Medication Errors in Acute Cardiac Care
An American Heart Association Scientific Statement From the Council on Clinical Cardiology Subcommittee on Acute Cardiac Care, Council on Cardiopulmonary and Critical Care, Council on Cardiovascular Nursing, and Council on Stroke

Jane E. Freedman, MD; Richard C. Becker, MD; Jesse E. Adams, MD; Steven Borzak, MD; Robert L. Jesse, MD; L. Kristin Newby, MD; Patrick O’Gara, MD; John C. Pezzullo, PhD; Richard Kerber, MD; Bernice Coleman, RN, PhD; Joseph Broderick, MD; Sally Yasuda, MS, PharmD; Christopher Cannon, MD

Medical errors occur commonly among hospitalized patients, with adverse events occurring in an estimated 3.7% to 16.6% of hospital admissions. Extrapolation of this information has led to an estimate of at least 44,000 deaths in US hospitals due to medical errors that are also commonly associated with complex or urgent care and prolonged hospital stays. In addition, preventable adverse medical events were the leading cause (19.3%) of all nonoperative adverse events. The importance of medical errors as a major contribution to adverse events has been the recent focus of several reviews and initiatives. Medication errors have recently been evaluated by the Institute for Safe Medical Practices (ISMP), and the British Medical Journal devoted a special issue to the subject of medical errors (March 18, 2000). The US Institute of Medicine (IOM) also published an extensive report examining the prevalence and reviewing potential causes of medical mistakes. The IOM’s report stated: ‘The problem is not bad people; the problem is that the system [of medical care] needs to be made safer.’

The definition of a medication error as approved by The National Coordinating Council for Medication Error and Prevention is ‘. . .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.’

A recent editorial by the author of the papers on which many of the IOM report’s more widely publicized estimates were based takes issue with the implication that doctors and hospitals are doing very little about the problem of injuries caused by medical care. In fact, if the studies referenced by the IOM are extrapolated to the national population, the expected number of deaths nationwide attributable to substandard care actually decreases from 92,000 in 1984 (based on New York data) to 25,000 in 1992. Whatever the accurate figures with regard to mortality are, it is clear that patient safety can be improved.

Recently, much has been written on both the incidence of medical errors and general ways of understanding and correcting this problem. The purpose of this review is (1) to focus on the scope and magnitude of medical errors occurring in acute cardiac care and (2) to examine potential solutions.

Prevalence of Medication Errors in Acute Cardiac Care
Assessing the scope of medical errors as they pertain specifically to acute cardiac care is difficult. Data are extremely

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This statement was approved by the American Heart Association Science Advisory and Coordinating Committee on August 30, 2002. A single reprint is available by calling 800-242-8721 (US only) or writing the American Heart Association, Public Information, 7272 Greenville Ave, Dallas, TX 75231-4596. Ask for reprint No. 71-0239. To purchase additional reprints: up to 999 copies, call 800-611-6083 (US only) or fax 413-665-2671; 1000 or more copies, call 410-528-4426, fax 410-528-4264, or e-mail klbradle@lww.com. To make photocopies for personal or educational use, call the Copyright Clearance Center, 978-750-8400.

Institutional affiliations of all authors may be found in the Appendix.
(Circulation. 2002;106:2623-2629.)

© 2002 American Heart Association, Inc.

Circulation is available at http://www.circulationaha.org DOI: 10.1161/01.CIR.0000037748.19282.7D
limited, well-designed clinical trials are scarce, and the information is often anecdotal. Despite these shortcomings, the available information does suggest reason for concern in the cardiovascular patient.

On the basis of the available studies examining cardiovascular patients, it is suggested that a significant degree of morbidity and mortality may be preventable. An evaluation of 182 deaths from cerebrovascular accidents, pneumonia, or myocardial infarction (MI) found that between 14% and 27% of the deaths might have been avoidable. For those with death attributed to MI, preventable deaths reflected primarily errors in management as compared with errors in diagnosis. Another careful evaluation of 203 cases of cardiac arrest found that 14% of the events followed an iatrogenic complication. Patients with iatrogenic cardiac arrest were less likely to be in cardiogenic shock or to have had an acute MI before arrest. The authors concluded that half of the cardiac arrests might have been prevented. The most common cause of potentially preventable arrest in these limited studies were (1) medication errors and toxicity (44%) and (2) suboptimal response by physicians to clinical signs and symptoms.

The potential for adverse outpatient drug reactions also has been examined. In one study, patients’ medication bottles and reported use were compared with physicians’ records in a cardiovascular practice. Discrepancies between recorded and reported medication use (including cardiac drugs) were common. In a multivariate analysis, patient age and the number of recorded medications were the most significant predictors of medication discrepancy.

In summary, the available data suggest that medication errors are a common occurrence in patients with cardiovascular disease and contribute substantially to adverse events, in both hospital and outpatient settings.

Types of Medication Errors in Acute Cardiac Care

Some estimates suggest that medication errors are increasing in clinical practice. Estimates based on death certificate data—which have significant limitations—show that, in 1993, an estimated 7391 individuals died from medication errors compared with only 2876 in 1983—a 2.6-fold increase in deaths in a 10-year period, although the relative number of prescriptions written during these years was not reported. In addition, outpatient deaths due to medication errors rose by 8.5-fold during this same period. Although there are many possible causes for medication errors, several general categories have been identified.

Drug Name Confusion Errors

A common cause of both outpatient and inpatient medical adverse events is drug name confusion on either handwritten or verbal orders. This problem, driven by a large number of drugs with name similarities (Table 1), applies primarily to patients with cardiovascular disease.

Drug name confusion can be exacerbated by the purchase of medications from pharmacies outside the United States if the marketed names are different. Similarly, the interchange of generic preparations and the mandatory substitution of generic for name-brand drugs can confuse patients. For example, a patient might take warfarin and Coumadin (Du Pont Pharma) without realizing that they are the same medication. Finally, errors associated with the use of abbreviations can also contribute to the danger of drug name confusion.

Prescribing and Dispensing Errors

In addition to problems involving drug name confusion, errors can occur at any stage of the medication process. These include errors made during prescribing, transcribing, dispensing, administering, or monitoring medications. Fibri-nolytic and antithrombotic therapy, used in the treatment of MI and acute coronary syndromes, are targeted areas of concern because any deviation in dose, duration, or intensity of systemic effect could adversely influence clinical outcome. Complex dosing and titration regimens for these drugs

---

### Table 1. List of Similar Drug Names in Cardiovascular Practice

<table>
<thead>
<tr>
<th>Drug</th>
<th>Drug With Similar Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accupril (ACE inhibitor)</td>
<td>Accutane (isotretinoin)</td>
</tr>
<tr>
<td>Accupril (ACE inhibitor)</td>
<td>Monopril (ACE inhibitor)</td>
</tr>
<tr>
<td>Aldolrol (methylprednisolone)</td>
<td>Indoral (β-adrenergic blocker)</td>
</tr>
<tr>
<td>Amiodarone (antiarrhythmic)</td>
<td>Amrinone (inotrope)</td>
</tr>
<tr>
<td>Avandia (rosiglitazone, hypoglycemic)</td>
<td>Coumadin (oral anticoagulant)</td>
</tr>
<tr>
<td>Captopril (ACE inhibitor)</td>
<td>Carvedilol (β-adrenergic blocker)</td>
</tr>
<tr>
<td>Cardene (Ca channel blocker)</td>
<td>Cardizem (Ca channel blocker)</td>
</tr>
<tr>
<td>Cardene (Ca channel blocker)</td>
<td>Cardura (Doxazosin)</td>
</tr>
<tr>
<td>Cardene (Ca channel blocker)</td>
<td>Codeine (narcotic)</td>
</tr>
<tr>
<td>Cardene SR (Ca channel blocker)</td>
<td>Cardizem SR (Ca channel blocker)</td>
</tr>
<tr>
<td>Cardizem SR (Ca channel blocker)</td>
<td>Cardizem CD (Ca channel blocker)</td>
</tr>
<tr>
<td>Cardura (β-blocker)</td>
<td>Coumadin (oral anticoagulant)</td>
</tr>
<tr>
<td>Cartezol (β-adrenergic blocker)</td>
<td>Carvedilol (β-adrenergic blocker)</td>
</tr>
<tr>
<td>Doxazosin (α1-adrenergic blocker)</td>
<td>Diltiazem (Ca channel blocker)</td>
</tr>
<tr>
<td>Dopamine (sympathomimetic amine)</td>
<td>Dopamine (sympathomimetic amine)</td>
</tr>
<tr>
<td>Epoproly (MAO inhibitor)</td>
<td>Enalapril (ACE inhibitor)</td>
</tr>
<tr>
<td>Fentanyl (analgesic)</td>
<td>Hydroxyzine (H1 antihistamine)</td>
</tr>
<tr>
<td>Inderal (β-adrenergic blocker)</td>
<td>Isosorbide (nitrates)</td>
</tr>
<tr>
<td>Isordil (nitrates)</td>
<td>Plendil (Felodipine, ACE inhibitor)</td>
</tr>
<tr>
<td>Lisinopril (ACE inhibitor)</td>
<td>Resperidol (antipsychotic)</td>
</tr>
<tr>
<td>Lovenox (ACE inhibitor)</td>
<td>Lovastatin (HMG CoA reductase inhibitor)</td>
</tr>
<tr>
<td>Metoprolol (β-adrenergic blocker)</td>
<td>Misoprostol (Prostaglandin E1)</td>
</tr>
<tr>
<td>Nifedipine (Ca channel blocker)</td>
<td>Nifedipine (Ca channel blocker)</td>
</tr>
<tr>
<td>Nifedipine (Ca channel blocker)</td>
<td>Nifedipine (Ca channel blocker)</td>
</tr>
<tr>
<td>Nitroderm (nitrates)</td>
<td>Nicardipine (nitrates)</td>
</tr>
<tr>
<td>Pindolol (β-adrenergic blocker)</td>
<td>Pindolol (Felodipine, ACE inhibitor)</td>
</tr>
<tr>
<td>Pravachol (HMG CoA reductase inhibitor)</td>
<td>Propranolol (β-adrenergic blocker)</td>
</tr>
<tr>
<td>Propranolol (β-adrenergic blocker)</td>
<td>Propyliod (cisapride)</td>
</tr>
<tr>
<td>Quinidine (antiarrhythmic)</td>
<td>Quinine (antimalarial)</td>
</tr>
<tr>
<td>Torresol (NSAID)</td>
<td>Inderal (β-adrenergic blocker)</td>
</tr>
<tr>
<td>Valsartan (AT2 receptor antagonist)</td>
<td>Losartan (AT2 receptor antagonist)</td>
</tr>
<tr>
<td>Verapamil (verapamil, ACE inhibitor)</td>
<td>Verapamil (Ca channel blocker)</td>
</tr>
</tbody>
</table>


Brand names are italicized.
increase the risk of serious errors, especially when multiple drugs from a particular class are available (on formulary) and management guidelines are absent, poorly designed, or not followed. Many of these drugs also have different dosing protocols, which further increases the chance of error. These concerns are substantiated by several reports that fibrinolytic drugs such as tissue plasminogen activator (t-PA) and streptokinase are associated with errors in dosing 5% to 12% of the time they are given.12–14 The problem likely will grow as new antithrombotic agents are developed and combination pharmacotherapies are employed in routine clinical practice.

The fibrinolytic agents reteplase15 and tenecteplase16 offer the benefit of easy bolus administration. One study documented a 19-minute time savings in door-to-drug time with the use of reteplase as compared with alteplase.17 Some reports suggest that the single-bolus fibrinolytic agents are associated with fewer medication errors than are t-PA or streptokinase. Reteplase is a double-bolus agent, administered as two 10-U boluses 30 minutes apart. Reteplase was compared with t-PA in the Global Use of Strategies to Open Occluded Coronary Arteries (GUSTO III) trial.15 Some feared that investigators and practitioners would omit the second bolus or delay its administration, but a recent analysis reported that fewer patients treated with reteplase had incomplete doses (1%) compared with those receiving t-PA (4%).17

One might expect fibrinolytic dosing errors to influence outcome in the setting of acute MI, with too low a dose associated with lower rates of infarct-related artery patency and higher doses associated with increased hemorrhagic complications. Although confounding factors may contribute,19 there does appear to be a narrow “therapeutic window” for fibrinolytic and antithrombotic regimens, and the potential for adverse outcomes is high if dosing deviations occur.19,20

The relationship between t-PA dose and intracranial hemorrhage was also investigated in >70,000 patients enrolled in the National Registry of Myocardial Infarction (NRMI-2).21 The outcomes of patients who received >1.5 mg/kg were compared with those who received ≤1.5 mg/kg. Higher doses were associated with twice the rate of intracranial hemorrhage, with the risk remaining elevated after adjusting for differences in baseline characteristics, including weight.21

Although most reports have consistently shown higher mortality and major hemorrhagic event rates among patients who have received an incorrect dose of fibrinolytics,10,20,22 a recent preliminary analysis of the ASsessment of the Safety and Efficacy of a New Thrombolytic (ASSENT)-2 trial has also highlighted the potential contribution of confounding factors (eg, age, weight).

Appropriate dosing of unfractionated heparin is vital for its safe and effective use. Many trials have shown a relationship between heparin dose and the intensity of anticoagulation and incidence of major hemorrhage, including intracranial bleeding. Also, many trials have shown that the dose of heparin administered influences the rate of intracranial hemorrhage significantly. In TIMI-9A and Global Use of Strategies to Open Occluded Coronary Arteries (GUSTO)-IIa, patients weighing >80 kg received an initial 1300-U/h heparin infusion. For those weighing <80 kg, the initial infusion rate was 1000 U/h. This strategy was associated with an increased rate of intracranial hemorrhage.24 Importantly, a reduced dose, as employed in TIMI-9B and GUSTO-IIIb, reduced major hemorrhage rates significantly.25 Because of the clear relationship between heparin dose and major hemorrhage, the 1999 update of the ACC/AHA Guideline for the Management of Acute MI recommends a new, lower dose of heparin: a bolus of 60 U/kg (maximum 4000 U) and an initial infusion of 12 U/kg per hour (maximum 1000 U/h).26

In the intensive care unit setting, antithrombotic agents have been the main drugs associated with adverse events, but other medications have been identified.28 In a recent study of medical inpatients, drugs for treating coronary heart disease and heart failure, including diuretics, nitrates, angiotensin-converting enzyme inhibitors, and calcium channel blockers, were associated with fatal adverse drug events.29 Specifically linked to administrative errors were vasoactive drugs, with the most common error being the wrong infusion rate.30 Digoxin has also been associated with medication errors and cardiac arrest among hospitalized patients.8 Several factors have been linked with digoxin toxicity, including aging-related changes in renal function, body mass, and polypharmacy.31

Errors involving acute cardiac care are also associated with renal impairment. Because both hypertension and congestive heart failure may cause or be associated with renal disease, it is not uncommon for the patients undergoing acute cardiac care to have renal insufficiency or failure. Monitoring angiotensin-converting enzyme inhibitors is also needed because cases of uremia related to their use are not uncommon and often occur because of failure to detect decreased renal function.32 Attempts have been made to limit errors related to dose adjustment necessitated by renal insufficiency, with the use of medication guidelines incorporated into a computerized order entry system.33 This system recommends adjusting drug dose and frequency in patients with renal insufficiency and has been shown to improve drug prescribing and patient outcomes.33

### Potential Errors in Thrombolytic Therapy for Acute Ischemic Stroke

Dosing errors are not uncommon with first- and second-generation fibrinolytic agents. An association between medication errors and increased morbidity and mortality has been observed and is compounded by excessive doses of antithrombins. Potential errors with dosing and timing of dosing for t-PA are also a concern in the treatment of acute ischemic stroke. The standard dose of t-PA for acute ischemic stroke is 0.9 mg/kg with 10% of the total dose given as a bolus and the rest administered over 1 hour (90 mg maximum).34 Treatment must begin within 3 hours. Heparin and aspirin are listed as contraindications during the first 24 hours after start of intravenous t-PA. The dose, time constraints, and protocol are substantially different than for treatment of acute ST-segment–elevation MI.

Data on the appropriate use of t-PA for acute ischemic stroke are very limited, but one of the major deviations from the standard protocol is initiation of treatment beyond 3 hours from onset. Patients who are treated outside of the recommended approved National Institute of Neurological Disor-
Errors of Omission

Although not always considered a safety error, an important issue in acute cardiac care is failure to follow guidelines by omitting medications demonstrated to be effective. A large number of randomized clinical trials performed in patients with cardiovascular disease have fostered management guidelines and standards of care with the expectation that medication will be offered to those who are most likely to benefit. Mounting experience also helps to define the risk-benefit relationship of treatment and potential adverse effects. Minimal data that address the appropriate use of medications are available from prospectively collected cohorts of patients with acute coronary syndromes. However, in a study evaluating patients with unstable angina, women (39% of the study group) were less likely than men to receive Agency for Health Care Policy Research (AHCPR)–recommended pharmacological treatment.44

Omission errors in acute cardiac care are represented most dramatically by the relatively low rates of aspirin administration in the first 24 hours of MI. This omission occurs despite the fact that aspirin reduces mortality and reinfarction,45–47 particularly when given in combination with fibrinolytic therapy.48 However, in the first National Registry of Myocardial Infarction (NRMI), involving 240,989 patients, only 87% of thrombolytic-treated patients received aspirin.49 Similarly, in the Cooperative Cardiovascular Project, only 80% of eligible patients received aspirin.49 The American Heart Association has published a scientific statement strongly urging physicians to increase the use of aspirin in appropriate patients.49

Although more recently recommended in the American Heart Association/American College of Cardiology acute coronary syndrome guidelines, initial50 data suggest that the early use of glycoprotein IIb/IIIa inhibitors in non–ST-elevation MI has not been routinely adapted into practice. Analysis of the NRMI 4 Registry between July 2000 and April 2001 suggests that only 24% of eligible patients received early glycoprotein IIb/IIIa therapy and its use was associated with lower in-hospital mortality.50

Anticoagulant therapy with warfarin for stroke prevention in atrial fibrillation is also underutilized. Age >80 years, language difficulties, insufficient physician knowledge of the potential benefits of warfarin, and patient disability are associated with reduced utilization.51

Long-term β-adrenergic receptor–blocker therapy after acute MI has been evaluated.45–47 The available data suggest that fewer than 50% of eligible patients actually receive treatment after hospital discharge.52 On the basis of the recognized benefits of β-blockade, it is believed that as many as 5000 deaths each year are attributable to its omission.53

There is increasing evidence that fibrinolytic therapy is underutilized, particularly in the elderly and those presenting beyond 6 hours from MI symptom onset. In NRMI-I, 12.4% of eligible patients did not receive any form of reperfusion therapy.44 Although emerging trends toward more appropriate treatment are evident, hospital delay times before initiation of fibrinolytic therapy remain long.45 Trend analyses from 1990 to 1993 suggest that the time from hospital evaluation to initiation of fibrinolytic therapy has shortened.45

Underutilization of t-PA for acute ischemic stroke is also substantial, as noted earlier, and reflects, in part, the delay in the time from patient arrival to start of therapy.42 However, unlike patients with acute MI, computed tomographic scanning of the head must be completed and reviewed before initiation of treatment with t-PA. In addition, treatment with t-PA must begin within 3 hours of symptom onset.

Methods to Limit Medication Errors in Acute Cardiac Care

The subject of medication errors has been investigated in broad medical areas, and advisory boards have made general recommendations. The recent US IOM report included recommendations to improve patient outcome by minimizing medical errors. The key points are as follows:

• Establish, through Congress, a Center for Patient Safety in collaboration with the Agency for Healthcare Research and Quality, which would set national goals for patient safety as well as further general knowledge and understanding of errors in health care.
• Develop a nationwide mandatory reporting system that collects state-level information on adverse events that result in death or serious harm.
• Establish performance standards for healthcare organizations that focus greater attention on patient safety and require regulators and accreditors of healthcare organizations to implement meaningful patient safety programs.

Improving Reporting of Adverse Medication Errors

Detection, reporting, and analysis of medical errors are vital to ensure patient safety. According to the ISMP, staff self-reporting is currently the most common method used to identify medication errors (97%). However, it is likely that
fewer than 50% of errors are actually reported. Although clinicians and other healthcare workers should communicate the occurrence of medication errors and adverse events directly, this method, when used alone, is clearly inadequate. In a prospective single-hospital study, traditional screening methods detected only 9 of 664 adverse drug events, whereas 92 were detected by professional voluntary reporting. More than 600 events were detected with a computerized adverse drug event monitoring system. In this study, the most common drug classes involved were analgesic, anti-infective, and cardiovascular agents. Another study directly compared computer-based adverse drug event monitoring with chart review and voluntary reporting. Interestingly, the computer monitor identified fewer adverse drug events than chart review but many more than voluntary reporting. In addition, the overlap among the adverse events identified was small, suggesting that adverse drug events may be routinely underestimated. Although the IOM report recommends reporting of errors, this is complicated by a litigation system that encourages secrecy. Insisting that physicians have an ethical duty to report injuries resulting from medical care leads to fear of malpractice litigation. Because of this dilemma, it has been suggested that medical leaders must address liability reform as part of the overall solution to the problem of medical errors.

Rational Prescribing

After several reports of major adverse outcomes associated with their use, some drugs, including terfenadine, astemizole, mibebradil, and cisapride, have been removed from the market. Despite previous educational efforts, these drugs continued to be prescribed inappropriately. New ways to decrease such prescribing practices must be developed. A promising means of minimizing prescribing errors includes the development of computerized order entry. An analysis of a computerized order entry system demonstrated that ordering drugs through a computerized system that displays guidelines, offers alternatives, and suggests appropriate doses and frequency can lead to significant and appropriate changes in prescribing practices. This study noted that the use of subcutaneous heparin sodium to prevent thrombosis in patients at bed rest increased from 24% to 47% after this intervention was suggested. The prescribing changes that occurred persisted over a 2-year follow-up. In a related study, a variety of medication errors, including dosing errors, frequency errors, route of administration errors, substitution errors, and inadvertent use of allergenic medications, were reduced after the institution of a computerized physician prescribing system. The 1999 National Survey of Pharmacy Practice in acute care settings evaluated drug dispensing and administration practices. Of pharmacies with centralized distribution, 77.4% had systems that were not automated, and only 13% of hospitals had electronic medication order-entry systems, although 27% were in the process of developing an electronic system. The addition of a pharmacist to the medical intensive care unit has been shown to be associated with a substantially lower rate of adverse drug events caused by prescribing errors. An analysis of new drugs being added to formularies for potential problems, such as name confusion or prescribing errors, can be undertaken as the product is being introduced to the hospital.

Other Potential Solutions

Computer-assisted order entry is an emerging phenomenon that appears promising as an enhancement in the quest to improve the efficiency and effectiveness of institutional processes related to medication use. However, with or without computer-assisted order entry, hospitals are engaging in efforts to ensure patient safety relative to medication use. The Joint Commission on Accreditation of Healthcare Organizations has established standards specific to safety of medications use that are adhered to by all acute care hospitals.

One process used to identify problems before they occur is the “Failure Mode Effects Analysis” or FEMA. A multidisciplinary team examines the spectrum of institutional processes associated with threats to patient safety. Medications taken and devices used in patient care are but two examples of areas scrutinized by FEMA. A principal team goal is to identify, assess, and recommend actions to prevent errors in medication use. In addition, all institutions have a mechanism to examine “Sentinel Events.” These are events that contribute to unexpected negative outcomes inclusive of medication errors.

Although medication errors and preventable adverse drug reactions are a common cause of morbidity and mortality, there is little education about these issues at either the medical undergraduate or graduate level. Efforts directed toward minimizing medication errors include the development of Centers for Education and Research on Therapeutics (CERTs). CERTs is a demonstration program authorized by the US Food and Drug Administration Modernization Act of 1997. The goal of the CERTs program is to improve therapeutic outcome and reduce adverse events through basic and clinical research, as well as through educational programs. These programs include basic prescription and order writing, The University of Arizona CERT, for example, develops educational programs focusing on avoiding medication errors in prescribing, particularly those due to drug interactions. These educational principles are organized according to the Principles for Quality Prescribing as listed in Table 2 and should include an understanding that rational prescribing

<table>
<thead>
<tr>
<th>TABLE 2. Physicians’ Principles for Quality Prescribing: Commit to Zero Tolerance for Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commit to . . .</td>
</tr>
<tr>
<td>1. Prescribing medications only when appropriate and necessary.</td>
</tr>
<tr>
<td>2. Fully informing patients about their medications and what they can do, including both positive and negative outcomes.</td>
</tr>
<tr>
<td>3. Reporting errors and adverse events so others will not repeat them.</td>
</tr>
<tr>
<td>4. Withstanding pressures to prescribe in ways that are not in the patient’s best interest.</td>
</tr>
<tr>
<td>5. Knowing thoroughly the drugs that you prescribe.</td>
</tr>
<tr>
<td>6. Anticipating and preventing drug interactions.</td>
</tr>
<tr>
<td>7. Establishing a partnership with pharmacists and nurses to monitor therapy for interactions or errors and to counsel patients effectively.</td>
</tr>
</tbody>
</table>

TABLE 3. Safe Practice Recommendations for Acute Cardiac Care

(1) Limit the number of fibrinolytic agents on the hospital formulary.
(2) Require streamlined protocols and standardized order forms.
(3) Refer to fibrinolytic drugs, especially tissue plasminogen activators, by their full generic or brand names, and avoid abbreviations, including their listing in preprinted and handwritten orders and drug protocols.
(4) For weight-based therapy, add prompts on standard order forms to record the patient’s weight.
(5) Minimize the complexity of the treatment regimen and be sure to consider all the associated drugs (especially other antithrombotic medications) that may be used to treat the patient, as well as potentially tight time constraints for administration.
(6) Make sure the protocols require the assessment of all recent drug therapy.
(7) Access to information should be increased, education provided, and access to new drugs on the formulary restricted.
(8) Evaluation of drug therapy given to ACS patients to assess outcomes, problems with administration, and the need for changes.

Adapted with permission from the Institute for Safe Medication Practices. ACS indicates acute coronary syndrome.

should be evidence based and that issues of consent may need to be modified in the setting of acute care. These programs are targeted at undergraduate and graduate medical education as well as practicing physicians. The Duke CERT has programs to improve appropriate utilization of aspirin in patients with coronary artery disease and β-blockers in congestive heart failure. Monitoring and analysis for physician compliance should be considered to determine the success of these efforts.

Recommendations for improving the safety of acute cardiac care have been proposed by the ISMP (Table 3). These recommendations focus on fibrinolytics and related drug therapy, with specific recommendations for reducing medication error. The basic recommendations suggest that standardization, simplification, enhanced dissemination of information, and restriction of access to potentially hazardous medications can reduce medication error.

Conclusion

The scope of the medication errors problem and its potential impact on patients with cardiovascular disease is unfolding gradually, but many questions remain unanswered. It is clear that with increasing patient age and the frequent prescribing of multiple medications, concerted efforts for prevention, reporting, and management must be undertaken nationwide. Improvements will be required in the epidemiological evaluation of medication errors to determine prevalence rates accurately and implement prevention policies. The IOM report calls for more systematic approaches to the prevention of injuries due to medication error, including the use of computer systems to prevent such injuries. These systems, however, are costly to develop and maintain, and healthcare insurers and employers have shown limited interest in supporting them. However, because all parties—physicians, healthcare providers, and employees—have a vested interest in avoiding medical errors and their consequences, creative solutions to funding these efforts must be made a priority.

Finally, the problem of medication errors must be introduced to healthcare professionals early in their training and the principles reinforced repeatedly. The medical community can reduce the frequency and clinical impact of medication errors by enhancing error detection rates, using appropriate methods for reporting errors, and implementing safer methods of drug ordering, dispensing, and tracking.

Appendix

Institutional Affiliations of the Authors

The Committee on Acute Cardiac Care, American Heart Association, and the Department of Medicine (J.E.F.), Boston University School of Medicine, Boston, Mass; the Department of Pharmacology (S.Y., J.C.P.), Biostatistics (J.C.P.), and the Georgetown Center for Education and Research on Therapeutics (S.Y.), Georgetown University, Washington, DC; the Department of Medicine, University of Massachusetts Medical School, Worcester (R.C.B.); the Department of Medicine, Jewish Heart Lung Institute, Louisville, Ky (J.E.A.); the Department of Medicine, Henry Ford and Vascular Institute, Detroit, Mich (S.B.); the Department of Internal Medicine, Virginia Commonwealth University Health System/Medical College of Virginia, Richmond, Va (R.L.J.); the Department of Medicine, Duke University Medical Center, Durham, NC (L.K.N.); the Department of Cardiothoracic Surgery, Cedars Sinai Medical Center, Los Angeles, Calif (B.L.C.); and the Department of Medicine, Brigham and Women’s Hospital, Boston, Mass (P.O., C.C.).

References


24. Randomized trial of intravenous heparin versus recombinant hirudin in acute coronary syndromes. The Global Use of Strategies to Open Occluded Coro-

25. Antman EM. Hirudin in acute myocardial infarction. Thrombolysis and


Key Words: AHA Scientific Statements • medical errors • medication errors • patients • drugs
Medication Errors in Acute Cardiac Care: An American Heart Association Scientific Statement From the Council on Clinical Cardiology Subcommittee on Acute Cardiac Care, Council on Cardiopulmonary and Critical Care, Council on Cardiovascular Nursing, and Council on Stroke

Jane E. Freedman, Richard C. Becker, Jesse E. Adams, Steven Borzak, Robert L. Jesse, L. Kristin Newby, Patrick O'Gara, John C. Pezzullo, Richard Kerber, Bernice Coleman, Joseph Broderick, Sally Yasuda and Christopher Cannon

_Circulation._ 2002;106:2623-2629
doi: 10.1161/01.CIR.0000037748.19282.7D

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2002 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/106/20/2623

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:
http://circ.ahajournals.org//subscriptions/