

A BRIEF HISTORY OF MEDICATION ERRORS

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The subject of medication errors has received more national attention recently than any other time, thanks to attention drawn to the subject by physicians. Pharmacists have a long history of conducting research on medication errors, starting 40 years ago with a study that demonstrated errors are a much bigger problem than anyone realized. Barker and McConnell compared the effectiveness of incident reports and voluntary reports to direct observation of nurses as error detection methods.¹ Thirty-six errors were documented by incident reports during the year studied. By comparison, two weeks worth of data collected by direct observation when extrapolated over the same one year period indicated that 51,200 errors may have occurred (including 600 wrong time errors). This figure is 1,422 times the number identified by incident reports. Other studies have confirmed the difference between the two methods.^{2,3,4,5,6,7}

Medication administration errors were used by researchers studying the quality of the output of drug distribution systems back in the 1960's when the unit dose drug distribution system was being developed.⁸ Such errors are recognized as an important indicator of quality of drug therapy from the patient's perspective. Research on the effect of automated drug dispensing devices on errors has been performed,⁹ showing that errors have not been eliminated by technology.

The history of the definition and terminology used when discussing medication errors is important to be aware of when evaluating the literature. Errors of omission and errors of commission were used in one study.¹⁰ "Drug misadventure" is a broad label applied to adverse drug reactions, prescribing errors, and medication errors.^{11,12} "Adverse drug events" are defined as an injury from a drug-related intervention, which can include prescribing errors, dispensing errors and medication administration errors - this term has been used in the medical literature in particular.¹³ The National Coordinating Council for Medication Error and Prevention defines a medication error as "... any preventable event that may cause or lead to inappropriate medication use or patient harm, while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems including: prescribing; order

communication; product labeling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." The research-based definition of a medication administration error is any deviation from the prescriber's written order, or as entered into a computer system by the prescriber.⁸ Medication errors are typically viewed as being related to drug administration while dispensing errors refer to mistakes made by staff in the pharmacy when distributing medications to nursing units or directly to patients in an ambulatory pharmacy setting. Medication error has been defined to include errors in the process of ordering or delivering a medication,¹⁴ whereas errors by the prescriber when ordering have typically been labeled prescribing errors.

Error category definitions that have been tested in research studies are described here. Categories may not be mutually exclusive; therefore, the reader is cautioned that rates for different error types cannot always be simply added to obtain an overall error rate. An unordered or *unauthorized drug error* is defined as administration of a dose of medication that was never ordered for that patient. (Some researchers refer to this type of error as a wrong drug error.) An *extra dose error* is counted if a dose is given in excess of the total number of times ordered by the physician, such as a dose given on the basis of an expired order, after a drug has been discontinued, or after a drug has been put on hold.

If a patient fails to receive a dose of medication that was ordered, an *omission error* is noted if no attempt was made to administer the dose. Reasons for the omission should be sought, such as doses withheld according to policy, (e.g., nothing by mouth before surgery). A *wrong dose error* occurs when any dose is given that contains the wrong number of preformed dosage units (such as tablets) or was, in the judgment of the observer, more than 17% greater or less than the correct dosage. Some researchers use a narrower definition of wrong dose errors for injectable doses that are measured by the nurse - any dose that is more than 10% different from the correct dosage would be in error.^{1,15,16,17,18} Wrong dose errors are counted for ointments, topical solutions, and similar medications only when the dose was quantitatively specified by the physician (e.g., in inches of ointment).

Wrong route errors are typically defined as those situations where a medication is administered to the patient using a different route than was ordered. An example would be the oral administration of a drug ordered for intramuscular use. Also included in this category are doses given in the wrong site, such as the left eye instead of the right eye.

Wrong time errors are typically defined as the administration of a dose more than 30 minutes (or 60 depending on the site) before or after the scheduled administration time, unless there is an acceptable reason. Acceptable reasons include situations where the physician has ordered that the patient not consume anything by mouth (NPO), or when the patient is off the floor at a diagnostic test or in surgery. The hospital's standardized dose administration schedule should be used to determine the time at which a regularly scheduled dose should be given. The schedule programmed into the pharmacy's computer system can be used to define correct administration times, but input from the nurse and patient preference should be accommodated.

A **wrong dosage form error** involves the administration of a dose form different from that ordered by the physician, provided the physician specified or implied a particular form. If an extended release tablet is crushed, a wrong dosage form error is counted if it is likely that the timing of the release of the drug has been destroyed.

A number of techniques have been used to study medication errors - here are twelve examples of error detection methods that have been used in research:

1. Direct observation¹⁹
2. Chart review^{20,21}
3. Incident reports involving medication errors²²
4. Stimulated self-report using interview^{15,16}
5. Attending medical rounds to listen for clues that an error has occurred²³
6. Doses returned to pharmacy²⁴
7. Urine testing as evidence of omitted drugs and unauthorized drug administration²⁵
8. Examination of death certificates²⁶
9. Attend nurse change of shift report²⁷
10. Medication administration record comparison to physician orders²⁸
11. Computerized analysis to identify patients receiving target or tracer drugs that may be used to treat a medication error
12. Comparison of drugs removed from an automated drug dispensing device for a patient to physician orders²⁹

In the future, it may be possible to adapt the computer-assisted adverse drug reaction program described by Dalton-Bunnow and Halvachs to medication errors.³⁰ This program uses a list of tracer antidote drugs to help identify when an adverse drug reaction may have occurred and stimulates a pharmacist review of the patient chart. The tracer drugs may also be ordered in response to an unintentional overdose (wrong dose error), or in response to the wrong drug being given – for example, naloxone ordered stat as a result of a narcotic overdose. Drugs may be ordered stat if a previous dose was omitted, as well. Other tracer or target drugs include diphenhydramine (except when ordered QHS PRN), flumazenil for benzodiazepine overdoses, and pytonadione injection ordered stat. Target orders that may be evidence that an error has occurred include transfer to ICU, orders to discontinue or hold a drug, and stat orders for drugs or labs. The pharmacist investigated suspect situations on a list of target drug orders by reviewing the patient's chart and collecting additional evidence that a wrong dose was given, or an unauthorized drug was administered, or that a drug was omitted. The hospital using this system for ADR's detected two per week, requiring an average of 2 hours of pharmacist time per week. If this system is applied to medication errors, it could complement an existing incident report system, or observation-based error detection system (the target drug program could cover the entire hospital instead of sampling as observation typically involves).

Error rates of over 40% have been measured for floorstock drug distribution systems (including wrong time errors) and over 20% when wrong time errors are subtracted.⁸ Error rates measured by observational studies of the medication administration process in hospitals range from 9-12% in 14 studies of unit dose systems (including wrong time errors).⁸ Error rates of less than 2% have been achieved in 7 observation-based studies (excluding wrong time errors).⁸ Studies of partially automated medication distribution systems measured error rates between 7-17%.^{6,31} Barker and colleagues³² estimated that errors (excluding wrong time errors) occur at a rate of about one error per patient per day, based on data from a number of studies.

Pharmacy error rates involving doses dispensed during the cart filling process (picking errors) range from 0.04% to 2.9%.^{33,34,35,36,37,38,39} Some state boards of pharmacies have allowed technicians to check other technicians after filling patient medication drawers instead of requiring a pharmacist to perform this task.⁴⁰ A comparison of the unit dose medication drawer checking accuracy of technicians and pharmacists found that the error rates by each group did not differ significantly: both identified a

1.2% cart fill error rate.⁴¹ Pharmacists overlooked more errors than technicians, however: 107 errors on 49,718 doses versus 50 errors overlooked by technicians on 55,470 doses. The authors noted that the percentage of missed errors that could have resulted in patient harm was not significantly different (25.2% for pharmacists versus 32.0% for technicians), but this means that 27 potentially serious errors were overlooked by pharmacists compared to 16 by technicians. The source of medication profile information used in checking the cart has also been studied. A study of missing dose rates measured a decrease from 0.93% to 0.33% when nursing and pharmacy personnel checked the cart against the patient's medication administration record.⁴²

The scope of the errors problem includes economically adverse consequences such as extended hospital stays, additional treatments, and malpractice suits. The mean cost of medication-related problems (medication errors and adverse drug reactions) at a university hospital ranged from \$95 for extra laboratory tests, to \$2,640 for intensive care. The estimated total cost of medication-related problems reported at the hospital during 1994 was \$1.5 million.⁴³

Hynniman and co-workers⁴⁴ calculated the cost benefits of various drug distribution systems in a study. It was proposed that the ultimate criterion for evaluating the expense of a medication system should be the cost per dose delivered correctly. The unit dose system had a cost per dose of \$0.33 with an error rate of 3.5%. The hospital with a floor stock system had a similar cost per dose of \$0.32, but had an error rate of 11.5%. Cost comparisons between drug distribution systems provide additional support to the proposition that the unit dose system is the least expensive to operate when nursing and pharmacy costs are considered.^{45,46} A report of insurance claims related to medication errors by the Physician Insurers Association of America reported an average indemnity payment of \$99,721 per claim between 1985 and 1992.⁴⁷ However, hospital attorneys say that most medication error-related claims are settled out of court for much larger amounts, because they are so hard for the provider to defend.⁴⁸

Recommendations for Error Prevention in the Future

Based on a long history of research, pharmacy medication system automation features that are desirable for prevention of medication administration errors are available.⁴⁹ The recommended system characteristics are as follows:

1. **Comprehensiveness**: Control over the medication distribution system should start with entry of the order into the computer and continue through administration to the patient.
2. **Focus**: "error-prone" dosage forms should be accommodated by the system, such as injections, oral liquids, and specially-prepared doses for pediatric patients.
3. **Dispenses unit doses**: Medications delivered to the nurse should not require further manipulation or preparation by the nurse.
4. **Signals at dosing times**: In order to minimize omission errors and wrong time errors, the device should remind the nurse when a dose is due.
5. **Labels machine printed & affixed**: The medication delivered should contain written labeling information that is machine-printed and affixed to the container.
6. **Machine identification**: It should be possible to identify the dose, patient, and person administering the dose prior to administration (e.g., with bar codes or radio frequency tags).
7. **Access controlled**: Medications should only be accessible at the right place at the right time based on the patient's medication profile, and only to approved personnel as verified by the machine.
8. **Captures dose administration**: Documentation of medication administration time and location should take place at the point of administration.
9. **Drug use information provided**: Any information that the nurse should be aware of in order to facilitate correct administration of the drug should be provided at the point of administration.
10. **Controls not easily compromised**: Any compromises or overrides of the system should be associated with a visible and/or audible alarm. Documentation of the override should occur simultaneously and automatically.

SUMMARY

History has a tendency to repeat itself. If pharmacists and administrators build on what's been learned in error research when implementing new medication systems, perhaps the (patient's) pain from repeating known mistakes and problems can be minimized.

1. A medication administration error is defined as:
 - a. an incorrect formulation from the pharmaceutical manufacturer
 - b. an administered dose of medication which deviates from the physician's order
 - c. absence of an MAR during drug administration
 - d. an incorrect drug or dose compounded by the pharmacy
2. An adverse drug event is defined as
 - a. patient injury from a drug-related intervention
 - b. medication administration error not resulting in patient harm
 - c. prescribing error that was corrected by the pharmacist
 - d. pharmacy dispensing error that the nurse catches
3. The medication error where a patient has failed to receive a dose is called:
 - a. Unauthorized drug error
 - b. Extra dose
 - c. Omission error
 - d. Wrong time
4. A patient receives Claforan 1 gram IV 24 hours after it was discontinued. If this is an error, what type is it?
 - a. Unauthorized drug error
 - b. Extra dose
 - c. Wrong time
 - d. No error
5. Ear drops are ordered to be administered in the right ear but the nurse gives it in the left ear. What type of error is this?
 - a. Unauthorized drug error
 - b. Extra dose
 - c. Wrong route
 - d. Wrong time
6. Medication administration error rates for unit dose systems (excluding wrong time errors) have been measured by observation between:
 - a. Less than 5%
 - b. 5-10%
 - c. 11-15%
 - d. 16-20%
7. Errors have been estimated, based on observation studies, to occur at a rate of:
 - a. One per patient admission
 - b. One per patient per day
 - c. One per nursing unit per month
 - d. One per hospital per year
8. The mean cost of medication-related problems (medication errors and adverse drug reactions) at a university hospital have been measured at
 - a. \$95 for extra laboratory tests
 - b. \$2,640 for intensive care
 - c. never been measured
 - d. a and b
9. The average claim payment after a medication error is approximately
 - a. \$10,000
 - b. \$50,000
 - c. \$100,000
 - d. \$1,000,000
10. To optimize medication safety, automated medication dispensing systems should include the following feature(s):
 - a. Dispense unit doses
 - b. Signal the nurse when a dose is due
 - c. drug use information is included with the dose
 - d. Access to drugs is controlled
 - e. All of the above

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