. In 2006 the ECRI Institute in the U.S. completed an update of its 1996 product comparison of decentralized AMDS.

The systematic review suggested priority within the context of limited evidence and financial resources for unit dose drug distribution and computerized prescription systems along with consideration of AMDS. Limited observational data suggested that implementation of AMDS requires careful attention to processes to achieve the full potential of this technology. No studies were identified that addressed clinical or cost-effectiveness of the Pyxis® and medDISPENSE® AMDS.

In the era of increased patient focus and medication-related adverse event reduction, well-designed technology including clinical decision support may require a culture change in many hospital environments. Significant initial and ongoing investment, in addition to planning and revision of medication processes for all users are required for the implementation of AMDS.

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