AAOS American Academy of Orthopaedic Surgeons
American Association of Orthopaedic Surgeons

Information Statement

Prevention of Medication Errors

This Information Statement was developed as an educational tool based on the opinion of the authors. It is not a product of a systematic review. Readers are encouraged to consider the information presented and reach their own conclusions.

Introduction

The Institute of Medicine (IOM) reports approximately 7000 deaths occur from hospital medication errors. Additionally, in 2006 costs of preventable adverse drug events are estimated to cost the nation approximately $3.5 billion dollars. Medication errors are often caused by a complex series of system problems. The systemic nature of these problems requires a multi-disciplinary approach. Solutions proposed in the medical literature require the participation of pharmacists, drug manufacturers, information systems (hardware/software, personnel), and the communication efforts of hospital personnel to reduce medication errors.

Technological solutions will continue to emerge as healthcare continues with efforts to improve safety and quality in all aspects healthcare delivery. Although there is evidence of benefits and improvements in care due implementing such systems, questions continue to arise. Much has been written illustrating the business case for the use of these products (CPOE, CDSS, EMR). To realize full benefit of any of these interventions implementation must be coupled with sufficient training and support, employed at all levels, easy to use, compliment existing tools and protocols within the institution and be just one part of a comprehensive Quality Improvement/Quality Care program.

The American Academy of Orthopaedic Surgeons (AAOS) recommends the highest standards for patient care. Healthcare environments should promote a culture of safety and establish a non-punitive reporting system to ensure an environment that is conducive to open communication.

The American Academy of Orthopaedic Surgeons (AAOS) recommends the following tools when prescribing, transcribing, dispensing, administering and monitoring patient medications: computerized physician order entry (CPOE); computerized decision support systems (CDSS); computerized monitoring of adverse drug events; pharmacist assisted rounds; high-risk drug protocols; and verbal order verification. These tools have significantly reduced medication errors, improved the quality of care and patient management capabilities, increased reimbursement, and have decreased billing time.

The following technologies will assist orthopaedic surgeons in preventing and reducing the incidence and severity of medication errors. Some tools may represent significant capital expenses for hospitals; however, others may be implemented with existing staff and procedures.

I. Prescribing

Computerized Physician Order Entry (CPOE)

CPOE enables the physician to order medications, tests, and procedures directly into the hospital computer system, thereby eliminating illegible handwriting while requiring the physician to complete all essential data fields. Errors related to missing data such as dose, route, and frequency of administration are avoided with the use of CPOE. Several studies have demonstrated CPOE's ability to decrease the rate of medication errors and increase compliance with recommended prescribing regimens.[2,3,4,5]

While the AAOS recognizes that CPOE requires a significant capital commitment, research has shown that return on investment can range from $180,000-$900,000 annually. Furthermore, with improvements in resource utilization and reductions in testing and imaging, some hospitals may save millions of dollars annually.[6] More accurate coding, as a result of improved data collection, can enable hospitals to realize increased physician reimbursements and may offer the possibility of decreased physician liability insurance premiums.[7,8]

CPOE will particularly improve communication efforts during the transfer of care. The literature cites cross-coverage of medical inpatients as a factor that may contribute to an adverse event. Lack of continuity of care during hospitalization has been related to an increased risk of adverse events, such as medication errors.[9,10] The centralization of charting functions provides more complete and timely patient information that may be accessed by covering physicians. Alert functions can be used to highlight pertinent data, such as allergies, and assist on-call physicians in assessing and planning the patient's care.

Physicians should participate in customizing the CPOE software to ensure that it is both user-friendly and specific to their therapeutic ordering needs. Software can be customized to allow physicians to prescribe their routine orders and to modify them as needed. Programs should be based on strong scientific evidence and written to accommodate specificity and minimize false-positive alerts. While software systems require an initial learning curve, eventually they will expedite orders for the entire health care team, improve communications, and enhance patient care.

The U.S. Department of Health and Human Services Department (DHHS) signed an agreement to license the College of American Pathologists' standardized medical vocabulary system. SNOMED will enable health care systems in the U.S. to share the same medical information technology platform. The standardization of nomenclature among institutions and the automatic exchange of clinical information will further diminish medical errors.

Computerized Decision Support Systems (CDSS)

CDSS provides a review of orders as they are written, comparing new and existing orders, scanning for possible drug interactions, appropriate dosing schedules, and alerting the physician to pertinent lab results, all of which impact the physician's decisions and the plan of care for the patient. CDSS can enhance clinical performance related to prescribing practices in addition to providing important reminders and alerts. This system can also recommend less expensive alternative medications to decrease patient care costs. CDSS has the means to identify and prevent duplications related to medications, testing, and imaging.

Pharmacist-assisted rounds

One of the least expensive and most easily accessed tools is the utilization of staff pharmacists when making medication decisions. Pharmacists, already familiar with the institution's formulary, can assist physicians in selecting medications from among those drugs that are stocked. In cases of patients with multiple medications, organ failure, or other conditions that make prescribing a challenge, pharmacists can offer their expertise in selecting the appropriate and most efficacious medications that will prevent adverse drug events. Additionally, pharmacists can assist in practicing

evidence-based medicine by guiding physicians' prescribing practices to conform to those outlined in peer-reviewed literature. Formulary medications often have a lower cost and a higher reimbursement rate than non-formulary medications. These medications may be more readily available in adjacent pharmacies, increasing the likelihood of patient compliance with post-operative medications.

Handwriting

The use of CPOE and standardized order sets will help to eradicate handwriting errors that can result in adverse patient events. Hospitals are implementing a predetermined set of abbreviations to minimize dual interpretations of the same abbreviations. If hand written, orders should be legible, complete, and reviewed with the pharmacist or appropriate staff to ensure the intended interpretation and transcription. Medication name and proper form (if more than one form exists), dose, route, and frequency should be included in the prescription. Legible signatures should be accompanied by a printed name. Prescriptions should contain contact information to ensure a timely review should staff need to contact the physician for clarification. All instructions should be written rather than abbreviated.

Abbreviations

The Institute for Safe Medication Practices (ISMP) has compiled a list of dangerous abbreviations, acronyms, and symbols for handwritten, patient-specific communications. Orthopaedic surgeons should be aware of potential problematic practices when prescribing medications. Prescriptions should avoid the abbreviations of drug names and should be printed in legible handwriting. Dosage units should be spelled out rather than using abbreviations. Following are some recommendations for abbreviation use:

Abbreviations	Intended Meaning	Misinterpretation	Suggested Practice
D/C	Discharge or discontinue	Premature discontinuation of drugs when D/C (intended to mean discharge) was interpreted as discontinued when followed by a list of drugs	Use "discharge" and "discontinue"
µ g	microgram	Mistaken for "mg" when handwritten	Use "mcg"
q.d. or QD	Every day	Mistaken as q.i.d. (four times a day)	Use "daily" or "every day"
q.o.d. or QOD	Every other day	Misinterpreted as q.d. (daily) or q.i.d. (four times a day)	Use "every other day"
Sub q	Subcutaneous	The "q" has been mistaken for "every"	Use "subcutaneous"
U or u	Unit	Read as a zero (O) or a four (4), causing a 10-fold overdose	Use "unit"

Decimal points

Physicians should use a zero to the left of a dose less than 1 (e.g., use 0.1 rather than .1) and avoid the use of a terminal zero to the right of the decimal point (e.g., use 5 rather than 5.0) to minimize ten fold dosing errors.

Standardized order sets

Absent the availability of CPOE and CDSS, standardized order sets and clinical pathways should be used for frequently performed procedures and admissions. Studies have suggested that the use of standard order sets have decreased hospital length of stay and improved the quality of care. Orthopaedic surgeons should customize their own sets for clinical preferences and utilize the order sets to minimize handwriting and increase standardization of care. Order sets should be reviewed with pharmacy personnel to ensure compliance with formulary requirements and reduce the use of outdated or inappropriate medications. Whenever possible, hospitals should receive inpatient and post-operative instructions prior to the patient's admission to facilitate a predetermined clinical protocol. Post-operative instructions should be comprehensive in order to improve compliance with follow-up visits, physical therapy, and other prescribed regimens.[1]

II. Transcribing

As outlined above, electronic order transcription is accomplished with CPOE and increases the speed and accuracy of transcription, which results in fewer medication errors. Reduction of handwritten orders and the use of standardized order sets also expedites the transcription of orders without CPOE.

Verbal order verification

Verbal orders should be avoided, if possible. Specific procedures should be in place to ensure clarity among health care workers. If a verbal order is given, the hospital should implement a "read-back and verify" protocol to ensure proper interpretation of the order. Standing order sets should help to eliminate many verbal orders.

III. Dispensing

Automated dispensing

In 2007 the Institute for Safe Medication Practices, along with invited stakeholders convened a national forum for the development of updated safe-use guidelines for automated dispensing cabinets. While there is little published literature on automated dispensing of medications, it is apparent that the use of this technology will decrease medication errors.[12] Human factors errors, such as "look alike" and "sound alike" drugs, will be prevented with automated dispensing. Additionally, the correct dosage will be ensured with the use of this technology.

High-risk drug protocols/policies

National patient safety organizations recommend monitoring safety practices when using high-alert medications. Concentrated electrolytes, including but not limited to sodium chloride, potassium chloride, and potassium phosphate greater than 0.9%, should be removed from patient care units. Additionally, heparin, warfarin, insulin, lidocaine, magnesium, muscle relaxants, chemotherapeutic agents, dextrose injections, narcotics, adrenergic agents, theophylline, and immunoglobin are all considered high-risk medications. Hospitals should recommend that pharmacies reduce the number, concentrations, and volume of high-alert medications in their formulary.

Bar coding

In 2006 the U.S. Food and Drug Administration (FDA) mandated that hospitals use bar codes for medication.[13] While the rule was finalized in 2004, hospital systems were given two years to comply with the rule., which required systems to phase in the use of bar code technologies for use with human drug products and biologic products. Bar code systems identify the national drug code

(NDC) for specific manufactured products. Use of automatic identification systems, e.g. bar code systems, result in improved scheduling of medications, fewer missed doses of medications, more efficient drug monitoring, improved medication records, and facilitate better communication between health care staff. Some bar code drug systems also produce cost efficiencies. Bar coding facilitates identification of the right patient, the right drug, and the right dosage. The AAOS supports efforts to automatically identify pharmaceuticals in health care settings.

Unit dose packaging

Packaging pharmaceuticals in unit dose applications is encouraged in health care settings. Pharmaceutical manufacturers will be instituting this packaging over the next few years to comply with federal regulations. Used in concert with bar code readers and computer systems, these technologies will enhance the administration of the proper drug and dose to the correct patient.

IV. Administering/Monitoring

The administration phase of medication delivery is presently a significant source of medical errors. The use of automated drug dispensing, unit dose packaging, and the bar coding of drugs will help eliminate errors in the administration phase of drug delivery. Changes in standard dosage will be recognized by the system and additional measures will have to be taken in order for the change to be made.

As described above, a computerized order entry system, alone or with a decision support system, can identify and offer solutions to potential medication errors. Additionally, these systems can be programmed to record data related to errors and near misses, which can be valuable tools for education and leading indicators of processes that contribute to medication errors. In the absence of such a system, routine audits of patient charts can also aid in the identification of inherently flawed practices, as well as provide feedback on the effectiveness of procedures intended to reduce errors and increase safety.

Patient education can also decrease medication errors. Empowering patients to ask questions about their care, including medications, tests, and procedures is essential to cultivating an environment of safety. Well-informed patients are better able to participate in their own care and contribute to better outcomes.

Medication Administration Record (MAR)

Medication administration records are mechanisms that record the time, date, and route of administration of ordered medications, in addition to the identity of the prescribing health care provider. Used properly, the MAR can function as both a prevention and intervention tool. Incorporating the MAR into a computerized system results in typed orders and administration information rather than handwritten orders, decreasing the potential for errors. The system can also be programmed to require a co-signer for high-risk medications, such as anti-coagulants or pain medication, thereby inserting an important double-check measure into the process. A computerized MAR can also record data as the process is taking place, preventing confusion over whether a dose was administered, when it was administered, and other details of administration.

Environmental Factors

Medical literature suggests that fatigue, poor lighting, an environment full of interruptions, noise, and an excessive workload may contribute to medical errors. Hospitals and ambulatory surgical centers should evaluate and monitor environmental factors to ensure that distractions are kept to a minimum.

In the event a medication error occurs, hospital administration, quality assurance, risk management, and physicians should investigate the root cause of the error regardless of the severity of the patient outcome. Medication errors should be analyzed to determine trends and systems should be rectified if determined to be problematic.

V. Medication Reconciliation

Medication reconciliation attempts to optimize drug therapy by accurately and completely reconciling medication, while reducing adverse drug events at transition points across the continuum of care. Technological advances will assist with accomplishing this goal. A medication list of what the patient is currently taking and those that are subsequently prescribed should be kept track of. Medications to be considered include prescriptions, over-the-counter drugs, vitamins, herbal supplements, and any product designated by the FDA as a drug. The Joint Commission requires that a Home Medications list be obtained within 24 hours of admission as part of the initial assessment. Home medications are characterized as medication taken prior to the patient's entry into the hospital. Through electronic records, medications are more easily tracked and medication reconciliation is more efficient. Studies have shown a significant decrease in adverse medication events as the result of medication reconciliation.

VI. Electronic Medical Records (EMRs)

Major arguments in favor of EMRs state that its implementation will potentially decrease medication adverse events, improve health and provide cost savings to healthcare. Electronic medical records are beneficial if the information is correctly input into the system. Patient records and history are readily accessible to clinicians and other healthcare providers. Although cost benefits will not be evident during the adoption period of the system, a gradual increase will be seen as time passes. ***The AAOS believes that patient safety must be a top priority in healthcare. The provision and maintenance of a safe working environment is the most cost effective tool for achieving this standard. Some technologies may be cost prohibitive for some hospital systems. However, cost-efficient, low technology tools are available and should be used to ensure the safest medication practices in the absence of more technologically advanced options.***

Although CPOE, EMRs, CDSS, barcoding, and other medical technological advances have shown evidence of a decrease in medication errors, studies have revealed that errors have occurred due to faulty computer interface, miscommunication with other systems and lack of sufficient decision support. Human errors have also played a role in errors through inexperience, inadequate knowledge, interruptions and typing errors. Malfunctions or errors must be taken into account when using this equipment or following procedures. There still remains the chance that an error can occur in any situation. The medical arena will continue to advance technologically in hopes to improve patient care and patient safety.

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