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**THE NATURE AND EXTENT OF MEDICAL INJURY IN
OLDER PATIENTS**

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The Public Policy Institute, formed in 1985, is part of the Research Group of the AARP. One of the missions of the Institute is to foster research and analysis on public policy issues of interest to older Americans. This paper represents part of that effort.

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FOREWORD

Preventable medical injury is a significant problem in America. Injuries and deaths attributable to medical error are numerous and costly. There has been mounting evidence over the past decade that thousands of patients die each year from those injuries, and many more suffer injuries that prolong their hospital stays. Public awareness of the dimensions of the problem increased dramatically after the Institute of Medicine (IOM) Committee on Quality of Health in America issued its 1999 report on medical error entitled, "*To Err is Human: Building a Safer Health System.*" The committee estimated that between 44,000 and 98,000 people die annually as a result of preventable medical injuries, and that costs associated with preventable injury total from \$17 to \$29 billion each year. The IOM report made a number of recommendations, including developing and funding a Center for Patient Safety in the Agency for Healthcare Research and Quality, creating a system of mandatory reporting of medical errors resulting in serious or fatal injury, and creating a voluntary reporting system for other errors with less serious outcomes.

We have known for nearly a decade that older patients are particularly at risk for medical injury. The *Harvard Medical Practice Study* (1990), which reviewed hospital records from patients discharged from four New York hospitals in 1984, was the first study to examine age-specific rates of medical injuries. It found that older patients were significantly more likely to suffer medical injury than younger patients were. A 2000 Public Policy Institute report by Dr. Eric Thomas and Dr. Troyen Brennan confirmed those findings.

Although we know that older patients suffer more preventable injuries than their younger counterparts do, little information has been available to explain how and why older patients are more likely to be injured, or what might be done to promote their safety. The Public Policy Institute commissioned Dr. Jeffrey Rothschild of the Harvard School of Medicine and Dr. Lucian L. Leape of the Harvard School of Public Health to survey and summarize the literature on the nature and extent of preventable medical injury among older patients. We believed that such a study would inform the discussion and provide guidance for developing a research agenda on this issue.

The paper that Dr. Rothschild and Dr. Leape have written not only meets those objectives, but substantially increases our knowledge base. By performing an exhaustive literature review, as well as accessing and analyzing previously unpublished data from several databases, the authors were able to develop a detailed portrait of medical injury in the older patient population. Their report provides a review of the nature and extent of injuries to older patients, examines *why* they are at greater risk of injury, and discusses *what can be done* to reduce accidental injury in older patients.

We believe that with this study, Dr. Rothschild and Dr. Leape make an important contribution to the study of preventable medical injury in older patients, and we trust that this document will help to advance the cause of patient safety.

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EXECUTIVE SUMMARY

Background

Concern about the extent of accidental injury to patients undergoing medical treatment has increased substantially in the past several years. This concern is partly in response to publicity surrounding egregious cases of mistreatment and partly in response to evidence indicating that the problem may be far more serious than previously assumed. A report issued by the Institute of Medicine in November 1999, which estimated that between 44,000 and 98,000 patients die each year as a result of preventable medical errors, and that costs associated with medical error total between \$17 billion and \$29 billion, has greatly increased public concerns about patient safety. This concern has stimulated a number of initiatives designed to improve patient safety. It is likely that these will lead to improvements in patient safety.

There is substantial evidence that older patients (defined as those age 65 and older) are at substantially greater risk for iatrogenic (treatment or procedure-related) medical injury than other age groups are. Because older patients have special problems and may require special measures to achieve acceptable levels of safety in health care, there is concern that they may not fully benefit from the safety improvements being designed.

Purpose

This research was initiated to identify the nature and extent of preventable medical injury among patients age 65 and older, to determine how and why their patterns of injury differ from those of younger patients, and to suggest some ways that iatrogenic injury among older patients can be addressed.

Methodology

This report synthesizes what is known about the extent and causes of iatrogenic injury in adults age 65 and older. It is based on a review of the literature and analysis of unpublished data from several databases. In addition, the Harvard Medical Practice database (previously published and referenced elsewhere in this report) was used for subanalysis within the older population.

Results

1. The Extent of Medical Injury in Older Patients

Medical injuries are unexpected and unfortunate consequences of well-intentioned health care. All ages are at risk, but older patients are at particular risk because they have more severe illnesses and more illnesses simultaneously than younger populations do. The

extent of iatrogenic medical injury in patients age 65 and older is substantial. At least 6 percent of hospitalized patients in that age group suffer an adverse event, defined as a treatment-caused injury that is serious enough to result in a measurable disability or to prolong a hospital stay. That rate is substantially higher than for younger age groups.

For example, in the Harvard Medical Practice Study, patients age 65 and older suffered twice as many diagnostic mishaps, four times as many therapeutic mishaps, two and a half times as many drug complications, and nine times as many falls as those under age 65. The risk of accidental injury increases with advancing age, particularly for falls and surgical complications. Two-thirds of iatrogenic injuries are due to errors and are, therefore, potentially preventable.

The reported iatrogenic injury rate among nursing home residents is staggering: several traumatic injuries per person per year in one comprehensive study, more than half due to falls. One-quarter of nursing home residents also suffer a medication complication each year. Approximately 2 million older Americans are patients in nursing homes. Estimates are that, at any time, 200,000 of these patients are recovering from an injury caused by a fall that occurred in the nursing home. Moreover, 160,000 have a urinary tract infection, and 200,000 have pressure sores.

The extent of injury among older patients outside of the hospital or nursing home has not been well studied, but the information available suggests that the risk of falls and medication complications among confined older patients receiving home care is at least as great as among those in nursing homes.

Older patients are particularly susceptible to several forms of iatrogenic complications: adverse drug events, falls, nosocomial infections, pressure sores, delirium, and surgical complications.

Adverse drug events (ADEs) are the most common type of treatment-caused injury in hospitalized patients, including patients age 65 or greater. In addition, ADEs are frequent complications among older persons in nursing homes and the ambulatory setting. In teaching hospitals, 6-7 percent of all patients suffer ADEs; the rate is higher still in older patients who are sicker and receive more drugs. The rate is probably somewhat lower in community hospitals, where fewer medications are used.

Approximately one-third of ADEs in hospitals are due to errors and are, therefore, preventable. The remaining two-thirds are adverse drug reactions (ADR), unpreventable, and often unpredictable, side-effects that occur even when a drug is used properly.

ADEs are a particular problem among older patients in nursing homes. One prospective study showed that in a four-year period, two-thirds of nursing home residents suffered an ADE. They are also common in the noninstitutionalized older population, primarily as a result of inappropriate prescribing. Surveys have shown that a substantial percentage of older patients receive at least one inappropriate drug. These patients are also at increased

risk because they take a large number of medications.

A study of older veterans showed that they were taking an average of eight drugs each, and 35 percent reported having had a drug reaction in the prior year—28 percent of which required an emergency room visit or hospitalization. Overall, untoward reactions to medications account for 15 percent of admissions to the hospital for patients over 60 (compared to 6 percent for younger patients).

Falls are a major public health problem among older persons. It has been estimated that, annually, falls are responsible for over 2,000,000 injuries, 369,000 admissions to hospital, and 9,000 deaths, at a cost of \$8 billion a year. The risk of falling and the likelihood that the resultant injuries (mostly hip fractures and brain injuries) will result in death increase substantially with advancing age. Over 250,000 hip fractures occur annually, almost all in older persons. In the health care setting, falls are most common in nursing homes; they occur less frequently in hospitalized patients. On average, half of older patients residing in nursing homes suffer falls each year.

Nosocomial infections occur in 6-17 percent of hospitalized patients, and may be equally frequent among nursing home residents. Like other iatrogenic complications, the risk of infection increases sharply with advancing age. Among nursing home residents, pneumonia is the most common form of infection and most likely to be fatal.

Pressure sores are a preventable form of iatrogenic injury that occurs in approximately 1.7 million patients each year. The vast majority develop in older patients in nursing homes. Up to 20 percent of nursing home patients have been found to have pressure sores.

Delirium is a common affliction of older patients, complicating the course of 2.3 million hospitalized patients annually, at a cost of \$4 billion. The underlying causes are related to aging of the brain and are unpreventable, but surgery and drug therapy are frequently precipitating events.

Surgical complications are twice as likely to occur in patients over the age of 65 as in younger patients, and the rates of complications and death increase sharply with age. Surgery is riskier in older patients because they have reduced physiologic reserve and are more likely to have multiple medical conditions. Patients age 65 and older account for half of all surgical emergencies and three-fourths of operative deaths.

2. Why Older Patients Are More at Risk of Injury

The greater risk of harm to older patients from medical interventions results both from increased exposure to opportunities for medical mistakes and from the likelihood that those mistakes will then lead to actual injury. Older patients are more susceptible to injury because of reduced compensatory mechanisms related to declining organ function. Functional decline (confusion, incontinence, loss of appetite, and tendency to fall) is

particularly likely to occur in older patients when they are hospitalized. These problems lead to additional treatments with their attendant risk of complications (“cascade iatrogenesis”). Patients who are already impaired (such as those who are unable to walk or take care of themselves) are at special risk.

Unfortunately, hospitalization itself—involving a change in environment and routines, often accompanied by enforced bed rest—can be a major cause of functional decline and lead to a progressive downhill course in patients who were previously functioning well. Physician errors that are well tolerated in younger patients can be devastating in older ones. For example, excessive fluid administration that would be relatively harmless in a young patient can lead to congestive heart failure in an older person with reduced cardiac reserve. In addition, dehydration or inappropriate drug usage that would be tolerated in the young can lead to renal failure in older patients with marginal kidney function.

Doctors are also more likely to miss diagnoses in older patients. The reasons are multiple and complex. Patients may give them inadequate clues, for example. Older patients are more likely to deny symptoms, in part because they have become accustomed to living with aches and pains of one sort or another, or because they interpret a new symptom as part of a chronic disorder they have. Older patients are also less likely than their children to be aggressive or assertive with doctors, often accepting inadequate explanations and not voicing concerns.

But most missed diagnoses result from physicians’ lack of sufficient training or experience to recognize that older patients often present with symptoms (e.g., delirium or fainting caused by an infection such as pneumonia) that are not directly related to a new disease process. Atypical presentation of diseases is a major pitfall for the nongeriatric specialist. In addition, some physicians have biases against older patients and conflicting attitudes about dying that compromise their objectivity.

Finally, the recent pressure by managed care organizations to shorten hospital stays has led to more care of the chronically ill being given outside the hospital setting, where supervision and expertise of caregivers are greatly reduced. This is particularly the case in nursing homes, where inexperienced caregivers confuse symptoms of disease or complications with the normal course of patients in decline.

Older persons are more susceptible to **adverse drug events** because they absorb and metabolize drugs differently than younger patients do, and they have more diseases requiring treatment, resulting in multiple drug use. In addition, they face the challenge of complying with complex medication dosing schedules. Also contributing to adverse events from medication is inadequate caregiver-to-patient instruction about how to take each medication and what side effects to look for—plus the fact that patients may get prescriptions from multiple physicians who may not be aware of other medications the patient is taking.

The causes of **falls** among older persons are complex. Progressive instability and difficulty

in walking is a common affliction of aging, and complete protection against falling is impossible, short of constant supervision or restraints. However, patients with dementia or depression, those on psychotropic drugs, those with visual or neurologic impairment, and those with mobility problems or a history of falling are at special risk and require special attention. Use of restraints is rarely a needed option, however, and the evidence is that they probably increase the risk of serious injury. Recent episodes of tragedies associated with unsupervised use of restraints have highlighted the hazard and led to calls for stricter regulation.

Nosocomial infections are a particular hazard for older patients. Pneumonia is disturbingly common in both hospitalized and nursing home patients. Decreased lung capacity, impaired cough reflex, and declining immunity all contribute to this increased susceptibility to pneumonia. Pulmonary aspiration is a major precipitating event, particularly in post-operative patients or those who are neurologically impaired. The use of urinary catheters is also a significant cause of infection. Both of these complications are common sequelae of prolonged hospitalization and multiple treatments.

The development of **pressure sores** is a potential hazard for anyone who is bedridden or chairbound, as many older hospitalized or nursing home patients are. A host of factors add to the risk: neurologic injury, malnutrition, fecal incontinence, orthopedic injuries, hypoalbuminemia, to mention a few.

Delirium is another iatrogenic complication with many causes, including infections, metabolic imbalances, alcohol withdrawal, insufficient social support, sleep deprivation, unfamiliar surroundings, pain, and isolation. A major problem is that doctors and nurses frequently fail to diagnose or misdiagnose delirium, mistakenly attributing mental changes to aging or dementia. As many as 25% of older patients experience delirium following surgery. Patients undergoing coronary-artery bypass surgery are particularly at risk. Inadequate control of pain in the post-operative period is a significant cause of delirium.

Age alone is not a risk factor for **post-operative complications**, but older patients tend to have reduced organ function and multiple chronic diseases that increase the risk of iatrogenic injury. In addition, the hazards of bed rest, blood clots, and nosocomial infections are real and present dangers for post-operative patients. Unfortunately, fear of increased risk of complications may also lead to risky behavior by the surgeon, who may delay surgery until it becomes necessary as an emergency, at which point the patient's reduced reserve and the ravages of the disease have been shown to increase the mortality risk as much as tenfold.

3. What Can Be Done to Reduce Accidental Medical Injury in Older Patients

Interest in improving patient safety has accelerated significantly in the past few years. The American Medical Association (AMA) founded the National Patient Safety Foundation,

major private and governmental health organizations have formed the National Patient Safety Partnership, and national advisory boards have called for an increased emphasis on prevention of medical errors.

All of these efforts will help older patients as well as others. Four strategies hold special promise for reducing the risks associated with health care for older patients: (1) application of lessons in error prevention from other industries, (2) reducing variability in medical care, (3) enhancing the roles of geriatric specialists, and (4) using risk profiling and discharge planning.

(1) Application of lessons in error prevention from other industries. Design for safety using human factors principles such as standardization, simplification, improved information access, appropriate automation, and training all workers to work in teams. These principles will work in health care as well.

(2) Reducing variability in medical care. Studies show substantial variation from hospital to hospital and from doctor to doctor in the application of life-saving treatments. Eliminating this variation through the dissemination of guidelines and the enforcement of standards in health care organizations will enhance safety.

(3) Enhancing the roles of geriatric specialists. Not surprisingly, care of older patients is better when provided by those who specialize in their care (geriatricians). Enhancing their role and developing multidisciplinary teams of geriatric specialists should be an agenda item for every hospital.

(4) Using risk profiling and discharge planning. Assessing and identifying older patients at risk for iatrogenic complications when they are admitted to the hospital is the first step in a comprehensive injury prevention program. Similarly, adequate assessment and discharge planning dramatically reduce the risk of post-hospitalization complications. These principles need to be applied in the outpatient setting as well.

For the six areas where older patients are at special risk, a host of interventions have been developed that, if applied throughout the health care industry, could have a major impact on the extent of accidental medical injury.

Reducing **adverse drug events** requires a multipronged approach. Several are related to better education of physicians who care for older patients. First, doctors need to be much better educated about drugs that carry special hazard when used in older patients. Fortunately, specific criteria have been developed to help physicians avoid inappropriate prescribing. The task is to get these criteria disseminated and used. Second, physicians need to be trained to better recognize adverse drug events so they do not treat them as “new illnesses.” Third, physicians and others need to learn about and use effective nonpharmacologic alternatives for such conditions as anxiety and sleep disorders.

Fourth, pharmacists need to be much more widely involved in medication management for

patients in all care settings. Fifth, regulators and private organizations can be major forces for change. The FDA is beginning to implement geriatric drug labeling that will provide critically needed information on how certain drugs should be used by older patients. The Institute for Healthcare Improvement (IHI) has launched a series of collaborative efforts in which IHI staff work with hospital teams to redesign their medication systems for safety.

Finally, information technology holds great promise for reducing medication errors. Computerized physician order entry not only eliminates paper prescriptions, but is powerfully effective at intercepting and preventing errors at the time of ordering. Its universal application could have a major impact on medication errors. “On-line” medication guidelines and information from real-time analysis of laboratory and drug data can also help physicians use medications correctly.

Falls can be prevented by implementing comprehensive programs that identify patients at risk and provide adequate safeguards. It has been shown that, when personnel are appropriately trained, the use of physical or chemical restraints can be dramatically reduced without an increase in falls.

The prevention of **nosocomial infections** requires more rigorous application of principles of infection control that have been well understood and taught for at least 50 years. In addition, efforts to avoid use of invasive treatments, such as endotracheal tubes and urinary catheters, should be encouraged. Similarly, the prevention of **pressure sores** depends on the application of long-established principles of nursing care, such as frequent turning of patients who are identified as being at risk. The ability to give such intensive “hands on” care is related to nursing-patient staffing ratios. A rising rate of pressure sores might well be an indicator of excessive staff reductions resulting from cost-cutting programs.

As with pressure sores, prevention of **delirium** begins with identifying patients at high risk and instituting prophylactic measures promptly. Effective pain control is an important component of prevention. Prevention of **post-operative complications**, perhaps more than with any other type of iatrogenic injury, requires a true multidisciplinary effort in which surgeon, geriatric specialist, and anesthesiologist work together to insure optimal preoperative preparation and attentive post-operative care. If such partnerships could be established early in the course of a surgical problem for each patient, they could help eliminate the most serious surgical risk of all: delay of needed surgery until it becomes an emergency.

Finally, we have much to learn from research about how to improve safety in caring for older patients. The development of more extensive longitudinal databases and analysis of outcomes can provide rich opportunities to better understand the limits, opportunities, and challenges in such care. Particular attention needs to be given to determining the effect of specialized training and care, staffing levels, and effective means of providing safe care outside the hospital setting. And doctors, nurses and patients will all profit from clearer information on the risks and probability of benefits for all treatments.

Conclusions

The risk of accidental injury is unacceptably high for all who undergo medical treatment but it is especially so for older patients. Some of these risks are unavoidable, the consequences of normal aging; others are brought on by the treatments themselves. In addition, many diseases are more prevalent in older patients, further reducing organ function and increasing susceptibility to injury. Finally, decreasing motor activity and dependency in the very old lead to complications such as pressure sores and falls.

However, the risk of complications from treatments is higher for older patients in large measure because they receive so many more of them. This is particularly true of medications. Specific treatments, such as surgical operations, have not been found to be intrinsically more hazardous in older patients, but they take on increased risk to the extent that patients have reduced organ function or coexistent ("comorbid") disease, or if surgery is delayed until it becomes an emergency.

The risks of medical treatment could be greatly reduced by wider application of principles and techniques that have been learned in recent years from geriatric research. The sad fact is that too many older patients are cared for by doctors and nurses with no geriatric training. This is true for patients in the hospital as well as at home or in nursing homes. With careful and expert care, older patients can weather many a medical storm. Providing that care is a major challenge to our medical care system.

INTRODUCTION

Concern about the extent of accidental injury to patients undergoing medical treatment has increased substantially in the past several years, partly in response to publicity surrounding egregious cases of mistreatment and partly in response to evidence indicating that the problem may be far more serious than previously assumed. Amid the calls for action, a number of public and private initiatives have emerged. The American Medical Association (AMA) has founded the National Patient Safety Foundation, which brings together stakeholders from all parts of the health care community—patients, doctors, nurses, pharmacists, therapists, regulators, advocacy groups, and others—to seek common ground for effective solutions to make health care safer. The Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) has recently improved policies addressing institutional error reporting. Organizational analysis, learning, and correction are now emphasized over fear of disclosure.¹

Improvement efforts on behalf of patients have become increasingly important throughout the health care delivery system. In addition to attention from government agencies and the involvement of several national medical societies, the medical error issue is receiving growing attention from academic researchers, community health care providers, integrated health care systems (i.e., the Veterans Health Administration), individual hospitals, and nonprofit organizations such as the Institute for Healthcare Improvement.

Increased attention to the patient-safety movement will presumably improve the care for all patients within the health care delivery system; however, there is reason for concern that older patients (defined as those age 65 and older) may not fully benefit from these improvements. Older patients are at special risk, have special problems, and may require special measures to achieve acceptable levels of safety in health care. We explore these issues in this report.

First, we examine the data available concerning the extent and nature of medical injury in older patients. We review the literature and analyze some available databases that measure the extent of injury, particularly preventable injury (that due to errors) in patients age 65 and older. We then look at several specific types of injuries that older patients are particularly susceptible to, such as adverse drug events, pressure sores, nosocomial infections, and falls. Next, we explore the reasons why older patients are at increased risk of iatrogenic injury. What are the physiological, pathological, sociological, and economic reasons for increased risk? And why are older patients at special risk of certain specific types of complications?

Finally, we examine what is known about how to reduce the risk of iatrogenic injury in older patients. This analysis draws upon a wealth of information from studies done over the past several decades by dedicated doctors and nurses who have attempted to prevent the complications of medical treatment. Most of this information comes from controlled clinical trials, although we have included information from descriptive studies when useful.

As in the preceding section, the discussion focuses initially on prevention of complications in general and then on the specific high-risk conditions.

MEDICAL INJURY IN OLDER PATIENTS

Medical injuries are unexpected and unfortunate consequences of well-intentioned health care. While all ages are at risk, older patients are at particular risk because they have more severe illnesses as well as more illnesses simultaneously (comorbidities) than younger populations do. The significance of medical injury in those age 65 and older may become more pronounced in the future because of recent trends in both population demographics and health care utilization in the older population.

The population of persons age 65 and older reached 34 million in 1997, or one of every eight Americans. The percentage of older Americans has tripled since the turn of the century. In 1997, the life expectancy for people reaching age 65 average an additional 17.6 years, children born in that year have an average life expectancy of 76.5 years. Population estimates for the year 2030 (the tail end for the “baby boomers” reaching 65+ years of age) are greater than 70 million. This is twice the number in 1997, and by 2030 is estimated to comprise 20% of the population in the United States.²⁰⁰

In 1995, 52.5% of the 65+ population reported having at least one disability, with one-third describing their disability as severe. Not surprisingly, older persons are also more likely than younger ones to be hospitalized. In 1995, over 40% of hospital admissions were attributed to those age 65 and older. Due to their longer average length of stay (mean 7.1 vs. 5.4 days), 49% of hospital occupancy was attributed to older patients.⁹² Both increased lifespan and a rising number of survivors with previously fatal disabilities has increased the need for nursing home services.

Nearly 2 million Americans live in approximately 20,000 nursing homes at an estimated annual cost of more than \$50 billion. By 2030, there could be 5 million nursing home residents.¹⁵ Current estimates are that 43% of those who reach age 65 will enter a nursing facility at some point in their lifetime.²⁰¹ In recent years, such residents have become older, sicker, and more functionally dependent.²⁰² The mean age for first nursing home admission is 78.5 years. The impact of these demographic shifts, in conjunction with the decreasing availability of nursing home beds and utilization constraints for hospitalized patients, has led to the “trickle down” of health care delivery to the community (outpatient and home health care).

Outpatient use of medical services also increases with advanced age. In 1995, persons under 65 years of age averaged five physician contacts annually, compared to 11.7 for the senior population. Demand for home health care is growing rapidly, and usage increases with age and the extent of functional impairment. In 1993, 3 million Medicare recipients received more than 160 million home health care visits.²⁰³

High-tech care in the home is also growing exponentially.²⁰⁴ Reasons for this trend include advances in medical technology, increased public awareness and preferences, growing

populations of chronically ill survivors, concerns about the increased risks of hospitalization, and the growing costs of hospital care.¹⁰⁵ Areas of home health care therapy for older persons include nutritional support (parenteral and enteral), long-term intravenous antibiotic therapy, renal dialysis therapy, respiratory care such as chronic mechanical ventilation, and cardiac care (drug infusions, arrhythmia detection, automatic defibrillation).¹⁰⁵

Home health care provides special challenges for the detection and monitoring of medical injuries. Because full-time health care providers are not present in that setting, providers need to be vigilant for the possible dangers of under-recognizing medical injuries. Otherwise, the opportunities for preventing or minimizing harm after an event has occurred could be missed.

In this section, we will discuss the extent and type of medical injuries, including those caused by errors. We will then look at several types of injuries that are especially common in older patients. Most available data come from hospitalized patients and nursing homes. At present, there is a paucity of evidence concerning medical injuries in the outpatient and home health settings.

The extent of iatrogenic (caused by treatment) injury in hospitalized older patients is substantial. In a retrospective review of randomly selected records for 30,000+ patients admitted to 51 New York State hospitals in 1984, the Harvard Medical Practice Study found adverse events in nearly 4% of patients.² Adverse events were defined as unintended injuries caused by medical management that resulted in measurable disability.² More than two-thirds of these iatrogenic injuries were due to errors and were, therefore, potentially preventable.³ Adverse events were more common in patients age 65 and older and, with some exceptions, increased with age regardless of type of event. Rates for all adverse events for different age groups were:

- ages 0-15 (years): 1.3%,
- ages 16-44: 2.6%,
- ages 45-64: 4.7%, and
- ages 65 and older: 5.9%.

Most notable was the increased number of adverse events in older patients due to nontechnical post-operative complications, drug-related incidents, and mishaps in both diagnosis and therapy. The increased rate of adverse events persisted, though to a lesser degree, after standardizing to several Disease Related Groups (DRGs). This minimized differences due to underlying disease states known to occur with aging.

Studies in specific settings suggest that the Harvard Medical Practice Study may have underestimated the extent of iatrogenic injury. For example, Steel found a 9% incidence of life threatening or disabling iatrogenic events among general medical service patients.⁴ The mean age of those patients incurring a severe preventable adverse event was 6.2 years greater than for patients whose hospital course was uncomplicated. A prospective study of

500 consecutive admissions of indigent patients age 65 and older admitted to a medical service found that 29% suffered complications as a result of hospitalization.⁵ A study of 232 predominately male admissions to a Veterans Administration (VA) hospital found that the complication rate for those under age 65 (mean age 50.3) was 29%, as compared to 45% for those age 65 and older (mean age 73.1). When classified by severity of illness on admission, the age differences in complication rates were less pronounced.⁶ Another study of 185 veterans conducted in an older population (all older than age 75, with a mean age of 81 years) found an incidence rate of 38% for hospital-acquired complications.⁷

Much less is known about the extent of injury outside the hospital. For example, except for studies on particular adverse events (such as medication errors, falls, and pressure sores), the data on iatrogenic injury in nursing homes are more difficult to come by. Available evidence comes from voluntary incident-reporting systems, which are known to severely underestimate the true extent of injury.⁸ Gurwitz completed a one-year retrospective review of adverse and unexpected events in a 700-bed, long-term care facility and found 3,390 reported events. The most common events were falls (2032), non-fall-related injuries (1631), and adverse drug events (180).⁸

Even less information is available on the extent of medical injuries in the various outpatient settings, including home health and specialized facilities such as renal dialysis centers and cancer chemotherapy clinics.

Along with current trends in relocating health care delivery (e.g., outpatient surgery centers), there is the recent addition to home health care: the hospital-at-home. Developed in England, the hospital-at-home involves home-based nursing and rehabilitation directed either toward preventing admission or facilitating early discharge from an acute care hospital.⁹ British investigators have demonstrated that outcomes for the post-hospital courses of patients discharged early to home with continued care compare favorably to outcomes from prolonged routine hospitalization. Both effectiveness and patient acceptability are comparable.⁹⁻¹¹ Hospital-at home may become more commonplace in the United States because of socioeconomic concerns. However, we have not found published data on frequency or severity of medical adverse events for these newer models of health care.

UNPUBLISHED DATA

To obtain a “finer grain” view of iatrogenic injury in older patients, we performed additional analyses of age-related complication rates for hospitalized patients in several data sets: the New York State Harvard Medical Practice Study, the Colorado and Utah Medical Practice Study, the Harvard Risk Management Foundation claims file, the Veterans Administration (VA) National Surgical Quality Improvement Program, and the Health Care Financing Administration Minimum Data Set.

In the Harvard Medical Practice Study, several complications rates are increased several-fold in the age 65 and older age group, compared to patients under age 65: diagnostic mishaps ($\times 2$), therapeutic mishaps ($\times 4$), drug complications ($\times 2.5$), and falls ($\times 9$). Within subsets of the older population (ages 65-74, 75-84, and 85 and older), complication rates consistently rise for all categories except for drug complications (Table 1).

Recently, Harvard researchers carried out a similar investigation in Colorado and Utah for patients admitted in 1992. In this retrospective review of 15,000 randomly selected charts from a representative sample of hospitals, a comparison of the rates of adverse events among younger (16-64 years of age) and older adults (age 65 and older) revealed that the incidence was significantly greater in older patients for adverse drug events (2.11% vs. 1.44%), events related to medical procedures (0.98% vs. 0.29%), and falls (0.14% vs. 0.01%) (Table 2).

The VA National Surgical Quality Improvement Program database, following the development of a validated tool by the National VA Surgical Risk Study, is one of the largest active resources for risk-adjusted measurements and surgical outcomes research. Previous studies by this group have demonstrated that age, as an independent variable, is less important in predicting post-operative outcome than are complexity scores, functional status, the emergency nature of cases, or the pre-operative anesthesia risk assessment scores.¹²⁻¹⁴

These researchers have provided data from fiscal year 1998 (October 1997 to September 1998) with respect to post-operative complications in older patients. Several risk factors did correlate with age. Functional health status declined with aging, as expected. While 8% of patients under the age of 65 were partially or totally dependent, the percentage increased to more than 15% for the 65-74 group, and reached 38% for ages 85 and older (Table 3). Emergency operations (as a percentage of all operations) more than doubled between patients under 65 to over 85 years of age. The number of surgical complications per patient consistently rose with aging, with three to four times as many of the oldest having more than one complication (Table 3). Iatrogenic problems following surgery affecting the lungs, kidneys, and cardiovascular system, as well as hospital-acquired infections, increased severalfold with aging (Table 4).

The Harvard Risk Management Foundation provides claims management for more than 7600 physicians associated with Harvard-affiliated medical institutions. During the five-year period covering 1994 to 1998, among 1,113 opened claims for compensation of medical injury, 160 (14.4%) were from claimants 65 years of age and older. The majority of claims were for inpatient activities (58% vs. 40%). In claimants age 65 and older, the most frequent allegations included improper performance of treatment (13%), failure to ensure safety (falls) (12%), improper performance of surgery (11%), failure to diagnose (11%) and delay in diagnosis (6%).

The most common locations cited in the claims were the physician office or clinic (20%), operating room (20%), patient's room (19%), emergency department (6%), and ambulatory/day surgery (5%). The severity of injury, as estimated by an insurance industry-based severity scale, was medium or high severity for 90% of claims in older patients, compared to 81% for the younger group.

Neither the Harvard Medical Practice Study, the Colorado and Utah Medical Practice Study, the VA National Surgical Quality Improvement Program, nor the Harvard Risk Management Foundation data include nursing home information. However, the Health Care Financing Administration (HCFA) does collect data from nursing homes. Long-term care facilities have been required by the Omnibus Budget Reconciliation Act (OBRA) of 1987¹⁵ to record more than 300 diagnostic, demographic, clinical, and treatment variables, using the Minimum Data Set and the Resident Assessment Protocols.¹⁶ Of these variables, 175 are quality indicators that are organized into care domains such as accidents, nutrition, skin care, infection control, and eight others.¹⁷⁻¹⁹

Recently, the Center for Health Systems Research and Analysis at the University of Wisconsin-Madison has developed a modified Minimum Data Set (MDS 2.0) to record the care of nursing home residents from several regions. Data from four Midwestern states show that, at any one point in time in 1995, the average percentage of patients in nursing homes with the following treatment-related injuries were: trauma (fractures, abrasions, burns), 16%; falls, 14%; urinary tract infections, 8%; and pressure sores (of all stages), 11% (Table 5). If these percentages were experienced nationwide by the estimated nursing home population of 2 million, the annual national prevalence of these adverse events would be: 320,000 nursing home residents with traumatic injuries; 200,000 with recent falls; 160,000 with urinary tract infections, and 200,000 with pressure sores.

The Minimum Data Set provides prevalence rates for other quality indicators that are risk factors for adverse events. These include the use of nine-plus medications, 14%; indwelling urinary catheters, 8%; antipsychotic medicine use (in the absence of an indication), 11%; and physical restraint use, 11%. With the exception of restraint use (a 38% decline), there were few patterns of improvement over the four-year study cycle. The extent of medical injuries in nursing homes, as elsewhere, is expected to increase substantially as the population ages.

SPECIFIC PROBLEMS

Several types of medical injuries are particularly common in older patients. We will examine six of these: adverse drug events, falls, nosocomial infections, pressure sores, delirium, and surgical complications.

ADVERSE DRUG EVENTS

Adverse drug events (ADEs) are the most common type of adverse event in hospitalized patients, including those age 65 and older.²⁰ In addition, ADEs are frequent complications among older persons in nursing homes and outpatient settings.²¹⁻²² An ADE has been defined as an injury resulting from the medical use of a drug.²⁷ It includes both preventable ADEs (those due to errors) and non-preventable ADEs, also called adverse drug reactions (ADR).^{8,23-26} An ADR is defined by the World Health Organization (WHO) as a noxious, unintended, and undesired effect of a drug when used for prophylaxis, diagnosis, or therapy. This definition specifically excludes inappropriate uses or errors. ADRs are due to the inherent properties of the drug, and at the current state of science they are not preventable.

Estimates of the incidence of ADEs in hospitalized patients have ranged from 1.5 to 35% of admissions.²⁸ In the large population-based Harvard Medical Practice Study, ADEs accounted for 19% of all disabling injuries, or 0.7% of admissions.² A more comprehensive study in two teaching hospitals found 6.5% of patients suffered an ADE, of which 28% were due to errors and thus preventable.²⁸ Using a computer algorithm and clinical, drug, and laboratory data, Classen et al. found 2.0% of patients suffered an ADE.³⁶ In a study of adverse drug events in older inpatients, Gray found a 14.8% incidence of ADEs among hospitalized older patients (mean age 78.2 years)³⁰—considerably greater than the overall 2% to 6.5% incidence of ADEs in the larger studies not restricted to those age 65 and older.^{28,36} As with other types of injuries, we will first look at hospitals, followed by nursing homes, and (where data are provided) the various outpatient settings.

ADEs are an important reason for admissions of older patients to the hospital from home. In 1969, Hurwitz observed that these events contributed to the need for the hospitalization in 15.4% of patients ages 60 or greater, compared to 6.3% for patients under age 60.³³ Williamson, in a study of 2000 admissions to 42 geriatric departments in Great Britain, found ADEs were solely responsible for, or contributed to, hospital admission in 10.5% of the population.³⁴ In a retrospective review of medical admissions, Colt found drug-related causes in 11.7% of patients over the age of 65. The average medication use prior to admission was 6.3, compared to 3.8 medications for patients admitted for other reasons.²⁴

Older patients are also more likely to incur ADEs during their hospitalization. In a prospective study of 9,148 consecutive patients admitted to 41 clinical centers, 532 patients (5.8%) were identified as having a probable or definite ADR during their hospital

course. The incidence of ADEs rose from 3.3% for patients under the age of 50—to 6.3% for ages 50-69 and 6.5% for ages 70-79.³⁵

ADEs are common problems in nursing homes because of the widespread phenomenon of multiple drug use. In an observational study conducted during a 24-hour period in 56 long-term care facilities, medication errors were found to have occurred in 8% of doses.³⁷ In a prospective study over a four-year period, 217 of 332 (67.4%) nursing home residents had 444 ADEs.³⁸ A retrospective study of 175 veterans age 65 and older admitted to a nursing home (over a period of 18 months) found that 32% had definite or probable ADEs (including both ADRs and injuries caused by medication errors). Some 22% of these were considered severe.³¹

The outpatient settings pose additional challenges for researchers investigating ADEs in the older patients. Most studies depend on patient self-reporting. In a prospective randomized study of mostly older patients interviewed by telephone, 30% reported experiencing undesirable symptoms from at least one medication.³⁹ Only three-quarters of these patients discussed the problem with their physician. Most continued to take the medication despite the perceived adverse reaction. The oldest patients reported fewer drug-related symptoms. It was unclear whether, among the oldest old, this was due to lack of awareness of an association between drug and symptom or to reluctance to blame medications or to report symptoms to their physicians.³⁹

The yield of medication-related problems reported by patients in telephone interviews may not, however, correlate with physician documentation summarizing office encounters. An outpatient chart review study revealed a 10% incidence of definite or probable ADRs during a single calendar year.⁴⁰ Consistent with findings of ADE studies of hospital and nursing home patients, complicated medication regimens often result in injuries. In a study of 167 older veterans (age 65 and older, each taking a minimum of five medications and with a mean of eight drugs per patient), 35% reported having had at least one ADR in the prior year. Twenty-eight percent of those with an ADR required an emergency room visit or hospitalization as a consequence of the implicated drug.²³

Most ADEs are unpredictable and not preventable. But inappropriate medication prescribing that results in untoward adverse events is preventable. One study of 414 subjects (75 years of age and older) who were interviewed at home revealed that 14% were using at least one inappropriate drug.⁴¹ This study looked at medications to be avoided by community-residing older persons. It did not address the additional threat to older patients of acceptable medications that are misused (e.g., wrong dosages, duration of treatment, or wrong clinical indications).

In the 1987 National Medical Expenditure Survey of 6171 people age 65 and older,⁴² 23.5% were receiving at least one drug from a list of 20 contraindicated drugs. On a national level, this pattern of potentially inappropriate prescribing was estimated to have an impact on over 6.5 million older persons residing in the community.

A larger study, addressing the same list of 20 drugs deemed inappropriate for older patients, found a lower incidence of inappropriate prescribing behavior. In the National Ambulatory Medical Care Survey,⁴³ of 8700 patient records for visits when prescriptions were written (2/3 of visits), 7.5% of patients were given inappropriate medications. At an annual rate of 5.4 visits per patient, this translated to an estimated 8½ million office visits by older patients in 1992 that were complicated by inappropriate drug prescribing.

While an overall figure for costs from adverse drug events in older persons is not available, it has been shown that an ADE in the hospital setting results in an additional length of stay of two days and costs \$2000 to \$2600 per episode. For a 700-bed hospital, this amounts to \$5.6 million annually.^{21,158} An estimate based on a probability pathway model projects drug-related morbidity and mortality in the outpatient setting to cost \$76.6 billion annually.²¹¹

FALLS

Falls are a major source of morbidity and mortality in the older population.⁴⁴ In 1985, falls resulted in over 2 million injuries, 369,000 admissions to hospitals, nearly 9000 deaths, and estimated direct costs of almost \$8 billion. Death due to falls is a common event in the oldest old, and the mortality is likely underestimated due to difficulties in data collection.²¹³ Among deaths from injury in persons age 65 and older, 23% are due to falls. This increases to 34% among persons age 85 and older.

Falls occur in all settings where the aged are found; home, hospital, and long-term care facilities.⁴⁵⁻⁴⁸ Falls, on average, occur each year in half of those age 65 and older residing in nursing homes, a third of those living at home, and about 2% of those in the hospital (Table 6).

Across the spectrum, about 1% of falls result in a hip fracture. However, the incidence of falls depends more on the patient's physical, medical, and psychiatric condition than on age. Unlike many other adverse events in older patients, falls occur more commonly in the community and nursing home settings than in the hospital.

Among nursing home patients, one study showed that injuries accounted for 94% of the 3390 incident reports of adverse and unexpected events during one year among very old residents (mean age 88.5). Falls caused 55% of those injuries.⁸ Not all falls have that result: in the same study, only 31.2% of 2032 falls resulted in injury. The annual per-patient incidence of fall-related injuries was greater for semidependent residents (1.42) than for dependent residents (0.71) or independent care residents (0.66).⁸ Others have reported that approximately half of nursing home residents fall each year, and 9% sustain serious injury.⁵⁰ The death rate due to falls increases dramatically for nursing home patients age 75 and older.

Falls, and their associated injuries, are also hazardous for older persons at home. The one-year incidence of falls among older community (home) residents is approximately 30%,

with resultant injuries in one-fourth to over one-half of falls (or 7.7-17.9% of older community residents).⁵¹ The most common serious injury from falls is a hip fracture; falls are the cause of almost all hip fractures in older patients.⁵² Approximately 250,000 patients sustain a hip fracture annually, with 150,000 resulting in death or substantial morbidity. With the predicted changing demographics, the annual number of fractures is expected to double by the year 2040.⁵³ Injuries from falls are costly to society. Recent estimates have calculated the annual additional cost for injurious falls to be \$19,940 per person.⁵⁴

Most falls in hospitalized patients also occur in those age 65 and older. In a retrospective case-control study of hospitalized patients (not limited to older patients), the estimated incidence of falls and injurious falls was 0.66% and 0.04%, respectively. After controlling for pre-event lengths of stay, severity of underlying illness, and comorbidity, fallers were found to stay in the hospital 71% longer, with a 61% increase in total charges.²⁷ This study was limited by its dependence on incident reports. Similar limitations are found in most nursing home and community studies as well.

The expected increase in falls in the decades ahead is supported by a recent epidemiological study. In a total population study, for all hospitalized patients nationwide, Finnish investigators analyzed fall-related injuries and deaths between 1971 and 1995.²⁰⁵ They found, after age adjustment, a greater than twofold increase in fall-related injuries during the 25-year period. On the other hand, the age-adjusted death rate was unchanged, possibly due to treatment advances. Another important finding was that the mean age of patients presenting with fall-related injuries increased from 67.3 to 73.0 years of age.

NOSOCOMIAL INFECTIONS

Nosocomial infections are those acquired in hospitals or nursing homes as a result of medical interventions. Older patients appear to be particularly susceptible to these infections.⁵⁵⁻⁵⁶ The incidence of hospital-acquired nosocomial infections in older patients ranges from 5.9 to 16.9 per 1000 patient days.⁵⁷ Acquired infections in those age 65 and older are also more likely to present in atypical ways, particularly for pneumonia, urinary tract infection, or occult sepsis.⁵⁸ This may result in a delay in diagnosis or treatment and contribute to poorer outcomes.

A retrospective review of 1200 nosocomial infections among 49,000 hospital admissions found decade-specific risks after age 59.⁵⁹ The risk in the 70 to 79 year-old age group was tenfold higher than for ages 40 to 49. However, this early study did not account for confounding differences in length of stay or comorbidities.

A wide range of results has been reported for nosocomial infection rates. For example, in one study of a historical cohort of 102,000 older patients hospitalized over a four-year period, 4% acquired a nosocomial infection.⁶⁰ By contrast, a prospective study of older patients in both the acute care and rehabilitation wards of a hospital revealed an incidence of hospital-acquired infection of 18.5%.⁶¹

Though less common, nosocomial infections are also a major problem among nursing home residents. In a study of 4259 residents in 53 nursing homes, the one-day prevalence rate for these infections (only infections newly acquired in the nursing home and not present on admission) was 4.4%.⁶² The most common types of nosocomial infections among nursing home patients are pneumonia, urinary tract infection, upper respiratory tract infections, and skin/wound infections. Patients from nursing homes account for 10%-18% of all hospital admissions.⁶⁴ Pneumonia is the most frequent reason for hospitalization of nursing home patients, with 29% of those who acquired pneumonia in a nursing home needing admission. Pneumonia is also the immediate cause of death for 6.5% to 40% of nursing home residents.⁶³

PRESSURE SORES

Pressure sores (also referred to as pressure ulcers or decubitus ulcers) are a major medical problem for older and frail patients (Table 7).⁶⁵⁻⁶⁶ Sixty percent of all new pressure sores develop in the hospital, with the remainder evenly divided between nursing homes and the homebound.⁶⁷ Approximately 5% of hospitalized patients acquire new pressure sores during their stay, resulting in 1.7 million hospital-acquired cases per year. Most of these patients are age 65 and older.¹⁵

In a national survey of 177 hospitals with a combined census of over 31,000 patients, the one-day prevalence for all pressure sores (including early and superficial sores and those present at admission) was 11.1%.⁶⁸ Eighty-one percent of these patients were 60 years of age and older. Among high-risk hospitalized older patients who are bed- or chairbound, the incidence ranges up to 29.5%.⁶⁹

Pressure sores acquired during hospitalization are associated with an average increased length of stay of two days and \$1500 in additional costs.^{66,69} In addition to the suffering incurred by patients, the additional costs expended annually are estimated to exceed \$5 billion (including 17,000 lawsuits per year).⁶⁵

Because of the higher number of nursing home patients who are immobilized, pressure sores in this setting are an important public health care issue. A study of nearly 20,000 residents in 51 nursing homes revealed that 11.3% already had a pressure sore on admission; for the remainder, the subsequent one-year incidence was 13.2%.⁷⁰ Another prospective study of nursing home admissions found 24% had pressure sores on admission. In a subset of these patients deemed to be at very high risk (patients with immobility, incontinence, sensory deprivation, poor nutritional status, and altered mental status), 73.5% acquired new pressure sores within the first eight weeks.⁷¹

Overall, the risk of dying is increased several fold in patients with pressure sores, but that observation likely reflects the severe underlying illnesses and poor functional status among these patients.⁷²⁻⁷³

DELIRIUM

Delirium, or acute confusional state, is a complication of hospitalization that occurs predominantly in patients age 65 and older. It is especially common after surgery. With patients over 65 years now accounting for nearly half of hospital occupancies, delirium is being recognized as an increasing cause of significant morbidity.⁷⁴ Delirium complicates the course of more than 2.3 million hospitalized patients per year and is responsible for more than \$4 billion of Medicare expenditures.⁷⁵ The prevalence of delirium on admission ranges from 14% to 24% of older patients and new cases develop during hospitalization in 9% to 31% of older patients (Table 8).^{65,75-79} Delirium at the time of admission is an independent predictor of poor hospital outcome.⁷⁵ Post-operative delirium has been found to occur in 9% to 61% of patients following knee replacement and femoral neck fracture repair.⁸⁰⁻⁸⁴ Post-operative delirium is associated with prolonged hospital stays, increased costs, morbidity, and mortality.

SURGICAL COMPLICATIONS

In the Harvard Medical Practice Study, post-operative complications accounted for half of adverse events and were nearly twice as frequent for patients age 65 and older.²⁰ One reason is that the likelihood for undergoing emergent operations is greater for the very old. This is often due to delay in diagnosis or postponement of elective surgical repair. In all age groups, the risk of complications is higher for emergency operations (53%, vs. 23% in elective cases).⁸⁵ For example, one study of 613 surgical patients over the age of 70 found that mortality was much higher for emergency operations (21%), compared to elective cases (1.9%).⁸⁶ Patients age 65 and older account for half of all surgical emergencies and three-quarters of operative deaths. In the VA National Surgical Quality Study, the number of surgical complications per patient consistently rose with aging, with three to four times as many of the oldest having more than one complication. (Table 3).

WHY ARE OLDER PATIENTS MORE AT RISK OF INJURY?

The greater risk of harm to older patients from medical interventions results from increased exposure to opportunities for medical mistakes and from the likelihood that those mistakes will then lead to actual injury. Factors include those associated with the aging process itself (“endogenous factors”) and those related to care (“exogenous factors”).

Endogenous factors lead to several types of hazards: (1) “cascade iatrogenesis,” or the serial development of multiple medical complications, associated with an increased susceptibility to external stresses; (2) increased vulnerability to injury because of reduced compensatory mechanisms; and (3) increased risk of functional decline and disability as a consequence of an iatrogenic insult.⁸⁸

Exogenous factors that increase the risk of injuries include (1) increased likelihood of being under-diagnosed or incorrectly diagnosed, often because of atypical disease presentations in older patients or being treated differently because of age bias and (2) shifts in health care away from the hospital.

Cascade iatrogenesis. Risk begets risk in older patients. An example is a patient with post-operative pain who was oversedated, leading to respiratory failure requiring mechanical ventilation. The patient subsequently developed a ventilator-associated pneumonia. In addition, hospitalization itself poses risks. Gillick evaluated the incidence of “depressed psychophysiologic functioning” that developed during hospitalization in a prospective study of 502 general medical admissions.⁸⁹ Four new onset functional symptoms unrelated to the initial medical problems were studied: confusion, falling, inadequate oral intake, and urinary incontinence. Compared to younger patients, patients older than age 70 had a nearly fivefold increase for at least one of these new symptoms. Subsequent medical interventions in response to these new problems created opportunities for additional medical complications. Two examples were (1) treating new urinary incontinence with catheterization that resulted in a nosocomial urinary tract infection, and (2) confusion and agitation due to pain, leading to treatment with psychotropic medications and physical restraints that resulted in acute delirium or pressure sores.

Certain older patients are particularly high risk for acquiring iatrogenic complications during their hospital admission. For example, in a retrospective study of older patients (mean age of 77.4 years) with hospital stays of 15 days or greater, 58.3% of patients with one of three common admission diagnoses (acute myocardial infarction, congestive heart failure, or pneumonia) suffered at least one iatrogenic complication.⁹⁰ Nearly two-thirds of adverse events were considered preventable. Sixteen percent of patients had more than one iatrogenic complication.⁹¹ The investigators described these patients as having been exposed to “cascade iatrogenesis.” Inadequate functional documentation on admission, as

well as inadequate initial diagnostic assessment, were found to be more prevalent in those patients with preventable complications.

Functional decline. Loss of important functional capacity, such as the ability to walk or care for oneself, is an important outcome of hospitalization in older patients that is associated with a poorer prognosis. The development of disability in those age 65 and older is strongly associated with adverse medical events during hospitalization.⁹² Thus, functional disability adds to the injury, resulting in greater residual harm than in younger patients. Risk factors predictive of patients at risk for post-discharge functional decline include preexisting bedsores, poor scores on the Mini Mental State Exam, previous impairment in their activities of daily living (ADL), or reduced social activity.⁹³ These patients are more likely to need home health care, nursing home placement, and rehabilitative services following hospitalization. The risks of falls, rehospitalization, institutionalization, and dying are substantially increased.⁹²

The Hospital Outcomes Project for the Elderly found that a third of patients discharged after acute hospitalization declined in at least one of their ADLs. At three months post-discharge, recovery to preadmission ADL levels was poor, with a fifth of patients continuing to manifest at least one new ADL disability.⁹² The causes of functional decline include the effects of illness itself, the effects of medical and surgical treatments, the high rate of adverse events in this population, and deconditioning associated with bedrest.⁹²

Creditor describes this functional decline as a “cascade to dependency,” due to the interplay of the effects of aging and hospital care associated with bedrest. These effects of aging and inactivity include decreased muscle strength and anaerobic capacity, vasomotor instability, baroreceptor insensitivity, reduced bone density, decreased respiratory capacity, loss of sensory input, increased skin fragility, and poor nutrition.⁹⁴ The potentially harmful effects of hospitalization, especially prolonged bedrest, include progression to long-term immobilization, sensory deprivation, and restraint use. Subsequent complications include progressive deconditioning, increased falls and fractures, confusion, pressure sores, incontinence, and thromboembolic disease.

Inappropriate care. In addition to an increased rate of complications from usual medical therapy, such as bedrest, older patients suffer iatrogenic injuries from inappropriate care. For example, congestive heart failure (CHF) is the most common reason for hospitalization of those age 65 and older and is responsible for over 500,000 admissions per year.⁹⁵ In a prospective observational study, 7% of admissions for CHF were found to be caused by treatment (e.g., fluid overload, misuse of drugs following a procedure).⁹⁵ Hospital mortality for this group with CHF was much greater, 32%, compared to 9% in the noniatrogenic cases.

Acute renal failure is another example of an iatrogenic disease in older patients. In a prospective study of inpatient renal service consultations, predominantly for acute renal failure, the most common causes for disease were iatrogenic: drugs, errors in peri-operative care, dehydration, and use of radiographic contrast dye.⁹⁶ Conversely, iatrogenic

acute renal failure in older patients can be prevented by attention to correction of volume depletion, age-adjusted prescribing of potentially nephrotoxic drugs, and improved pre-operative assessment/preparation.

Misdiagnosis and atypical disease presentations. Another source of errors is in the diagnosis of medical problems. Underdiagnosis (or delayed diagnosis) of illnesses occurs in all health care settings but is more common with those age 65 and older.⁸⁷ Autopsy studies reveal antemortem underdiagnosis rates of 61% for fatal pulmonary emboli in older institutionalized patients, followed by missed diagnosis of metastatic cancer of 42% and CHF of 31%.⁵⁹ Underdiagnosis in older patients is more likely to occur if a nongeriatric physician cares for the patient. Studies comparing geriatric assessments with those made by primary care or nongeriatric specialists find the latter miss many diagnoses, particularly gait disturbances, metabolic problems, early cancers, presence of untreated infections, and reversible causes of incontinence and dementia.⁹⁷⁻⁹⁸

Gorbien has categorized the reasons for underdiagnosis in older patients into four groupings: (1) *patient-related causes*, which include denial of symptoms, attribution of symptoms simply to old age, passive behavior when interacting with physicians, isolation, and decreased levels of education and sophistication; (2) *physician-related causes* including biases against older patients, inadequate geriatric medical knowledge, deficient efforts to reach out to the disenfranchised older population, conflicting attitudes about death and dying, and an apparent overall decrease for the concern of problems related to older persons; (3) *situation-related causes*, such as the increasing complexity of medical problems in older patients and the different manifestations of diseases associated with aging; and (4) *system-related causes*, which include inadequate access to medical care (immobility, transportation issues, and poverty) and disincentives from reimbursement deficiencies for time-intensive visits associated with an increasingly sicker older population.⁸⁷

Another reason for the underdiagnosis of new medical problems is that illness may present in atypical patterns in older patients. For example, they may present with signs and symptoms that are nonfocal and remote from the diseased organ system, masking important diagnostic clues. The “weakest link” theory holds that this phenomenon is due to failure of the most vulnerable organ system that was impaired before the new physiologic challenge. This explains the common initial observations of delirium or depression (central nervous system), urinary incontinence (urinary tract system), falling (musculoskeletal), or near-syncope (cardiovascular) that are seen with remote diseases such as pneumonia or urinary tract infections.⁸⁸

Fried et al. describes models of illness presentation that are related to aging. In her depiction of the traditional “medical model” (unrelated to patient age), signs and symptoms correspond directly to specific diseases.⁹⁹ For geriatric illnesses, the usual temporal and organ system relationship often fails. For example, older patients may seek medical evaluation as a result of several chronic diseases adding up to a cumulative functional decline, or a new complaint may be wrongly perceived by the patient as an

exacerbation of a previously diagnosed chronic disorder. These presentations pose additional challenges to clinicians inadequately trained in geriatric medicine.

Communication barriers between patient and physician are another challenge to providing error-free health care. Correct diagnoses begin with accurate history taking, which is difficult if patient and doctor don't speak the same language. The rise in immigration has led to increasing diversity, with associated language barriers.¹⁰⁰ In addition, the increasing complexity of medical treatment and terminology requires patient sophistication. Unfortunately, inadequate literacy skills, especially with respect to health care, are more prevalent in the older population.¹⁰¹

Shift to nonhospital care settings. With shortened hospital stays resulting from pressure by managed care organizations, therapy previously given in acute care settings is often administered to patients at home or in outpatient facilities. As a result, patients are increasingly dependent on nonphysician health care providers. Consequently, adverse events outside hospitals and chronic care facilities are more difficult to track and less well studied.⁴¹⁻⁴² The ambulatory care settings in both home and physicians' offices are vulnerable to many of the same underlying systemic failures that lead to injuries within institutions. The quality of undersupervised care in nursing homes is of particular concern to consumers, as well as to insurance companies and governmental agencies.¹⁰² There are several reasons why this concern is justified. For example, nursing assistants perform the overwhelming share of patient care in nursing homes and some may not have proper training or be properly supervised.¹⁰³ Information transfer concerning a new nursing home patient's clinical history is often unreliable or incomplete, as is physician documentation in nursing home records.¹⁰³

Physician supervision of patient management is further diminished in home health care. However, the nature and frequency of adverse events in this setting have been less well studied. In a small prospective Australian study of 231 patients receiving "hospital-in-the-home" care, the incidence of adverse events was 3.5%.¹⁰⁴ The results from this observational study may not be transferable to American programs unless they share common therapeutic guidelines to avoid hospitalization in comparably ill patients.

Sources of performance failures by individual team members in home health care include ineffective patient and staff training and education, noncompliance with protocols and standards (including poor patient selection), communication breakdowns, and inadequate monitoring.¹⁰⁵

The Food and Drug Administration (FDA) has issued regulations pertaining to medical care in the home. Examples include the Safe Medical Device Reporting Act for facilities (including home health care entities) and manufacturers, and the Medical Products Reporting Program (Medwatch) for the post-marketing surveillance of adverse events, especially those due to drugs. However, little attention has been given to human factors or outcomes research. The responsibility for supervising family or nonprofessionals caring for older patients at home is unclear.

We next examine the causes of increased risks for the six types of injuries, previously described, to which older patients are particularly susceptible.

SPECIFIC PROBLEMS

ADVERSE DRUG EVENTS

While the relationship between the extent of ADEs and growing older is strong, the mechanisms responsible for these observations are less well understood. In a thoughtful analysis of the relationship of aging to ADEs, Gurwitz and Avorn conclude that while an association does exist for certain medications, most studies demonstrating a positive relationship between aging and ADEs do not account for the confounding effects of increased coexisting illnesses and multiple drug use.⁹⁴ That is, patient disease and pathophysiologic and functional characteristics, not simply chronologic age, are the important factors in the development of ADEs.⁹⁴

Unfortunately, many studies have compared incidence rates and outcomes for different age groups without accounting for severity of illness in their analysis. Thus, they may erroneously conclude that there is a positive correlation of aging alone to adverse medical events. Nevertheless, because senior citizens are more likely to be taking multiple drugs and to have chronic diseases, they are at greater risk for ADEs.

We will look at four reasons for the increased extent of ADEs in patients age 65 and older: (1) the normal effects of aging on the body's handling of, and response to, certain pharmaceutical agents; (2) the importance of multiple drug use, including the direct effect of using many drugs and the difficulties older patients experience in correctly complying with often complex regimens; (3) the problem of inappropriate prescribing by physicians; and (4) age bias by physicians that can lead to a form of inappropriate care unique to this age group: underprescribing.

Age-related changes in physiology and drug actions. Physiologic changes associated with aging are also associated with an increased susceptibility to certain adverse drug events (ADEs) in older patients. These changes include alterations in drug absorption, distribution, metabolism, and excretion. Age-related changes include a decrease in lean body mass and total body water, increased fat-to-muscle ratio, decreased hepatic metabolism, decreased renal clearance, and altered sensitivity to various medications. These physiologic differences may result in increased serum concentrations of drugs and prolonged drug half-lives. If not compensated for (i.e., correct reductions in dosing), they can lead to ADEs in older patients.

Not only is aging associated with alterations in the physiologic handling of certain drugs, but older patients may respond differently to certain drugs at doses that are well tolerated

by younger adults. If physicians do not know about or ignore these differences, serious overdosing can occur. Unfortunately, overdosing is not rare. For example, one study found that initial prescribing doses that exceeded those recommended for geriatric use accounted for three-fourths of the preventable ADEs in hospitalized older patients.³⁰

In addition to differences in drug dosing, certain classes of drugs are associated with more complications in those age 65 and older. For example, psychoactive agents continue to be a common cause of ADEs in older patients. Sverstad and Mount have identified several reasons for problems associated with prescribing psychoactive agents for these patients: multiple drug use, excessive dosing, prolonged treatment durations with inadequate efforts to taper or adjust dosing, duplication of pharmacologic therapy (same class), and the use of dangerous combinations that include antipsychotic agents.¹⁰⁶

Multiple drug use. In addition to the concerns of prescribing excessive doses and drug types poorly tolerated by older patients, there are problems associated with prescribing many drugs simultaneously. This poses risks for several reasons: more drugs result in a greater likelihood of an ADE from any individual drug; the possibility of noncompliance is greater with more drug use; and drug-drug interactions are more likely when the number of possible drug combinations is greater.

Col studied 315 older patients (mean age 76.6 years) admitted to an acute care hospital. Adverse events from drugs were directly responsible for 11.4% of those admissions. The incidence of admissions due to noncompliance was 16.8%. In both categories, the number of medications per patient correlated with need for admission. The study found that patients living alone, those using multiple pharmacies, and those receiving prescriptions for medications not covered by insurance or perceived as being too expensive were at increased risk for noncompliance.¹⁰⁷

The extent of medication use by those age 65 and older also correlates with the rate of ADEs in nursing homes. A study of 56 long-term care facilities found medication errors occurring in 8% of ordered or administered doses.³⁷ The most common errors were those of omission (41.5%). Errors from unauthorized drug administration (such as out-of-date or unsigned orders) were equally frequent. In a retrospective study of 175 older veterans admitted to a nursing home, the prescription drug use averaged seven drugs per resident. In 32% of patients, ADEs were identified, of which 22% were considered severe.³¹ Serious injury also took place as a result of drug withdrawal in another 13%. In a prospective study of nursing home residents, 67% had probable ADRs (non-error related complications). The only significant difference between patients with ADRs and those without were the number of medications per patient (mean 7.8 vs. 3.3).³⁸

Multiple drug regimens often involve complex dosing schedules that, even for sophisticated or well-informed patients, are challenging to master. Because of frequent changes in drug regimens, the transition from hospital to home (and nursing home as well) is a vulnerable period for ADE development. Patients are more susceptible initially after

discharge because of unfamiliarity with new drug regimens, plus confusion about the medications still available at home or prescribed before hospitalization.¹⁰⁸

The large number of medications taken at home by older patients (and the associated complicated dosing schedules) increases the risk of ADEs. Studies of older persons in outpatient settings, with rare exception,²³ have addressed only ADRs and may therefore underestimate the extent of all ADEs. Hospital readmission (defined as a hospitalization occurring within six months of initial discharge) occurred in 35% of geriatric patients discharged on three or more medications.¹⁰⁹ In this prospective study, 20% of the readmissions were for drug-related causes; three-quarters of those readmissions were determined to be potentially preventable. Only a few studies have found no correlation in outpatients between aging and the number of medications per patient.²²⁻⁴⁰

Poor supervision of chronic drug use by older patients may be an important cause of drug-related adverse events.¹¹⁰ In-home pharmacist evaluation can effectively correct for these ADEs, as has been shown in the long-term care setting.¹¹¹

In an effort to reduce the incidence of ADEs in older patients, some physicians have responded by limiting the extent of multiple drug use. This has led to a new category of adverse events: injuries due to discontinuing medication, an association often not recognized. Clinical deterioration may not be accurately attributed to the changing drug regimen.¹¹² A retrospective review of 124 patient charts (previously followed for a year during another trial), found 238 discontinued drugs. Despite the appropriate discontinuation (including proper tapering of certain medications), 26% resulted in hospitalization or visits to urgent care clinics or emergency rooms. The investigators found that underlying disease exacerbations may occur up to four months after discontinuation.¹¹²

Inappropriate prescribing. Injuries from medication use can also occur from prescribing drugs that are inappropriate for older patients. Explicit criteria for determining inappropriate medication use have been developed by Beers et al. for nursing homes.¹¹³ They then used 30 criteria (19 drugs to avoid and 11 unsafe drug-prescribing patterns) to study patients in 12 nursing homes. Forty percent of residents had at least one inappropriate medication order, equivalent to 7% of all prescriptions.¹¹⁴ Surveillance based on spontaneous reporting systems has been the usual technique for institutional self-analysis of prescribing errors. This, however, significantly under-emphasizes the extent of the problem.⁸ Computerized surveillance has greatly assisted in the improved recognition of ADEs in hospitalized patients, and more studies using similar techniques in nursing homes are needed.^{28,36,115,116}

Gurwitz has identified six factors contributing to inappropriate prescribing in nursing homes: (1) insufficient physician training for long-term patient care; (2) the negative impact of low reimbursement on the extent of physician care; (3) the lack of organized medical staffs in nursing homes; (4) the dependence on nursing for many prescribing decisions (including the liberal use of “as needed” [PRN] and telephone orders); (5) the

increasing use of nursing assistants to do the work formally under the responsibility of a well-trained nurse; and (6) pressures exerted by patients and their families on the nursing home and medical staff.¹¹⁷

Age bias and underprescribing. Geriatric medicine is making inroads into our understanding of the differences in treating illnesses in older patients. Previously established approaches to older patients often involved simple and unproven strategies, such as restricting standard therapies found to be beneficial in the general population. These age-related biases can lead to inadequate prescribing in older patients. In many ways, these errors of omission, or undertreatment, are more insidious than the more obvious errors of commission. Therefore, underprescribing can be more difficult to recognize and correct. In an overzealous effort to follow the Hippocratic oath of “first doing no harm,” some physicians are prescribing inadequate drug therapies for their patients.

Age bias is suggested when a proportionately greater degree of underuse of indicated medications occurs in the oldest old.¹¹⁸ This behavior is similar to those mentioned earlier with respect to both undertreatment or postponing of indicated operations until emergent conditions require the surgeon to intervene (though later, at greater risk). Future drug studies need to remove arbitrary age restrictions that currently may result in age-biased therapy because of inadequate supportive data.²¹⁰

An example of underprescribing is the use of anticoagulants in patients age 70 and older. Long-term anticoagulation is recommended for several chronic illnesses, such as atrial fibrillation. Nonetheless, surveys reveal that many older patients with appropriate indications for needing anticoagulation are not receiving these prescriptions.¹¹⁹⁻¹²¹ One cause is an exaggerated physician fear of a disproportionately high risk of bleeding in older patients.¹²² In a combined retrospective and prospective cohort study of 2376 patients receiving the anticoagulant warfarin, bleeding events (after adjustment for the intensity of anticoagulation) were not associated with age.¹²³ The only exceptions were for those over the age of 80 with life-threatening or fatal complications. Also of note, the oldest old (those more than 80 years of age) had a greater variability in the prothrombin time results and more frequent needs for dose adjustments and lab testing.

In another example of ageism (age bias), patients 75 and older—when compared to a 65-74-year-old group and matched in all other respects—were found to be underprescribed for ACE inhibitors for congestive heart failure, and for beta-blockers or aspirin after myocardial infarctions. Ironically, several underprescribed interventions—such as influenza immunization or the treatment of transient ischemic attacks (minor strokes) are actually more effective for those age 65 and older—because of the greater risk of poorer outcomes in untreated older patients.⁸⁸ Such deficient prescribing behavior has led Ganz to conclude that age is “an independent negative correlate of evidence-based cardiac medication use.”¹¹⁸

FALLS AND RESTRAINTS

Epidemiological studies of falls in different settings (especially in homes and nursing homes) have revealed several common features.¹²⁴ Between a third and half of older home dwellers have a history of falls. Age, being female, and living alone are all associated with increased rates of falling. Environmental factors (stairs, obstacles) are more important causes of falling for the younger and healthier members of the 65-and-older age group, while host-related factors (decreased mobility, visual impairment, dizziness, neurologic or cardiovascular disease) play a more significant role for the older and frail. In a summary of eight studies, predominantly of home residents, 55% of falls were due to medically diagnosed conditions, and 37% were a result of environmental hazards.¹²⁵

Nonenvironmental risk factors most associated with falling in long-term care facilities include a history of falling in the past, being able to walk (with or without assistance), a diagnosis of dementia, and use of drugs (especially sedative-hypnotics, vasodilators, antidepressants, and diuretics).⁴⁴ Psychotropic drugs are frequently associated with an increased risk of falls, especially when prescribed with other medications associated with hypotension. Benzodiazepines, principally in higher doses or longer-acting forms, are also associated with increased fall rates.¹²⁶

Depression and dementia are important risk factors for falling and are common in older persons, especially in the nursing home population. Depressed older women have 40% increased odds of falling.⁸² In the recent past, psychotropic drugs were found to have been used in about half of long-term care facility dwellers.¹²⁷ After controlling for confounding by the illnesses for which psychotropic medications are used, the risk of falls attributable to psychotropics was 36%.¹²⁷ Newer antidepressants are free of some of the adverse characteristics of older drugs, but comparisons to older agents have not demonstrated the expected decrease in fall rates and related injuries.¹²⁸

Patients who are considered at risk for falling due to behavioral problems or noncompliance pose difficult management issues for health care workers, and often lead to the use of restraints. Chemical restraints are psychoactive drugs used inappropriately—e.g., for discipline or to reduce certain behaviors unrelated to current medical problems.¹²⁹ Physical restraints are devices used to restrict movement. The use of restraints has become a controversial issue in recent years.¹³⁰ The earlier growth of restraint use was probably due to several reasons: ease of application, minimal training requirements, ready accessibility, and immediate results on patient behavior.¹²⁵ The incidence of mechanical restraint use varies from 7.4% to 22% for acute care patients and 25 to 41% for long-term care facilities.¹²⁵

Concerns about unnecessary and possibly dangerous use of physical restraints have led to governmental regulations. In the 1987 Omnibus Budget Reconciliation Act (enacted in 1990), nursing home regulations established new prohibitions for the inappropriate use of restraints. In 1992, the Food and Drug Administration (FDA) published a safety alert on the potential hazards of restraint devices and required the reporting of such incidents.

Since the mid-1990s, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has placed greater emphasis on patient rights and individualized care plans. Subsequent studies suggest these regulations have favorably reduced restraint use.¹³⁰ This is borne out in our analysis of the Minimum Data Set (MDS 2.0) for the years 1992-1995 (Table 4).

The effectiveness of physical restraint use is questionable. The most frequent reason for restraining long-term care facility residents is to prevent fall-related injuries and wandering.¹³¹ Unfortunately, mechanical restraints have been associated with no decrease, and a possible increase, in serious injuries from falls.¹³⁰⁻¹³² In hospitalized patients, restraints have been associated with increased mortality rates, longer lengths of stays, an increased incidence of nosocomial infections, pressure sore development, and emotional distress.^{45,131,133} Ethicists have proposed that restraint use require informed consent, except for immediate protection of staff.⁴⁵

NOSOCOMIAL INFECTIONS

Nosocomial infections, such as hospital-acquired pneumonia, are important complications of hospitalization and nursing home care. Those age 65 and older are predisposed to pneumonia because of changes in lung capacity, cough reflex, and immunity, all of which decrease with age. Independent risk factors putting older patients at greater risk of hospital-acquired pneumonia include poor nutritional status, neuromuscular disease, and witnessed aspiration events.¹³⁴

Nosocomial pneumonia among inpatients occurs twice as often in older than younger patients and is associated with poorer outcomes.¹³⁴ Both functional and cognitive declines are important indicators for the increased mortality among inpatients diagnosed with nosocomial pneumonia.¹³⁵ Pulmonary aspiration is an important precursor of nosocomial pneumonia and subsequent death. For example, a prospective study in a VA long-term care facility was conducted among functionally impaired older men who aspirated. Ninety percent had severe irreversible chronic neurologic disease. The mortality for that group, during the eight months of study, was 23%, and 87% were dead within three years.¹³⁶

In long-term care facilities, pneumonia and urinary tract infections combined account for approximately half of the nosocomial infections.¹³⁷⁻¹³⁸ Indwelling urinary catheters are the major risk factor for urinary tract infections and subsequent urosepsis. Other risk factors for nosocomial infections include fecal and urinary incontinence, antibiotic use in the prior month, intravenous lines, nasogastric tubes, and steroid use.⁶¹

Nursing homes are also potentially hazardous for the spread of communicable diseases. Tuberculosis (TB) is more common in older patients and has reached alarming proportions in nursing facilities. For individuals age 65 years and older, rates are fourfold higher in nursing homes than for older persons living at home.¹³⁹ In more than 12,000 new nursing home admissions in Arkansas over a three-year period, the prevalence of positive TB skin tests (PPD) increased from 10.9% to 18.4% within the first month of residence.¹⁴⁰ This

increase indicated recent exposure to TB. In addition to the increased risks of transmission among older nursing home residents, the clinical and radiologic presentation for acute infection or reactivation may be atypical in older patients and mimic bacterial pneumonia. This may result in delayed or missed diagnosis and treatment.

PRESSURE SORES

Pressure sores are widely regarded as evidence of poor nursing care. However, the reality is more complex. Bedridden and chairbound older patients are particularly vulnerable. Those at greatest risk for pressure sores have fecal incontinence, orthopedic injuries, or hypoalbuminemia. Other risk factors include longer lengths of hospital stay, neurosurgical trauma, neuromuscular diseases, malnutrition, lymphopenia, decreased body weight, dry skin, immobility, and an altered level of consciousness.^{141,65} The incidence, severity, and likelihood that pressure sores will progress to stages refractory to healing all increase dramatically in patients with several risk factors.

Older patients with limited mobility and any of the aforementioned risk factors create difficult challenges in patient care. As a result, skin breakdown can develop in the setting of moisture, friction, shearing forces, and pressure.¹⁴² Treatment variables (in contrast to the previous patient-specific characteristics) that predispose to pressure ulcer development include the type of surface support, nurse staffing ratios, frequency of patient turning/repositioning, and certain medications.⁶⁹

DELIRIUM

The most common causes of delirium are medications, new infections, metabolic derangements, and alcohol or drug withdrawal.⁷⁶ Predisposing factors include age, comorbid conditions, and preexisting cognitive or functional impairment. Among external influences are insufficient social support, sleep deprivation, unfamiliar or new environments, pain, and stimuli reduction (such as isolation or the absence of windows). Unfortunately, health care professionals often fail to detect delirium.

Physicians have been found to be deficient in diagnosing 30% to 50% of delirious patients. Nurses are slightly better, with incorrect diagnoses in the 10% to 30% range.¹⁴³ Poor communication between older patients and physicians can result in doctors' failing to recognize acute changes in mental status, occasionally leading to blaming the patient for any subsequent judgment errors.¹⁴⁴ Additional reasons for the failure to diagnose delirium include misdiagnosis as dementia or a psychiatric illness such as depression, overlooking delirium while attending to other diseases, and mistakenly attributing the behavior to normal aging.

Many serious medical problems can manifest initially with only mental status changes. The underlying illness may present with atypical, nonspecific, or less pronounced symptoms. Examples of illnesses in older patients that may be difficult to diagnose include pneumonia,

sepsis, and myocardial infarctions.⁷⁶ Despite prompt recognition, the effects of delirium may last after successful treatment of the underlying cause.

Often thought to be only a temporary problem when acquired during a hospitalization, delirium has been found to persist in as many as 95% of discharged older patients.¹⁴⁵ One long-term study followed older patients considered low risk (not frail) during a high-risk period for developing delirium: post-operatively.¹⁴⁶ Such delirium, also known as post-operative cognitive dysfunction, was present at the end of the first week in 25.8% and persisted in 10% until the end of the three-month follow-up period.

Coronary artery revascularization with cardiopulmonary bypass has been shown to be especially likely to cause post-operative delirium in older patients. Possible mechanisms include decreased cerebral autoregulatory mechanisms, hypothermia, hypoperfusion, air or particulate microemboli, and the absence of pulsatile blood-flow.¹⁴⁷ While certain types of surgery are associated with post-operative delirium, these mechanisms are independent of the type of anesthesia used.

Most trials have failed to demonstrate a correlation between the route of anesthesia (general, epidural, or regional) and the incidence of post-operative delirium.^{81,147} Pain at rest in the post-operative period is an independent risk factor for post-operative delirium.¹⁴⁸ However, the choice of narcotic analgesia, its route of administration, or the cumulative dose received are not independent risk factors. Some authors have concluded that the method of pain management is less significant than the quality of post-operative analgesia as a determinant of developing delirium.¹⁴⁸

Inouye believes delirium can serve as a marker (and therefore an opportunity for improvement) of the quality of hospital care.²⁰⁶ He describes five pathways related to delirium that reflect how hospitals fail in caring for older patients: iatrogenesis, failing to recognize the delirium, health care provider attitudes toward older patients, the rapid pace and technological focus of hospital care, and reductions in skilled nursing staff.²⁰⁶

SURGICAL AND POST-OPERATIVE COMPLICATIONS

Evidence suggests that age alone is not an important risk factor for many types of surgery. The oldest old (over age 90) with few pre-operative comorbid conditions who undergo non-emergent operations have outcomes comparable to those of younger age groups.¹⁴⁹ Older patients, many with chronic diseases, are increasingly undergoing bolder and more complex procedures.^{149,85,150} In a study of 74 frail nursing home patients undergoing major surgery (i.e., open repair hip fractures, amputations, and open abdominal procedures), all of the peri-operative mortality (3.8%)⁸⁵ was associated with emergency procedures. More current data suggest that with improved anesthetic and surgical techniques, the differences in surgical risks between different age groups may be shrinking.

However, as noted, older patients often have functional impairment or other diseases that increase surgical risk. Linn reviewed 108 surgical series between 1931 and 1980 involving

50,000 older patients.¹⁵¹ Though limited by differences in study techniques and inconsistent reporting of comorbidities, he nevertheless was able to observe several important trends. Aging correlated with increased mortality in elective general surgical patients. Emergency surgery (when compared to elective operations) had a threefold greater mortality for most ages, but plateaus for the oldest old. The authors hypothesized that patients who survived to very old ages are “biologically elite” and are not greater surgical risks.¹⁵¹

Other studies have suggested that part of the reason for the increased surgical mortality in older patients is a reluctance to electively operate earlier based on chronologic age alone. Among the reasons physicians avoid (or ultimately just delay) operating on older patients, are concerns surrounding post-operative risks. For example, the possible development of post-operative blood clots presents additional risks for operating on chronically ill and debilitated patients. The incidence of deep vein thrombosis and pulmonary emboli increases with age.^{45,155} In a retrospective review of over 16,000 cases of thromboembolic disease in a Medicare population, the incidence was approximately twice as frequent in ages 85 to 89, when compared to ages 65 to 69.¹⁵⁵ The peri-operative period for major surgery is associated with a hypercoagulable state and the additional risks of immobility. Now, with prophylactic anticoagulation provided before, during, and after surgery, this complication is often preventable.

Fear of increased risk of complications may lead to procrastination of surgery until it becomes necessary as an emergency, dramatically increasing the mortality risk for the patient. A recent prospective study of 900 patients age 65 and older found nonelective admissions and poor pre-operative functional status (determined by standardized anesthesia scoring systems) to be significant risk factors for surgical mortality.¹⁵² The investigators also suggested there was a bias against elective operations for those over the age of 65. For many operations in the older patients, surgeons decided not to operate until nonsurgical treatments had failed. Younger patients with comparable surgical indications did not face similar management patterns. Others have also found that nonelectively admitted surgical patients (unlike elective admissions) were disproportionately older.¹⁵³⁻¹⁵⁴

WHAT CAN BE DONE TO REDUCE ACCIDENTAL MEDICAL INJURY IN OLDER PATIENTS?

In the Harvard Medical Practice Study, two-thirds of adverse events in hospitalized patients were determined to be preventable.² Efforts to prevent medical errors in older patients commence with the same principles that apply to care of patients of all ages. However, in addition to physiologic differences and the increased likelihood of coexisting chronic diseases, older individuals are also exposed to unique socioeconomic and political influences that predispose them to medical injury (e.g., age bias, diminished health care access, increased needs of the functionally dependent, and lack of financial support to redesign safer homes and chronic care facilities). Therefore, in addition to physicians, nurses, and institutional administrators, public health and health policy leaders must play integral roles in minimizing harm to senior citizens from medical care. Fortunately, interest in patient safety has been accelerating recently.

Increasing awareness of the problem of iatrogenic injury has led to efforts by several national organizations to achieve safer health care. Examples include the American Medical Association's creation of the National Patient Safety Foundation in 1997; the Veterans Health Administration establishing the National Patient Safety Partnership in 1997, and the Joint Commission on Accreditation of Organizations revising its medical error reporting policies in 1998 to encourage disclosure.¹

In 1998, the President's Advisory Commission advocated prioritizing medical error prevention, and in 1999, the annual report of the Medicare Payment Advisory Commission (MedPAC) devoted a chapter to the need for expanded efforts in patient safety. Similarly, statewide coalitions, health care organizations, insurance carriers, and quality improvement leaders such as the Institute of Healthcare Improvement are contributing to the current movement toward an error-free environment.

At least four strategies hold promise for reducing accidental injury in older patients: (1) application of lessons in error prevention from non-health related industries, (2) reducing variability in medical care, (3) enhancing the roles of geriatric specialists and geriatric care units, and (4) using risk profiling and discharge planning.

Application of lessons in error prevention from other industries. Successful programs to reduce adverse medical events embrace the successful experiences of other industries. These include lessons from cognitive science and human factors research, systems theory, institutionalizing safety, and cultural shifts.³ High-reliability organizations (high-risk industries that achieve high levels of safety, such as aviation) apply these principles to the design of their systems. They also emphasize management of workflow and schedules to prevent fatigue and minimize stress. High-reliability organizations also provide extensive training in teamwork and individual responsibility for safety.

These principles need to be adopted by health care organizations as well. For example, the movement to a culture of safety should foster dialogue among providers to share proven solutions, encourage innovative approaches tailored to the special aspects of caring for older patients, and lead to implementation of best practices throughout the health care continuum.

The principles of total quality management (TQM), including interdisciplinary approaches, are important in senior care.¹⁵⁶ These incorporate teams that include physicians and nonphysician health care providers—such as physical therapists, social workers, and psychologists—working increasingly with the nursing profession. The principles for improving the quality of care and preventing errors have been well described.^{3,28-29,157-159} Leape has outlined several human factors concepts for medical error reduction that should be built into the design of all systems: simplify (reduce nonessential procedures or steps in work processes), standardize (limit unnecessary variety), stratify (customize care), improve communication, properly use defaults, carefully automate, use ergonomic aides, understand limitations of attention and vigilance, and encourage the reporting of errors in a nonpunitive environment.¹⁶⁰

Safety design characteristics also include improving information access, error proofing, reducing reliance on memory, standardization, training, and using buffers or redundancy to absorb inevitable errors but minimize their harm.³

Reducing variability in treatment of older patients. Growth in the volume and complexity of medical care has led to unintended harmful consequences.¹⁶¹ Fisher believes that with more diagnoses to treat and more treatment options available, physicians are more likely to make mistakes and possibly less likely to recognize iatrogenic harm.¹⁶¹ For example, outcome data for acute myocardial infarction in 150,000 older patients have demonstrated significant variation in mortality across hospitals.¹⁶³ It was not “high-technology” interventions that were most responsible for the differences in the 30-day mortality rates. Instead, the greater use of efficacious, evidence-based medical therapies (such as aspirin and beta-blockers) was the major determinant of improved outcomes.

In this study, teaching hospitals had better outcomes. Hospitals differ not only in academic affiliation (teaching vs. nonteaching), but also with respect to their full-time personnel (both nursing and physician staff). In one of the few studies of its kind, a recent nursing study found an inverse relationship between nurse staffing and both post-operative nosocomial pneumonia and urinary tract infections.²¹² In general, however, there is a paucity of literature regarding the extent of differences in the rates of preventable adverse events across hospitals and which characteristics account for safer hospitals, especially among those caring for predominant older patients.

Enhancing the role of geriatric specialists and geriatric care units. The evidence is clear, however, that outcomes are better and complications are less likely when older patients are cared for by geriatric physicians and nurse specialists. In one study of older patients with nursing home-acquired pneumonia, those cared for by physicians with a

Certificate of Added Qualifications in Geriatrics had a threefold greater likelihood of survival.¹³⁵ In this study, the geriatric providers had direct patient responsibility and participated in policy decisions.

Similarly, in geriatric units where structural and process-oriented factors have been reorganized and directed toward the needs of older patients, care has improved.⁷ Clinical trials in a hospital medical unit, physically redesigned along with a multidisciplinary approach to caring for older patients and to iatrogenic prevention, have demonstrated improved functional outcomes while saving costs.¹⁶⁵⁻¹⁶⁷

Examples of process changes in Acute Care for Elder (ACE) units with positive results include: team-directed, rather than physician-directed care; function-focused rather than disease-focused care; and supplementing traditional biomedical models of care for older patients with a biopsychosocial model.¹⁶⁵ These successes emphasize the importance of remodeling processes of care and strategies employing specialized teams of providers with direct responsibilities in patient care.

In contrast are the negative results of a randomized controlled trial that studied the impact of a geriatric consultation team on the incidence of adverse events in older patients (mean age 81.5). In this VA study, the incidence of hospital-acquired complications was 38%, with adverse events evenly distributed among medications, procedures, accidents, and nosocomial infections.⁷ The complication rate was not reduced by the use of the geriatric team.

On analysis, the failure by this team of specialists was determined to be due to limitations in their consultative role. They did not have the authority to change either patient care or the safety of the patient environment. Other comprehensive geriatric assessment studies that did not result in concurrent institutional reengineering have had similarly disappointing results.¹⁶⁴ What is needed is geriatric care, not geriatric consultation.

Risk profiling and discharge planning. Assessing the risk profile of older patients at the time of admission to the hospital can identify patients at risk for functional decline after hospitalization. The most important independent predictors are advanced age; low preadmission independent functioning, as measured by activities of daily living (ADL); and cognitive impairment.⁹² Follow-up patient assessments are also important in reducing medical errors after patient transfer or discharge to one's home. In particular, ensuring stability at the time of discharge from the hospital improves outcome. Older patients who are sent home in an unstable condition have twice the 30-day mortality as those discharged in a stable condition do.¹⁶⁸

Discharge planning can be particularly important for older patients with complex medical needs. Naylor has demonstrated the short-term effectiveness of comprehensive discharge planning for hospitalized older patients and the value of intensive follow-up of patients at high risk for poor outcomes.¹⁶⁹⁻¹⁷⁰ In this research, high-risk patients chosen at random for an intervention program received discharge planning by experienced advanced-practice

gerontology nurses. Readmissions were most frequently due to inadequate treatment during the index (initial) hospitalization. At six months, the intervention group had a 45% reduction in the readmission rate.¹⁶⁹

Comprehensive geriatric assessment has also been applied to the home health care sector. Studies have demonstrated both cost savings and success in delaying the development of disability or need for a nursing home.¹⁷¹⁻¹⁷²

SPECIFIC PROBLEMS

ADVERSE DRUG EVENTS

Reducing ADEs in older patients will require the expanded participation of physicians and other health care professionals, hospital administrators, and the information technology sector to redesign the medication systems in most hospitals. These efforts should also include methods to (1) increase physician knowledge of appropriate drug usage; (2) develop methods for early recognition of an ADE; (3) reduce unnecessary medication use and utilize nonpharmacologic alternatives, while avoiding age biased underprescribing of appropriate therapy; (4) integrate pharmacists into the physician-patient relationship; (5) involve national organizations to increase awareness and participation in solutions to the ADE problem; and (6) take advantage of successful new information technologies.

Increase physician knowledge. Beers has developed, with a panel of nationally recognized experts, explicit criteria on inappropriate drug use in older patients.¹⁷⁶ This group outlined two classes of drugs that are frequently associated with adverse outcomes: those that pose a general hazard for many in the geriatric population, and those that are hazardous only under certain medical conditions. Examples of the former (independent of diagnosis) include propoxyphene, indomethacin, flurazepam, methyldopa, and chlorpropamide. Examples of the latter (diagnosis-based) include use of sedatives in patients with chronic obstructive lung disease, use of aspirin with concurrent anticoagulant therapy, use of drugs with anticholinergic properties in patients with benign prostatic hypertrophy, and use of tricyclic antidepressants in patients with cardiac arrhythmias. These recommendations need to be widely disseminated and used by physicians.

Promote early recognition. Physicians often fail to recognize ADEs, leading to continuing injury and unnecessary additional therapy and tests. Rochon describes the problem of under-recognized and preventable patterns that are a consequence of an ADE as the “prescribing cascade.”¹⁷⁷ This cascade occurs when an ADE is misinterpreted as a newly acquired illness, leading to additional prescribed therapy for this “new illness,” which places the patient at risk for additional harm. Examples include new onset or exacerbation of hypertension in older patients who take nonsteroidal anti-inflammatory drugs, leading to the initiation of antihypertensive therapy; or extrapyramidal symptoms after initiation of metoclopramide, resulting in new drug therapy for presumed Parkinson’s disease. Continuing education of physicians needs to include more instruction on recognizing drug complications.

Reduce unnecessary drug use or substitute with safer treatments. This requires periodic review of medications, optimally after each visit or monthly in nursing homes. Reevaluation should focus on the continued need for optimal doses of all drugs. Substituting non-drug-based treatment is one way to reduce multiple drug use and hazardous combinations of medications in older patients. Nonpharmacologic sleep protocols for inpatients, for example, are an effective means of reducing the use of sedatives and the risks of ADEs. In a prospective study of older patients receiving sedative-hypnotics, the use of sedatives was reduced from 54% to 31%. The “nontoxic” alternatives included back rubs, relaxation tapes, and warm bedtime drinks.¹⁷⁸ The authors also predicted an overall reduction in delirium by 3%. If such methods were applied to the entire Medicare population, the yearly cost savings could be an estimated \$120 million.¹⁷⁸

Increase the use of pharmacists. Pharmacists are an underutilized resource for preventing medication errors. They provide important safeguards for older patients in hospitals and nursing homes. Their role should be expanded to other settings. For example, pharmacy evaluation of patients’ medication programs, now well established in long-term care facilities, should be equally effective for all older outpatients whose doctors prescribe complex drug regimens. Pharmacists could play a much larger role in preventing patient mismanagement of medications due to noncompliance, lack of understanding of their drug regimens, use of unnecessary or expired drugs, and use of medications from multiple physicians.¹¹¹

Develop organizational initiatives. The Food and Drug Administration in 1998 began to implement geriatric drug-use labeling requirements. This rule requires drug manufacturers to include labeling with geriatric-specific precautions, indications, and dosing modifications for drugs with predominantly renal-dependent excretion.¹⁷⁹ Initially, six drug categories will require this labeling improvement: psychotropics, nonsteroidal anti-inflammatory agents, certain cardiac drugs, oral hypoglycemics, anticoagulants, and quinolone antibiotics. Unfortunately, the completion of this project is not expected soon, while the toll on older patients from misuse continues.

The Institute for Healthcare Improvement has launched a series of “Breakthrough Collaboratives” directed at reducing adverse drug events. Hospitals send multidisciplinary teams to learn methods for changing their medication systems, to make them safer via human factors principles. The success of some of these teams has been striking.¹⁶⁰

Use new information technology. Informatics solutions to the ADE problem have been successively implemented in several academic centers and are expected to gain widespread acceptance.²¹ One of the most powerful aids to safe prescribing is computerizing the entire ordering process. Computerized physician-order entry with decision support has been shown to substantially reduce the incidence of ADEs and to be cost effective.^{116,180} Online real-time antibiotic guidelines for critically ill patients has also been shown to reduce costs, lengths of stay, and physician time.¹⁸¹ Outpatient pharmacotherapy in older patients can be improved by using computerized algorithms that routinely review drug

utilization and notify physicians of potential medication problems.¹⁸² Potentially inappropriate geriatric prescribing was changed in 24% of pharmacy orders after computer-generated alerts.¹⁸³

FALLS AND RESTRAINTS

Falls can be prevented by active programs, consistently applied. For example, falls consultation services have reduced nursing home falls by 19% and fall-related injuries by 31%.⁵⁰ Successful fall prevention programs target high-risk patients, particularly previous fallers.¹⁸⁴⁻¹⁸⁷ These programs have been demonstrated to be cost effective. In the home setting, Tinetti achieved a 44% reduction in falls by use of a multifactorial intervention program that included medication review, education, training in gait and transfer skills, changes in environmental hazards, strengthening exercises, and behavioral modifications.¹⁸⁴

Some geriatric clinics have used computerized fall risk-factor databases to improve identification of patients in greatest need of fall prevention efforts.¹⁸⁸ A simpler fall prediction model using three risk factors (hip weakness, poor balance, and multiple drug use) predicted a one-year fall rate of 12% in those without these risk factors, as compared to 100% when all three factors were present.¹⁸⁹ These results successfully classified people in both institutional and home care settings.⁵¹ In a controlled trial of 301 community-dwelling older persons (age 70 and older), the use of such risk prediction information—to target medication adjustments, behavioral instructions, and exercise programs—resulted in a 24% reduction in falls over one year.¹⁸⁴

Despite the improvements in reducing inappropriate use of physical restraints for fall prevention in nursing homes, physical restraints continue to be used frequently in hospitals, especially for managing critically ill patients (most commonly when they are on life support systems). Improved guidelines for sedation and analgesia—as well as environmental, organizational, and cultural improvements to redesign care of critically ill patients—have resulted in decreased utilization of restraints and improved outcomes.¹³⁰ Nonetheless, this practice continues to be a serious problem.

In 1999, the American Medical Association Council on Scientific Affairs published an updated report on the use of restraints in nursing homes.²⁰⁷ This report cites literature showing that successful implementation of restraint use guidelines results in tremendous reductions in restraint use. The report suggests achievable goals for limiting restraint use in nursing homes to under 5%, such these guidelines need to be more widely adopted.

NOSOCOMIAL INFECTIONS

Prevention of nosocomial infections in older patients requires following sound health care principles that apply to all ages: following correct hand-washing techniques, providing appropriate wound and skin care, ensuring proper immunizations, and minimizing patient

contact with those who have contagious illnesses. Infections can also be reduced by decreasing the prolonged use of broad-spectrum antibiotics or invasive devices (i.e., endotracheal tubes, nasogastric tubes, indwelling urinary catheters, and central venous catheters).

PRESSURE SORES

Pressure sore prevention begins with early risk assessment to identify patients most likely to benefit from prevention strategies.⁶⁵ Commonly used risk assessment tools are the Norton and Braden Scales. On-line decision support systems to assist in documentation and to provide guideline-based recommendations have been shown to lead to a 60% reduction in pressure sores over a six-month period.¹⁹⁰ Staff education alone can reduce hospital-acquired pressure sores by more than half.¹⁹¹ Education would promote both earlier clinical recognition (when ulcers are reversible) and improved wound care. Prevention addresses problems associated with mechanical loading due to immobility, support surfaces, skin care, moisture, incontinence, and nutrition. The guidelines published by the Agency of Health Care Policy and Research are comprehensive and practical. They should be widely implemented.²⁰⁸⁻²⁰⁹

DELIRIUM

Hospital-acquired delirium, especially for post-operative patients, is amenable to primary prevention. Risk assessment, as we have seen for other types of preventable injuries, allows for programs to efficiently target the high-risk older patients. Identifying those patients may improve allocation of interventions in a more cost-beneficial manner. Several investigators have developed predictive models for the onset of delirium in both medical and elective surgical patients.^{83,93,192} Risk factors include cognitive impairment, visual impairment, dehydration, alcohol abuse, markedly abnormal blood electrolyte or glucose levels, and serious comorbidities.

In a prospective study of 852 medical patients, Inouye has demonstrated a one-third reduction in delirium for hospitalized older patients when they undergo a multicomponent intervention to reduce risk factors.⁷⁴ A geriatric-anesthesiologist team intervention program has also been shown to reduce the incidence of post-operative delirium.⁸² In addition to pre-operative assessment, this intervention included intraoperative precautions (avoiding hypoxia or dehydration, anesthetic technique) and post-operative attention to providing pain relief, environmental support, and intervention in early confusional states. Successful efforts to reduce delirium combine these practice recommendations.

SURGICAL AND POST-OPERATIVE COMPLICATIONS

Preventing complications from surgery and other invasive procedures requires attention to all phases of treatment: pre-hospital, pre- and post-operative care, and rehabilitation. An important first step is to ensure that the procedure is appropriate. Older patients require

especially careful medical assessment by the surgeon, the primary care provider, and the anesthesiologist; collaboration by this team should continue throughout the hospitalization. Pre-operative preparation requires taking the time to stabilize all active medical problems, so that the patient is in an optimal state at the time of surgery. In addition to the usual risks, older patients are particularly prone in the post-operative period to complications that are a consequence of bedrest, pain management, and several predictable physiologic responses. All require meticulous attention.

In addition to the earlier described risks of specific drugs such as narcotics, benzodiazepines, and psychotropic medications, anesthetic drugs can pose particular hazards. Special techniques are necessary for regional, epidural, and general anesthetic medication choices and dosing for older patients.¹⁰ Effective pain management in older patients requires that adequate doses of analgesia be given, with the health care team being cognizant of the differences in pharmacologic metabolism, excretion, and sensitivity that require adjustment. Patient-controlled analgesia (PCA) has been successively used in older patients, including frail ones without pre-operative dementia or confusion prior to enrollment. In these patients, the incidence of complications and inadequate pain relief decreased when PCA was conducted with careful age-adjusted dose titration.¹⁹⁵

A summary of some of the error-prevention strategies that have been employed is presented in Table 9.

FUTURE RESEARCH NEEDS

Research efforts to improve health care for those age 65 and older should be greatly expanded. The agenda should include methods to improve data collection, development of tools for patients to make better decisions that result in safer care, improved methods of caring for older patients, and further impact analyses of aspects of patient care that are known to pose added risks (e.g., nursing and physician staffing levels, specialized training for nurses and physicians who care for older patients, patient care outside the hospital, and new technologies and medications).

Longitudinal databases that are rich in clinical data, such as the Minimum Data Set, can greatly assist the evaluation of organizational processes and outcomes for long-term care facilities. These offer much more useful information than do the administrative databases currently used to examine episodic care (such as discharge diagnoses and medical procedures).¹⁶² Databases can also give both physicians and patients the necessary information to help in complex decision-making processes.

As patients age, the relationship of benefit to risk of treatment changes. This changing relationship has received little study in the past. In many cases, the potential gain in survival from therapy diminishes with aging, while the risks of therapy increase.¹⁷³ As a result, treatment benefits are often less clear-cut for older persons. Welch describes the competing risks of treatment benefits and the increased risks in older patients of death from other causes. He suggests that these patients (with or without physician help) need to be more selective in accepting only clearly effective treatments, and they should be less willing to accept the risks of associated complications.¹⁷³

Home health care, and more recently the advent of acute care for older patients in “home-hospitals,” provide opportunities for research into the prevention of medical errors and improvement in outcomes.¹⁷⁴ Avoiding the risks of adverse events associated with hospitalization is one of the reasons behind the enthusiasm for the home-hospital movement. However, home health care has, to date, not been shown to be less hazardous than inpatient care. In fact, in one of the few studies looking at adverse events at home, a review of 269 patients receiving outpatient parenteral antibiotic therapy found that the frequency and types of ADEs were similar to those in hospitalized patients; 8% required rehospitalization.¹⁷⁵ The current expansion of home health care demands prospective research to determine appropriate indications for the use of these alternatives to hospital care for older patients.

CONCLUSIONS

The risk of accidental injury is unacceptably high for all who undergo medical treatment, but especially for older patients. Not only is the overall risk of injuries higher for them, but these patients are more susceptible to certain types of complications and injuries. Those include falls, complications from the use of medications, hospital-acquired (nosocomial) infections, pressure sores, post-operative complications, and delirium.

Some of these risks are the consequences of normal aging and thus unavoidable; others are brought on by the treatments themselves. Normal aging is associated with declining organ function that makes older patients less able than younger ones to withstand the effects of disease or the complications of treatments. With a given exposure, they are more likely to develop pneumonia or fracture a bone. In addition, many diseases are more prevalent in older patients, further reducing organ function and activity in the very old and leading to complications such as pressure sores and falls.

The risk of complications of treatments is higher for older patients in large measure because they receive so many more of them. This is particularly true of medications. Specific treatments, such as surgical operations, have not been found to be intrinsically more hazardous in older patients, but they take on added risk to the extent that patients have reduced organ function or increased coexistent ("comorbid") disease, or receive inexperienced peri-operative care.

The risks of medical treatment can be greatly reduced by applying principles and techniques learned in recent years from geriatric research. Major improvements in the quality of care, particularly the reduction of medical injuries, could be realized if these techniques were applied more widely. The sad fact is that they have not been. Too many older patients are cared for by doctors and nurses with no geriatric training. This is true for patients cared for in the hospital as well as for people at home or in nursing homes. With careful and expert care, older patients can weather many a medical storm. Providing that care is a major challenge to our medical care system.

Table 1: Harvard Medical Practice Study: Rates of adverse events* in older patients.

AGES		ALL AGES	<65	>=65	OLDER PATIENTS ONLY			
					65-74	75-84	>85	
		Percent of patients						
Study Population: % of Total	%	100	83.3	16.7	10.4	4.5	1.7	
	(n)	(31,429)	(26,184)	(5245)	(3283)	(1421)	(541)	
Diagnostic Mishap Rate		.30	.27	.48	.37	.63	.74	
Therapeutic Mishap Rate		.23	.15	.63	.49	.56	1.66	
Drug Complication Rate		.63	.52	1.22	1.28	1.20	.92	
Fall Rate		.07	.03	.27	.12	.42	.74	
Operative Complication Rate		1.64	1.36	3.05	2.77	3.03	4.81	
All Adverse Events Rate		3.7	3.2	5.9	NA	NA	NA	

*Adverse event: an injury caused by treatment that results in a disability (temporary or permanent) or prolongs hospital stay.

Rates are percent of hospital admissions, calculated from a random sample of 30,000 admissions.

Table 2: Colorado and Utah* Medical Practice Study:

Rates of adverse events in older patients.

EVENT TYPE	Age 16-64 (%)	Age 65+ (%)
Incorrect or Delayed Diagnosis	0.22	0.27
Medical Procedures ⁺	0.29	0.98
Drug Complications	0.41	1.43
Falls ⁺	0.01	0.14
Operative Complications ⁺	1.44	2.11

* Weighted rates for the populations of both states from a random sample of 15,000 admissions.

⁺ p < 0.05

Table 3: Veterans Administration (VA) National Surgical Quality Improvement Program:
Incidence of selected risk factors and outcomes.

AGES	≤ 64 (n=52,18)	65-74 (n=27,113)	75-84 (n=14,544)	≥ 85 (n=1,117)
Percent of patients				
Functional Health Status				
Independent	92.0	84.7	77.5	61.3
Partially Dependent	6.5	12.2	17.2	28.6
Totally Dependent	1.5	3.0	5.3	10.1
Emergency Cases (as % of all operations)	7.0	7.5	9.7	14.2
Number of Complications per Patient				
1	5.3	8.5	9.9	11.5
2	1.0	2.3	2.9	3.4
3	0.7	1.8	2.5	2.8

Based on an analysis of 95,492 patients who underwent surgery in the VA hospitals between October 1997 and September 1998.

Table 4: VA National Surgical Quality Improvement Program: Incidence of selected post-operative complications after major surgery among veterans* (Fiscal Year 1998)

AGES	≤64 (n=52,718)	65-74 (n=27,113)	75-84 (n=14,544)	≥ 85 (n=1,117)
POST-OPERATIVE COMPLICATION	Percent with complications			
Pneumonia	1.0	2.5	3.5	4.7
Pulmonary Embolism	0.1	0.2	0.2	0.5
Failure to Wean >48 hours	1.0	2.2	2.7	2.8
Reintubation	0.8	1.9	2.3	3.2
Renal Insufficiency.	0.2	0.4	0.7	0.7
Acute Renal Failure	0.2	0.3	0.5	0.3
Urinary Tract Infection	1.0	2.4	3.8	4.9
Cardiac Arrest→CPR ⁺	0.3	1.0	1.4	2.0
Myocardial Infarction	0.2	0.6	0.9	0.8
Systemic Sepsis	0.5	1.1	1.5	1.6

Based on an analysis of 95,492 patients.

* Major surgery is any operation conducted under general, spinal, and/or epidural anesthesia and all carotid endarterectomies and inguinal herniorrhaphies, regardless of anesthesia type.

+ CPR = cardiopulmonary resuscitation

Table 5: Center for Health Systems Research and Analysis, Multiple Data Set 2.0:
Selected quality indicators.

QUALITY INDICATORS	1992	1993	1994	1995	NATIONAL PROJECTED
					ESTIMATES ¹
MEAN PREVALENCE RATES					
Percent of patients					
Any Injury	14	16	17	16	320,000
Falls	15	16	15	14	280,000
Use of 9+ Medications	16	17	20	22	440,000
Indwelling Catheters	7	7	7	8	160,000
Urinary Tract Infections	8	9	8	8	160,000
Antipsychotic Use	13	13	12	11	220,000
Long-Acting BDZ*	3	3	3	3	60,000
Daily Physical Restraints	18	17	15	13	260,000
Stage 1-4 Pressure Sore	10	12	6	11	220,000
Facilities Reporting (n)	785	793	802	464	
Sample Size of Residents (n)	48,049	50,151	72,081	36,715	

*Benzodiazepines

1. Estimated national experience, based on 1995 results representing a point in time from four states [not necessarily representative of the national nursing home population, estimated at 2 million residents and extrapolated to all (~20,000) nursing homes]

Table 6: Studies on incidence of falls

Author	Year	Patients enrolled	Age	Fall Incidence	Injuries from Falls	Location
					Percent	
Tinetti ⁵¹	1988	336	78.3 (mean)	32	7.7	Community
O'Loughlin ⁵²	1993	409	74.8 (mean)	29.1	17.9	Community
Thapa ⁴⁵	1996	1228	65-84 ≥ 85	49 41	9	Nursing Home
Morgan ⁴⁹	1985	12,218	65+	1.9	0.025	Hospital

Table 7: Studies on incidence of pressure sores.

Author	Year	Patients enrolled	Age (mean)	Incidence (percent)	Location	Comments
Allman ¹⁴¹	1995	286	73.7	12.9	Hospital	Patients with impaired mobility
Bianchetti ¹⁹⁶	1993	92	NA	22.8	Hospital	Patients with increased risk factors
Moody ¹⁹¹	1988	228	76.8	14.8	Hospital	After education→ decreased incidence to 5.4%
Brandeis ⁷⁰	1990	14,345	79.6	13.2	Nursing Home	52 nursing homes
Brandeis ¹⁹⁷	1995	2011	84.3	6.2 ¹	Nursing Home	270 nursing homes, Minimum Data Set resource

1. Self-reporting by institution.

Table 8: Studies on inpatient delirium.

Author	Year	Patients enrolled	Age(Mean)	Incidence (percent)	Comments
Schor ¹⁹⁸	1992	291	80.5	31.3	Medical/Surgical
Inouye ⁹³	1993	281	78.7	19.9	Medical Service
Marcantonio ⁸³	1994	1341	67	9	Non-cardiac surgery
Pompei ⁷⁸	1994	755	76.5	19.7	Medical /Surgical
Inouye ¹⁹⁹	1996	508	78.5	16.1	Medical Service
Inouye ⁷⁴	1999	426	79.8	15	Medical Service

Table 9: Error-prevention strategies for older patients.

PROBLEM	REASON	SOLUTION/INTERVENTION
Adverse Drug Events	Multiple drug use Aging-related physiologic alterations in metabolism, excretion, drug effects Drug knowledge dissemination, allergy checking, dispensing Underprescribing	Review medication indications Appropriate dose adjustments Computerization, physician order entry, decision support, bar-coding technology Avoid age bias; decisions based on comorbidities, not chronologic age
Falls	Medications Physical restraints Environmental Weakness, gait disturbances, deconditioning	Limit psychoactive pharmacotherapy Restraint use guidelines Modify for older/handicapped; ergonomic aids Training, exercise programs, reduce unnecessary bedrest; assistive devices; risk assessment
Pressure Sores	Immobility Malnutrition Local factors	Increase mobility, scheduled turning Nutritional assessment and treatment Risk assessment; skin care, mattress changes; address incontinence, moisture, etc.
Nosocomial Infections	Aspiration Antibiotic resistance Instrumentation	Aspiration precautions Restrict broad-spectrum therapy Minimize duration; catheter care guidelines; hand-washing
Delirium	Medications Environmental Analgesia/Pain Post-operative	Appropriate drug and dosing indications; non-pharmacologic approaches to insomnia Physical modifications; staff education; minimize isolation Pain management guidelines; behavioral approaches Anesthetic and peri-operative care adjustments
Surgical and Peri-operative Complications	Wound infections Thromboembolic events Excessive mortality rates	Diligent wound care Early mobilization, prophylactic therapy Improved patient selection; minimize emergency cases when electively indicated
Functional Decline	Prolonged hospitalization Prolonged bedrest Inappropriate transfer	Geriatric risk assessment; interdisciplinary team care Early mobilization and rehabilitation; improved utilization of nonhospital care settings Stabilize prior to transfer; discharge planning and follow-up
Diagnostic Errors	Under- or missed diagnosis Systemic failures	Geriatric assessment; understanding pathophysiology and altered disease presentations in older patients; discontinuing unproved or refuted chronologic age-based algorithms Improve medical access; correct reimbursement deficiencies; reorganize care structures and processes; information management solutions

NOTES

1. Leape LL, Woods DD, Hatlie MJ, Kizer KW, Schroeder SA, Lundberg GD: Promoting patient safety by preventing medical error [editorial]. *JAMA* 1998;280:1444-1447.
2. Brennan TA, Leape LL, Laird NM, et al.: Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *N.Engl.J.Med.* 1991;324:370-376.
3. Leape LL: Error in medicine. *JAMA* 1994;272:1851-1857.
4. Steel K, Gertman PM, Crescenzi C, Anderson J: Iatrogenic illness on a general medical service at a university hospital. *N.Engl.J.Med.* 1981;304:638-642.
5. Reichel W: Complications in the care of five hundred elderly hospitalized patients. *J.Am.Geriatr.Soc.* 1965;13:973-981.
6. Jahnigen D, Hannon C, Laxson L, LaForce FM: Iatrogenic disease in hospitalized elderly veterans. *J.Am.Geriatr.Soc.* 1982;30:387-390.
7. Becker PM, McVey LJ, Saltz CC, Feussner JR, Cohen HJ: Hospital-acquired complications in a randomized controlled clinical trial of a geriatric consultation team. *JAMA* 1987;257:2313-2317.
8. Gurwitz JH, Sanchez-Cross MT, Eckler MA, Matulis J: The epidemiology of adverse and unexpected events in the long-term care setting. *J.Am.Geriatr.Soc.* 1994;42:33-38.
9. Coast J, Richards SH, Peters TJ, Gunnell DJ, Darlow MA, Pounsford J: Hospital at home or acute hospital care? A cost minimization analysis. *BMJ.* 1998;316:1802-1806.
10. Richards SH, Coast J, Gunnell DJ, Peters TJ, Pounsford J, Darlow MA: Randomised controlled trial comparing effectiveness and acceptability of an early discharge, hospital at home scheme with acute hospital care. *BMJ.* 1998;316:1796-1801.
11. Shepperd S, Harwood D, Gray A, Vessey M, Morgan P: Randomised controlled trial comparing hospital at home care with inpatient hospital care. II: cost minimisation analysis. *BMJ.* 1998;316:1791-1796.
12. Daley J, Khuri SF, Henderson W, et al.: Risk adjustment of the post-operative morbidity rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J.Am.Coll.Surg.* 1997;185:328-340.
13. Khuri SF, Daley J, Henderson W, et al.: The National Veterans Administration Surgical Risk Study: risk adjustment for the comparative assessment of the quality of surgical care. *J.Am.Coll.Surg.* 1995;180:519-531.
14. Khuri SF, Daley J, Henderson W, et al.: Risk adjustment of the post-operative mortality rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J.Am.Coll.Surg.* 1997;185:315-327.
15. Evans JM, Chutka DS, Fleming KC, Tangalos EG, Vittone J, Heathman JH: Medical care of nursing home residents. *Mayo Clin.Proc.* 1995;70:694-702.

16. Anonymous. Development of MDS-based module for short-stay and clinically intense SNF patients, rehabilitation hospitals and long term care hospitals. www.hcfa.gov/medicare. HCFA. [cited:10-26-1998].
17. Do AN, Ray BJ, Banerjee SN, et al.: Bloodstream infection associated with needleless device use and the importance of infection-control practices in the home health care setting. *J.Infect.Dis* 1999;179:442-448.
18. Danzig LE, Short LJ, Collins K, et al.: Bloodstream infections associated with a needleless intravenous infusion system in patients receiving home infusion therapy. *JAMA* 1995;273:1862-1864.
19. Gambassi G, Landi F, Peng L, et al.: Validity of diagnostic and drug data in standardized nursing home resident assessments: potential for geriatric pharmacoepidemiology. *Med.Care* 1998;36:167-179.
20. Leape LL, Brennan TA, Laird N, et al.: The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N.Engl.J.Med.* 1991;324:377-384.
21. Classen DC, Pestotnik SL, Evans RS, Lloyd JF, Burke JP: Adverse drug events in hospitalized patients. Excess length of stay, extra costs, and attributable mortality. *JAMA* 1997;277:301-306.
22. Hutchinson TA, Flegel KM, Kramer MS, Leduc DG, Kong HH: Frequency, severity and risk factors for adverse drug reactions in adult out-patients: a prospective study. *J.Chronic.Dis.* 1986;39:533-542.
23. Hanlon JT, Schmader KE, Koronkowski MJ, et al.: Adverse drug events in high risk older outpatients. *J.Am.Geriatr.Soc.* 1997;45:945-948.
24. Colt HG, Shapiro AP: Drug-induced illness as a cause for admission to a community hospital. *J.Am.Geriatr.Soc.* 1989;37:323-326.
25. Lamy PP: The elderly and drug interactions. *J.Am.Geriatr.Soc.* 1986;34:586-592.
26. Roberts MS, King M, Stokes JA, et al.: Medication prescribing and administration in nursing homes. *Age.Ageing* 1998;27:385-392.
27. Bates DW, Pruess K, Souney P, Platt R: Serious falls in hospitalized patients: correlates and resource utilization. *Am.J.Med.* 1995;99:137-143.
28. Bates DW, Cullen DJ, Laird N, et al.: Incidence of adverse drug events and potential adverse drug events. Implications for prevention. ADE Prevention Study Group. *JAMA* 1995;274:29-34.
29. Leape LL, Bates DW, Cullen DJ, et al.: Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA* 1995;274:35-43.
30. Gray SL, Sager M, Lestico MR, Jalaluddin M: Adverse drug events in hospitalized elderly. *J.Gerontol.A.Biol.Sci.Med.Sci.* 1998;53:M59-M63
31. Gerety MB, Cornell JE, Plichta DT, Eimer M: Adverse events related to drugs and drug withdrawal in nursing home residents. *J.Am.Geriatr.Soc.* 1993;41:1326-1332.
32. Stewart RB, Hale WE: Acute confusional states in older adults and the role of polypharmacy. *Annu.Rev.Public Health* 1992;13:415-430.
33. Hurwitz N: Predisposing factors in adverse reactions to drugs. *Br.Med.J.* 1969;1:536-539.

34. Williamson J, Chopin JM: Adverse reactions to prescribed drugs in the elderly: a multicentre investigation. *Age Ageing* 1980;9:73-80.
35. Carbonin P, Pahor M, Bernabei R, Sgadari A: Is age an independent risk factor of adverse drug reactions in hospitalized medical patients? *J.Am.Geriatr.Soc.* 1991;39:1093-1099.
36. Classen DC, Pestotnik SL, Evans RS, Burke JP: Computerized surveillance of adverse drug events in hospital patients. *JAMA* 1991;266:2847-2851.
37. Barker KN, Mikeal RL, Pearson RE, Illig NA, Morse ML: Medication errors in nursing homes and small hospitals. *Am.J.Hosp.Pharm.* 1982;39:987-991.
38. Cooper JW: Probable adverse drug reactions in a rural geriatric nursing home population: a four-year study. *J.Am.Geriatr.Soc.* 1996;44:194-197.
39. Klein LE, German PS, Levine DM, Feroli ERJ, Ardery J: Medication problems among outpatients. A study with emphasis on the elderly. *Arch.Intern.Med.* 1984;144:1185-1188.
40. Schneider JK, Mion LC, Frengley JD: Adverse drug reactions in an elderly outpatient population. *Am.J.Hosp.Pharm.* 1992;49:90-96.
41. Stuck AE, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, Beck JC: Inappropriate medication use in community-residing older persons. *Arch.Intern.Med.* 1994;154:2195-2200.
42. Willcox SM, Himmelstein DU, Woolhandler S: Inappropriate drug prescribing for the community-dwelling elderly. *JAMA* 1994;272:292-296.
43. Aparasu RR, Fliginger SE: Inappropriate medication prescribing for the elderly by office-based physicians. *Ann.Pharmacother.* 1997;31:823-829.
44. Myers AH, Baker SP, Van Natta ML, Abbey H, Robinson EG: Risk factors associated with falls and injuries among elderly institutionalized persons. *Am.J.Epidemiol.* 1991;133:1179-1190.
45. Thapa PB, Brockman KG, Gideon P, Fought RL, Ray WA: Injurious falls in nonambulatory nursing home residents: a comparative study of circumstances, incidence, and risk factors. *J.Am.Geriatr.Soc.* 1996;44:273-278.
46. King MB, Tinetti ME: Falls in community-dwelling older persons. *J.Am.Geriatr.Soc.* 1995;43:1146-1154.
47. Tinetti ME, Doucette JT, Claus EB: The contribution of predisposing and situational risk factors to serious fall injuries. *J.Am.Geriatr.Soc.* 1995;43:1207-1213.
48. Mahoney JE, Tinetti ME: Immobility and Falls: factors associated with serious injury during falls by ambulatory nursing home residents. *Clin.Geriatr.Med.* 1998;14:699-726.
49. Morgan VR, Mathison JH, Rice JC, Clemmer DI: Hospital falls: a persistent problem. *Am.J.Public Health* 1985;75:775-777.
50. Ray WA, Taylor JA, Meador KG, et al.: A randomized trial of a consultation service to reduce falls in nursing homes. *JAMA* 1997;278:557-562.
51. Tinetti ME, Speechley M, Ginter SF: Risk factors for falls among elderly persons living in the community. *N.Engl.J.Med.* 1988;319:1701-1707.

52. O'Loughlin JL, Robitaille Y, Boivin JF, Suissa S: Incidence of and risk factors for falls and injurious falls among the community-dwelling elderly. *Am.J.Epidemiol.* 1993;137:342-354.
53. Morrison RS, Chassin MR, Siu AL: The medical consultant's role in caring for patients with hip fracture. *Ann.Intern.Med.* 1998;128:1010-1020.
54. Rizzo JA, Friedkin R, Williams CS, Nabors J, Acampora D, Tinetti ME: Health care utilization and costs in a Medicare population by fall status. *Med.Care* 1998;36:1174-1188.
55. Norman DC, Castle SC, Cantrell M: Infections in the nursing home. *J.Am.Geriatr.Soc.* 1987;35:796-805.
56. Franson TR, Duthie EHJ, Cooper JE, Van Oudenhoven G, Hoffmann RG: Prevalence survey of infections and their predisposing factors at a hospital-based nursing home care unit. *J.Am.Geriatr.Soc.* 1986;34:95-100.
57. Riedinger JL, Robbins LJ, Bergstrom NI: Prevention of iatrogenic illness: adverse drug reactions and nosocomial infections in hospitalized older adults, strategies for preventing pressure ulcers. *Clin.Geriatr.Med.* 1998;14:681-698.
58. Berman P, Hogan DB, Fox RA: The atypical presentation of infection in old age. *Age.Ageing* 1987;16:201-207.
59. Gross PA, Rapuano C, Adrignolo A, Shaw B: Nosocomial infections: decade-specific risk. *Infect.Control.* 1983;4:145-147.
60. Saviteer SM, Samsa GP, Rutala WA: Nosocomial infections in the elderly. Increased risk per hospital day. *Am.J.Med.* 1988;84:661-666.
61. Hussain M, Oppenheim BA, O'Neill P, Trembath C, Morris J, Horan MA: Prospective survey of the incidence, risk factors and outcome of hospital-acquired infections in the elderly. *J.Hosp.Infect.* 1996;32:117-126.
62. Magaziner J, Tenney JH, DeForge B, Hebel JR, Muncie HLJ, Warren JW: Prevalence and characteristics of nursing home-acquired infections in the aged. *J.Am.Geriatr.Soc.* 1991;39:1071-1078.
63. Muder RR, Brennen C, Swenson DL, Wagener M: Pneumonia in a long-term care facility. A prospective study of outcome. *Arch.Intern.Med.* 1996;156:2365-2370.
64. Muder RR: Pneumonia in residents of long-term care facilities: epidemiology, etiology, management, and prevention. *Am.J.Med.* 1998;105:319-330.
65. Evans JM, Andrews KL, Chutka DS, Fleming KC, Garness SL: Pressure ulcers: prevention and management. *Mayo Clin.Proc.* 1995;70:789-799.
66. Allman RM: The impact of pressure ulcers on health care costs and mortality. *Adv.Wound.Care* 1998;11:2
67. Guralnik JM, Harris TB, White LR, Cornoni-Huntley JC: Occurrence and predictors of pressure sores in the National Health and Nutrition Examination survey follow-up. *J.Am.Geriatr.Soc.* 1988;36:807-812.
68. Meehan M: National pressure ulcer prevalence survey. *Adv.Wound.Care* 1994;7:27-28.
69. Allman RM: Pressure ulcer prevalence, incidence, risk factors, and impact. *Clin.Geriatr.Med.* 1997;13:421-436.

70. Brandeis GH, Morris JN, Nash DJ, Lipsitz LA: The epidemiology and natural history of pressure ulcers in elderly nursing home residents. *JAMA* 1990;264:2905-2909.
71. Bergstrom N, Braden B: A prospective study of pressure sore risk among institutionalized elderly. *J.Am.Geriatr.Soc.* 1992;40:747-758.
72. Berlowitz DR, Wilking SV: The short-term outcome of pressure sores. *J.Am.Geriatr.Soc.* 1990;38:748-752.
73. Thomas DR, Goode PS, Tarquine PH, Allman RM: Hospital-acquired pressure ulcers and risk of death. *J.Am.Geriatr.Soc.* 1996;44:1435-1440.
74. Inouye SK, Bogardus ST, Charpentier PA, et al.: A multicomponent intervention to prevent delirium in hospitalized older patients. *N.Engl.J.Med.* 1999;340:669-676.
75. Inouye SK: Delirium in hospitalized older patients. *Clin.Geriatr.Med.* 1998;14:745-764.
76. Inouye SK: The dilemma of delirium: clinical and research controversies regarding diagnosis and evaluation of delirium in hospitalized elderly medical patients. *Am.J.Med.* 1994;97:278-288.
77. Inouye SK, Rushing JT, Foreman MD, Palmer RM, Pompei P: Does delirium contribute to poor hospital outcomes? A three-site epidemiologic study. *J.Gen.Intern.Med.* 1998;13:234-242.
78. Pompei P, Foreman M, Rudberg MA, Inouye SK, Braund V, Cassel CK: Delirium in hospitalized older persons: outcomes and predictors. *J.Am.Geriatr.Soc.* 1994;42:809-815.
79. Elie M, Cole MG, Primeau FJ, Bellavance F: Delirium risk factors in elderly hospitalized patients. *J.Gen.Intern.Med.* 1998;13:204-212.
80. Williams-Russo P, Urquhart BL, Sharrock NE, Charlson ME: Post-operative delirium: predictors and prognosis in elderly orthopedic patients. *J.Am.Geriatr.Soc.* 1992;40:759-767.
81. Parikh SS, Chung F: Post-operative delirium in the elderly. *Anesth.Analg.* 1995;80:1223-1232.
82. Gustafson Y, Brannstrom B, Berggren D, et al.: A geriatric-anesthesiologic program to reduce acute confusional states in elderly patients treated for femoral neck fractures. *J.Am.Geriatr.Soc.* 1991;39:655-662.
83. Marcantonio ER, Goldman L, Mangione CM, et al.: A clinical prediction rule for delirium after elective noncardiac surgery. *JAMA* 1994;271:134-139.
84. Marcantonio ER, Goldman L, Orav EJ, Cook EF, Lee TH: The association of intraoperative factors with the development of post-operative delirium. *Am.J.Med.* 1998;105:380-384.
85. Keating HJ: Major surgery in nursing home patients: procedures, morbidity, and mortality in the frailest of the frail elderly. *J.Am.Geriatr.Soc.* 1992;40:8-11.
86. Keller SM, Markovitz LJ, Wilder JR, Aufses AHJ: Emergency and elective surgery in patients over age 70. *Am.Surg.* 1987;53:636-640.

87. Gorbien MJ, Bishop J, Beers MH, Norman D, Osterweil D, Rubenstein LZ: Iatrogenic illness in hospitalized elderly people. *J.Am.Geriatr.Soc.* 1992;40:1031-1042.
88. Resnick NM, Marcantonio ER: How should clinical care of the aged differ? *Lancet* 1997;350:1157-1158.
89. Gillick MR, Serrell NA, Gillick LS: Adverse consequences of hospitalization in the elderly. *Soc.Sci.Med.* 1982;16:1033-1038.
90. Lefevre F, Feinglass J, Potts S, et al.: Iatrogenic complications in high-risk, elderly patients. *Arch.Intern.Med.* 1992;152:2074-2080.
91. Potts S, Feinglass J, Lefevre F, Kadah H, Branson C, Webster J: A quality-of-care analysis of cascade iatrogenesis in frail elderly hospital patients. *QRB.Qual.Rev.Bull.* 1993;19:199-205.
92. Sager MA, Rudberg MA, Jalaluddin M, et al.: Hospital admission risk profile (HARP): identifying older patients at risk for functional decline following acute medical illness and hospitalization. *J.Am.Geriatr.Soc.* 1996;44:251-257.
93. Inouye SK, Viscoli CM, Horwitz RI, Hurst LD, Tinetti ME: A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. *Ann.Intern.Med.* 1993;119:474-481.
94. Gurwitz JH, Avorn J: The ambiguous relation between aging and adverse drug reactions. *Ann.Intern.Med.* 1991;114:956-966.
95. Rich MW, Shah AS, Vinson JM, Freedland KE, Kuru T, Sperry JC: Iatrogenic congestive heart failure in older adults: clinical course and prognosis. *J.Am.Geriatr.Soc.* 1996;44:638-643.
96. Davidman M, Olson P, Kohen J, Leither T, Kjellstrand C: Iatrogenic renal disease. *Arch.Intern.Med.* 1991;151:1809-1812.
97. Miller MB, Elliott DF: Errors and omissions in diagnostic records on admission of patients to a nursing home. *J.Am.Geriatr.Soc.* 1976;24:108-116.
98. Radecki SE, Kane RL, Solomon DH, Mendenhall RC, Beck JC: Are physicians sensitive to the special problems of older patients? *J.Am.Geriatr.Soc.* 1988;36:719-725.
99. Fried LP, Storer DJ, King DE, Lodder F: Diagnosis of illness presentation in the elderly. *J.Am.Geriatr.Soc.* 1991;39:117-123.
100. Carrasquillo O, Orav EJ, Brennan TA, Burstin HR: Impact of language barriers on patient satisfaction in an emergency department. *J.Gen.Intern.Med.* 1999;14:82-87.
101. Williams MV, Parker RM, Baker DW, et al.: Inadequate functional health literacy among patients at two public hospitals. *JAMA* 1995;274:1677-1682.
102. Murtaugh CM, Kemper P, Spillman BC, Carlson BL: The amount, distribution, and timing of lifetime nursing home use. *Med.Care* 1997;35:204-218.
103. Ouslander JG: Medical care in the nursing home. *JAMA* 1989;262:2582-2590.
104. Montalto M: How safe is hospital-in-the-home care? *Med.J.Aust.* 1998;168:277-280.
105. Rothkopf MM, Rothkopf GS: *Standards and Practice of Homecare Therapeutics*, Baltimore, MD, Williams & Wilkins; 1997:10.

106. Svarstad BL, Mount JK: Nursing home resources and tranquilizer use among the institutionalized elderly. *J.Am.Geriatr.Soc.* 1991;39:869-875.
107. Col N, Fanale JE, Kronholm P: The role of medication noncompliance and adverse drug reactions in hospitalizations of the elderly. *Arch.Intern.Med.* 1990;150:841-845.
108. Omori DM, Potyk RP, Kroenke K: The adverse effects of hospitalization on drug regimens. *Arch.Intern.Med.* 1991;151:1562-1564.
109. Bero LA, Lipton HL, Bird JA: Characterization of geriatric drug-related hospital readmissions. *Med.Care* 1991;29:989-1003.
110. Michocki RJ, Lamy PP: A "risk" approach to adverse drug reactions. *J.Am.Geriatr.Soc.* 1988;36:79-81.
111. Hsia DE, Rubenstein LZ, Choy GS: The benefits of in-home pharmacy evaluation for older persons. *J.Am.Geriatr.Soc.* 1997;45:211-214.
112. Graves T, Hanlon JT, Schmader KE, et al.: Adverse events after discontinuing medications in elderly outpatients. *Arch.Intern.Med.* 1997;157:2205-2210.
113. Beers MH, Ouslander JG, Rollinger I, Reuben DB, Brooks J, Beck JC: Explicit criteria for determining inappropriate medication use in nursing home residents. UCLA Division of Geriatric Medicine. *Arch.Intern.Med.* 1991;151:1825-1832.
114. Beers MH, Ouslander JG, Fingold SF, et al.: Inappropriate medication prescribing in skilled-nursing facilities. *Ann.Intern.Med.* 1992;117:684-689.
115. Jha AK, Kuperman GJ, Teich JM, et al.: Identifying adverse drug events: development of a computer-based monitor and comparison with chart review and stimulated voluntary report. *J.Am.Med.Assoc.* 1998;5:305-314.
116. Bates DW, Leape LL, Cullen DJ, et al.: Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA* 1998;280:1311-1316.
117. Gurwitz JH, Soumerai SB, Avorn J: Improving medication prescribing and utilization in the nursing home. *J.Am.Geriatr.Soc.* 1990;38:542-552.
118. Ganz DA, Lamas GA, Goldman L, Gutierrez PR, Mangione CM: Age-related differences in management of heart disease: A study of cardiac medication use in an older cohort. *J.Am.Geriatr.Soc.* 1999;47:145-150.
119. White RH, McBurnie MA, Manolio T, et al.: Oral anticoagulation in patients with atrial fibrillation: Adherence with guidelines in an elderly cohort. *Am.J.Med.* 1999;106:165-171.
120. Antani MR, Beyth RJ, Covinsky KE, et al.: Failure to prescribe warfarin to patients with nonrheumatic atrial fibrillation. *J.Gen.Intern.Med.* 1996;11:713-720.
121. Beyth RJ, Antani MR, Covinsky KE, et al.: Why isn't warfarin prescribed to patients with nonrheumatic atrial fibrillation? *J.Gen.Intern.Med.* 1996;11:721-728.
122. McCrory DC, Matchar DB, Samsa G, Sanders LL, Pritchett EL: Physician attitudes about anticoagulation for nonvalvular atrial fibrillation in the elderly. *Arch.Intern.Med.* 1995;155:277-281.

123. Fihn SD, Callahan CM, Martin DC, McDonell MB, Henikoff JG, White RH: The risk for and severity of bleeding complications in elderly patients treated with warfarin. The National Consortium of Anticoagulation Clinics. *Ann.Intern.Med.* 1996;124:970-979.
124. Perry BC: Falls among the elderly: a review of the methods and conclusions of epidemiologic studies. *J.Am.Geriatr.Soc.* 1982;30:367-371.
125. Rubenstein LZ, Robbins AS, Schulman BL, Rosado J, Osterweil D, Josephson KR: Falls and instability in the elderly. *J.Am.Geriatr.Soc.* 1988;36:266-278.
126. Monane M, Avorn J: Medications and falls. Causation, correlation, and prevention. *Clin.Geriatr.Med.* 1996;12:847-858.
127. Thapa PB, Gideon P, Fought RL, Ray WA: Psychotropic drugs and risk of recurrent falls in ambulatory nursing home residents. *Am.J.Epidemiol.* 1995;142:202-211.
128. Thapa PB, Gideon P, Cost TW, Milam AB, Ray WA: Antidepressants and the risk of falls among nursing home residents. *N.Engl.J.Med.* 1998;339:875-882.
129. Dreyer, P. Guidelines for the Use of Restraints in LTCFs. www.state.ma.us/dph/rstraint. [cited: 10-9-1998].
130. Frengley JD, Mion LC, Mahoney JE: Physical restraints in the acute care setting: issues and future direction immobility and falls. *Clin.Geriatr.Med.* 1998;14:727-743.
131. Tinetti ME, Liu WL, Ginter SF: Mechanical restraint use and fall-related injuries among residents of skilled nursing facilities. *Ann.Intern.Med.* 1992;116:369-374.
132. Capezuti E, Evans L, Strumpf N, Maislin G: Physical restraint use and falls in nursing home residents. *J.Am.Geriatr.Soc.* 1996;44:627-633.
133. Evans LK, Strumpf NE: Tying down the elderly. A review of the literature on physical restraint. *J.Am.Geriatr.Soc.* 1989;37:65-74.
134. Hanson LC, Weber DJ, Rutala WA: Risk factors for nosocomial pneumonia in the elderly. *Am.J.Med.* 1992;92:161-166.
135. Medina-Walpole AM, McCormick WC: Provider practice patterns in nursing home-acquired pneumonia. *J.Am.Geriatr.Soc.* 1998;46:187-192.
136. Pick N, McDonald A, Bennett N, et al.: Pulmonary aspiration in a long-term care setting: clinical and laboratory observations and an analysis of risk factors. *J.Am.Geriatr.Soc.* 1996;44:763-768.
137. Farber BF, Brennen C, Puntereri AJ, Brody JP: A prospective study of nosocomial infections in a chronic care facility. *J.Am.Geriatr.Soc.* 1984;32:499-502.
138. Alvarez S, Shell CG, Woolley TW, Berk SL, Smith JK: Nosocomial infections in long-term facilities. *J.Gerontol.* 1988;43:M9-17.
139. Stead WW, Lofgren JP, Warren E, Thomas C: Tuberculosis as an endemic and nosocomial infection among the elderly in nursing homes. *N.Engl.J.Med.* 1985;312:1483-1487.
140. Dorken E, Grzybowski S, Allen EA: Significance of the tuberculin test in the elderly. *Chest* 1987;92:237-240.

141. Allman RM, Goode PS, Patrick MM, Burst N, Bartolucci AA: Pressure ulcer risk factors among hospitalized patients with activity limitation. *JAMA* 1995;273:865-870.
142. Allman RM, Laprade CA, Noel LB, et al.: Pressure sores among hospitalized patients. *Ann.Intern.Med.* 1986;105:337-342.
143. Francis J: Delirium in older patients. *J.Am.Geriatr.Soc.* 1992;40:829-838.
144. Vroman G, Kohen I, Volkman N: Misinterpreting cognitive decline, in Bogner MS (ed): *Human Error in Medicine*. Hillsdale, NJ, Lawrence Erlbaum Associates; 1994:93-122.
145. Murray AM, Levkoff SE, Wetle TT, et al.: Acute delirium and functional decline in the hospitalized elderly patient. *J.Gerontol.* 1993;48:M181-M186
146. Moller JT, Cluitmans P, Rasmussen LS, et al.: Long-term post-operative cognitive dysfunction in the elderly ISPOCD1 study. ISPOCD investigators. International Study of Post-operative Cognitive Dysfunction. *Lancet* 1998;351:857-861.
147. Dodds C, Allison J: Post-operative cognitive deficit in the elderly surgical patient. *Br.J.Anaesth.* 1998;81:449-462.
148. Lynch EP, Lazor MA, Gellis JE, Orav J, Goldman L, Marcantonio ER: The impact of post-operative pain on the development of post-operative delirium. *Anesth.Analg.* 1998;86:781-785.
149. Burns-Cox N, Campbell WB, van Nimmen BA, Vercaeren PM, Lucarotti M: Surgical care and outcome for patients in their nineties. *Br.J.Surg.* 1997;84:496-498.
150. Lubin MF: Is age a risk factor for surgery? *Med.Clin.North Am.* 1993;77:327-333.
151. Linn BS, Linn MW, Wallen N: Evaluation of results of surgical procedures in the elderly. *Ann.Surg.* 1982;195:90-96.
152. Edwards AE, Seymour DG, McCarthy JM, Crumplin MK: A 5-year survival study of general surgical patients aged 65 years and over. *Anaesthesia* 1996;51:3-10.
153. Fowkes FG, Lunn JN, Farrow SC, Robertson IB, Samuel P: Epidemiology in anesthesia. III: Mortality risk in patients with coexisting physical disease. *Br.J.Anaesth.* 1982;54:819-825.
154. Vaz FG, Seymour DG: A prospective study of elderly general surgical patients: I. Pre-operative medical problems. *Age.Ageing* 1989;18:309-315.
155. Kniffin WDJ, Baron JA, Barrett J, Birkmeyer JD, Anderson FAJ: The epidemiology of diagnosed pulmonary embolism and deep venous thrombosis in the elderly. *Arch.Intern.Med.* 1994;154:861-866.
156. Kresevic D, Holder C, Murtaugh CM, Kemper P, Spillman BC, Carlson BL: Interdisciplinary Care: The amount, distribution, and timing of lifetime nursing home use. *Clin.Geriatr.Med.* 1998;14:787-798.
157. Berwick DM: Continuous improvement as an ideal in health care. *N.Engl.J.Med.* 1989;320:53-56.

158. Bates DW, Spell N, Cullen DJ, et al.: The costs of adverse drug events in hospitalized patients. Adverse Drug Events Prevention Study Group. *JAMA* 1997;277:307-311.
159. Anonymous: Sentinel events: approaches to error reduction and prevention. *Jt.Comm.J.Qual.Improv.* 1998;24:175-186.
160. Leape LL, Kabacene A, Bewick D, Rossener J: *Reducing Adverse Drug Events*, Boston, MA, Institute for Healthcare Improvement; 1998.
161. Fisher ES, Welch HG: Avoiding the unintended consequences of growth in medical care. How might more be worse? *JAMA* 1999;281:446-453.
162. Berlowitz DR, Brandeis GH, Moskowitz MA: Using administrative databases to evaluate long-term care. *J.Am.Geriatr.Soc.* 1997;45:618-623.
163. Chen J, Radford MJ, Wang Y, Marciniak TA, Krumholz HM: Do "America's Best Hospitals" perform better for acute myocardial infarction? *N.Engl.J.Med.* 1999;340:286-292.
164. Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ: Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet* 1993;342:1032-1036.
165. Covinsky KE, Palmer RM, Kresevic DM, et al.: Improving functional outcomes in older patients: lessons from an acute care for elders unit. *Jt.Comm.J.Qual.Improv.* 1998;24:63-76.
166. Landefeld CS, Palmer RM, Kresevic DM, Fortinsky RH, Kowal J: A randomized trial of care in a hospital medical unit especially designed to improve the functional outcomes of acutely ill older patients. *N.Engl.J.Med.* 1995;332:1338-1344.
167. Palmer RM, Landefeld CS, Kresevic D, Kowal J: A medical unit for the acute care of the elderly. *J.Am.Geriatr.Soc.* 1994;42:545-552.
168. Palmer RM: Acute Hospital Care, in Cassel CK, Cohen HJ, Larson EB, et al. (eds): *Geriatric Medicine*. New York City, Springer; 1997:119-129.
169. Naylor M, Brooten D, Campbell R, et al.: Comprehensive discharge planning and home follow-up of hospitalized elders. A randomized clinical trial. *JAMA* 1999;281:613-620.
170. Naylor M, Brooten D, Jones R, Lavizzo-Mourey R, Mezey M, Pauly M: Comprehensive discharge planning for the hospitalized elderly. A randomized clinical trial. *Ann.Intern.Med.* 1994;120:999-1006.
171. Stuck AE, Aronow HU, Steiner A, et al.: A trial of annual in-home comprehensive geriatric assessments for elderly people living in the community. *N.Engl.J.Med.* 1995;333:1184-1189.
172. Rubin CD, Sizemore MT, Loftis PA, Adams-Huet B, Anderson RJ: The effect of geriatric evaluation and management on Medicare reimbursement in a large public hospital: a randomized clinical trial. *J.Am.Geriatr.Soc.* 1992;40:989-995.
173. Welch HG, Albertsen PC, Nease RF, Bubolz TA, Wasson JH: Estimating treatment benefits for the elderly: the effect of competing risks. *Ann.Intern.Med.* 1996;124:577-584.

174. Leff B, Burton JR: Acute medical care in the home [editorial]. *J.Am.Geriatr.Soc.* 1996;44:603-605.
175. Hoffman-Terry ML, Fraimow HS, Fox TR, Swift BG, Wolf J.E.: Adverse effects of outpatient parenteral antibiotic therapy. *Am.J.Med.* 1999;106:44-49.
176. Beers MH: Explicit criteria for determining potentially inappropriate medication use by the elderly. *Arch.Intern.Med.* 1997;157:1531-1536.
177. Rochon PA, Gurwitz JH: Optimising drug treatment for elderly people: the prescribing cascade. *BMJ.* 1997;315:1096-1099.
178. McDowell JA, Mion LC, Lydon TJ, Inouye SK: A nonpharmacologic sleep protocol for hospitalized older patients. *J.Am.Geriatr.Soc.* 1998;46:700-705.
179. Skolnick AA: FDA sets geriatric drug use labeling deadlines. *JAMA* 1997;278:1302
180. Pestotnik SL, Classen DC, Evans RS, Burke JP: Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann.Intern.Med.* 1996;124:884-890.
181. Evans RS, Pestotnik SL, Classen DC, et al.: A computer-assisted management program for antibiotics and other anti-infective agents. *N.Engl.J.Med.* 1998;338:232-238.
182. Schiff GD, Rucker TD: Computerized prescribing: building the electronic infrastructure for better medication usage. *JAMA* 1998;279:1024-1029.
183. Monane M, Matthias DM, Nagle BA, Kelly MA: Improving prescribing patterns for the elderly through an online drug utilization review intervention: a system linking the physician, pharmacist, and computer. *JAMA* 1998;280:1249-1252.
184. Tinetti ME, Baker DI, McAvay G, et al.: A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *N.Engl.J.Med.* 1994;331:821-827.
185. Province MA, Hadley EC, Hornbrook MC, et al.: The effects of exercise on falls in elderly patients. A preplanned meta-analysis of the FICSIT Trials. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *JAMA* 1995;273:1341-1347.
186. Close J, Ellis M, Hooper R, Glucksman E, Jackson S, Swift C: Prevention of falls in the elderly trial (PROFET): a randomised controlled trial. *Lancet* 1999;353:93-97.
187. Rizzo JA, Baker DI, McAvay G, Tinetti ME: The cost-effectiveness of a multifactorial targeted prevention program for falls among community elderly persons. *Med.Care* 1996;34:954-969.
188. Dyer CAE, Watkins CL, Gould C, Rowe J: Risk-factor assessment for falls: from a written checklist to the penless clinic. *Age.Ageing* 1998;27:569-572.
189. Robbins AS, Rubenstein LZ, Josephson KR, Schulman BL, Osterweil D, Fine G: Predictors of falls among elderly people. Results of two population-based studies. *Arch.Intern.Med.* 1989;149:1628-1633.
190. Bergstrom NI: Strategies for preventing pressure ulcers. *Clin.Geriatr.Med.* 1997;13:437-454.

191. Moody BL, Fanale JE, Thompson M, Vaillancourt D, Symonds G, Bonasoro C: Impact of staff education on pressure sore development in elderly hospitalized patients. *Arch.Intern.Med.* 1988;148:2241-2243.
192. Fisher BW, Flowerdew G: A simple model for predicting post-operative delirium in older patients undergoing elective orthopedic surgery. *J.Am.Geriatr.Soc.* 1995;43:175-178.
193. Carson JL, Duff A, Berlin JA, et al.: Peri-operative blood transfusion and post-operative mortality. *JAMA* 1998;279:199-205.
194. Hebert PC, Well G, Blajchman MA, et al.: A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. *N.Engl.J.Med.* 1999;340:409-417.
195. Egbert AM, Parks LH, Short LM, Burnett ML: Randomized trial of post-operative patient-controlled analgesia vs. intramuscular narcotics in frail elderly men. *Arch.Intern.Med.* 1990;150:1897-1903.
196. Bianchetti A: Risk factors for the development of pressure sores in hospitalized patients: Results of a prospective study. *Archives of Gerontology and Geriatrics* 1993;16:225
197. Brandeis GH, Berlowitz DR, Hossain M, Morris JN: Pressure ulcers: the Minimum Data Set and the Resident Assessment Protocol. *Adv.Wound.Care* 1995;8:18-25.
198. Schor JD, Levkoff SE, Lipsitz LA, et al.: Risk factors for delirium in hospitalized elderly. *JAMA* 1992;267:827-831.
199. Inouye SK, Charpentier PA: Precipitating factors for delirium in hospitalized elderly persons. Predictive model and interrelationship with baseline vulnerability. *JAMA* 1996;275:852-857.
200. Anonymous: Profile of Older Americans. www.aoa/dhhs.gov/aoa/stats/profil [cited:11-27-1998].
201. Kemper P, Murtaugh CM: Lifetime use of nursing home care. *N.Engl.J.Med.* 1991;324:595-600.
202. Shaughnessy PW, Kramer AM: The increased needs of patients in nursing homes and patients receiving home health care. *N.Engl.J.Med.* 1990;322:21-27.
203. Welch HG, Wennberg DE, Welch WP: The use of Medicare home health care services. *N.Engl.J.Med.* 1996;335:324-329.
204. Boling PA: *The Physician's Role in Home Health Care*, New York City, Springer Publishing Company; 1997.
205. Kannus P, Parkkari J, Koskinen S, et al.: Fall-induced injuries and deaths among older adults. *JAMA* 1999; 281: 1895-1899.
206. Inouye SK, Schlesinger MJ, Lydon, TJ: Delirium: A symptom of how hospital care is failing older persons and a window to improve quality of hospital care. *Am. J. Med* 1999; 106: 565-573.
207. Guttman R, Altman, RD, Karlan MS, et al.: Report of the Council on Scientific Affairs. Use of restraints for patients in nursing homes. *Arch. Fam. Med.* 1999;8:101-105.

208. Bergstrom N, Allman RM, Carlson CE, et al.: Treatment of pressure ulcers in adults: Prediction and prevention. Guideline Report No. 3. AHCPR Publication No. 93-0013, 1992.
209. Bergstrom N, Bennet MA, Carlson CE, et al.: Treatment of pressure ulcers. Clinical Practice Guideline, No. 15. AHCPR Publication No. 95-0652, 1994.
210. Gollub, SB: Is intensive drug therapy appropriate for older patients? [Commentary]. *Lancet* 1999; 353:940-941.
211. Johnson JA, Bootman JL. Drug-related morbidity and mortality: a cost-of-illness model. *Arch Intern. Med.* 1995; 155:1949-1956.
212. Kovner C, Gergen PJ. Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image* 1998; 30:315-321.
213. Sattin, RW. Falls among older persons: A public health perspective. *Annu. Rev. Public Health* 1992; 13; 489-508.

BIBLIOGRAPHY

- Allman RM: The impact of pressure ulcers on health care costs and mortality. *Adv.Wound.Care* 1998;11:2.
- Allman RM: Pressure ulcer prevalence, incidence, risk factors, and impact. *Clin.Geriatr.Med.* 1997;13:421-436.
- Allman RM, Goode PS, Patrick MM, Burst N, Bartolucci AA: Pressure ulcer risk factors among hospitalized patients with activity limitation. *JAMA* 1995;273:865-870.
- Allman RM, Laprade CA, Noel LB, et al.: Pressure sores among hospitalized patients. *Ann.Intern.Med.* 1986;105:337-342.
- Alvarez S, Shell CG, Woolley TW, Berk SL, Smith JK: Nosocomial infections in long-term facilities. *J.Gerontol.* 1988;43:M9-17.
- Anonymous: Profile of Older Americans. www.aoa/dhhs.gov/aoa/stats/profil [cited:11-27-1998].
- Anonymous. Development of MDS-based module for short-stay and clinically intense SNF patients, rehabilitation hospitals and long term care hospitals. www.hcfa.gov/medicare. HCFA. [cited:10-26-1998].
- Anonymous:: Sentinel events: approaches to error reduction and prevention. *Jt.Comm.J.Qual.Improv.* 1998;24:175-186.
- Antani MR, Beyth RJ, Covinsky KE, et al.: Failure to prescribe warfarin to patients with nonrheumatic atrial fibrillation. *J.Gen.Intern.Med.* 1996;11:713-720.
- Aparasu RR, Fliginger SE: Inappropriate medication prescribing for the elderly by office-based physicians. *Ann.Pharmacother.* 1997;31:823-829.
- Barker KN, Mikeal RL, Pearson RE, Illig NA, Morse ML: Medication errors in nursing homes and small hospitals. *Am.J.Hosp.Pharm.* 1982;39:987-991.
- Bates DW, Leape LL, Cullen DJ, et al.: Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA* 1998;280:1311-1316.
- Bates DW, Spell N, Cullen DJ, et al.: The costs of adverse drug events in hospitalized patients. Adverse Drug Events Prevention Study Group. *JAMA* 1997;277:307-311.
- Bates DW, Pruess K, Souney P, Platt R: Serious falls in hospitalized patients: correlates and resource utilization. *Am.J.Med.* 1995;99:137-143.

- Bates DW, Cullen DJ, Laird N, et al.: Incidence of adverse drug events and potential adverse drug events. Implications for prevention. ADE Prevention Study Group. *JAMA* 1995;274:29-34.
- Becker PM, McVey LJ, Saltz CC, Feussner JR, Cohen HJ: Hospital-acquired complications in a randomized controlled clinical trial of a geriatric consultation team. *JAMA* 1987;257:2313-2317.
- Beers MH: Explicit criteria for determining potentially inappropriate medication use by the elderly. *Arch.Intern.Med.* 1997;157:1531-1536.
- Beers MH, Ouslander JG, Fingold SF, et al.: Inappropriate medication prescribing in skilled-nursing facilities. *Ann.Intern.Med.* 1992;117:684-689.
- Beers MH, Ouslander JG, Rollinger I, Reuben DB, Brooks J, Beck JC: Explicit criteria for determining inappropriate medication use in nursing home residents. UCLA Division of Geriatric Medicine. *Arch.Intern.Med.* 1991;151:1825-1832.
- Bergstrom NI: Strategies for preventing pressure ulcers. *Clin.Geriatr.Med.* 1997;13:437-454.
- Bergstrom N, Bennet MA, Carlson CE, et al.: Treatment of pressure ulcers. Clinical Practice Guideline, No. 15. AHCPR Publication No. 95-0652, 1994.
- Bergstrom N, Allman RM, Carlson CE, et al.: Treatment of pressure ulcers in adults: Prediction and prevention. Guideline Report No. 3. AHCPR Publication No. 93-0013, 1992.
- Bergstrom N, Braden B: A prospective study of pressure sore risk among institutionalized elderly. *J.Am.Geriatr.Soc.* 1992;40:747-758.
- Berlowitz DR, Brandeis GH, Moskowitz MA: Using administrative databases to evaluate long-term care. *J.Am.Geriatr.Soc.* 1997;45:618-623.
- Berlowitz DR, Wilking SV: The short-term outcome of pressure sores. *J.Am.Geriatr.Soc.* 1990;38:748-752.
- Berman P, Hogan DB, Fox RA: The atypical presentation of infection in old age. *Age.Ageing* 1987;16:201-207.
- Bero LA, Lipton HL, Bird JA: Characterization of geriatric drug-related hospital readmissions. *Med.Care* 1991;29:989-1003.
- Berwick DM: Continuous improvement as an ideal in health care. *N.Engl.J.Med.* 1989;320:53-56.

- Beyth RJ, Antani MR, Covinsky KE, et al.: Why isn't warfarin prescribed to patients with nonrheumatic atrial fibrillation? *J.Gen.Intern.Med.* 1996;11:721-728.
- Bianchetti A: Risk factors for the development of pressure sores in hospitalized patients: Results of a prospective study. *Archives of Gerontology and Geriatrics* 1993;16:225.
- Boling PA: *The Physician's Role in Home Health Care*, New York City, Springer Publishing Company; 1997.
- Brandeis GH, Berlowitz DR, Hossain M, Morris JN: Pressure ulcers: the Minimum Data Set and the Resident Assessment Protocol. *Adv.Wound.Care* 1995;8:18-25.
- Brandeis GH, Morris JN, Nash DJ, Lipsitz LA: The epidemiology and natural history of pressure ulcers in elderly nursing home residents. *JAMA* 1990;264:2905-2909.
- Brennan TA, Leape LL, Laird NM, et al.: Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *N.Engl.J.Med.* 1991;324:370-376.
- Burns-Cox N, Campbell WB, van Nimmen BA, Vercaeren PM, Lucarotti M: Surgical care and outcome for patients in their nineties. *Br.J.Surg.* 1997;84:496-498.
- Capezuti E, Evans L, Strumpf N, Maislin G: Physical restraint use and falls in nursing home residents. *J.Am.Geriatr.Soc.* 1996;44:627-633.
- Carbonin P, Pahor M, Bernabei R, Sgadari A: Is age an independent risk factor of adverse drug reactions in hospitalized medical patients? *J.Am.Geriatr.Soc.* 1991;39:1093-1099.
- Carrasquillo O, Orav EJ, Brennan TA, Burstin HR: Impact of language barriers on patient satisfaction in an emergency department. *J.Gen.Intern.Med.* 1999;14:82-87.
- Carson JL, Duff A, Berlin JA, et al.: Peri-operative blood transfusion and post-operative mortality. *JAMA* 1998;279:199-205.
- Chen J, Radford MJ, Wang Y, Marciniak TA, Krumholz HM: Do "America's Best Hospitals" perform better for acute myocardial infarction? *N.Engl.J.Med.* 1999;340:286-292.
- Classen DC, Pestotnik SL, Evans RS, Lloyd JF, Burke JP: Adverse drug events in hospitalized patients. Excess length of stay, extra costs, and attributable mortality. *JAMA* 1997;277:301-306.
- Classen DC, Pestotnik SL, Evans RS, Burke JP: Computerized surveillance of adverse drug events in hospital patients. *JAMA* 1991;266:2847-2851.

- Close J, Ellis M, Hooper R, Glucksman E, Jackson S, Swift C: Prevention of falls in the elderly trial (PROFET): a randomised controlled trial. *Lancet* 1999;353:93-97.
- Coast J, Richards SH, Peters TJ, Gunnell DJ, Darlow MA, Pounsford J: Hospital at home or acute hospital care? A cost minimisation analysis. *BMJ*. 1998;316:1802-1806.
- Col N, Fanale JE, Kronholm P: The role of medication noncompliance and adverse drug reactions in hospitalizations of the elderly. *Arch.Intern.Med.* 1990;150:841-845.
- Colt HG, Shapiro AP: Drug-induced illness as a cause for admission to a community hospital. *J.Am.Geriatr.Soc.* 1989;37:323-326.
- Cooper JW: Probable adverse drug reactions in a rural geriatric nursing home population: a four-year study. *J.Am.Geriatr.Soc.* 1996;44:194-197.
- Covinsky KE, Palmer RM, Kresevic DM, et al.: Improving functional outcomes in older patients: lessons from an acute care for elders unit. *Jt.Comm.J.Qual.Improv.* 1998;24:63-76.
- Daley J, Khuri SF, Henderson W, et al.: Risk adjustment of the post-operative morbidity rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J.Am.Coll.Surg.* 1997;185:328-340.
- Danzig LE, Short LJ, Collins K, et al.: Bloodstream infections associated with a needleless intravenous infusion system in patients receiving home infusion therapy. *JAMA* 1995;273:1862-1864.
- Davidman M, Olson P, Kohen J, Leither T, Kjellstrand C: Iatrogenic renal disease. *Arch.Intern.Med.* 1991;151:1809-1812.
- Do AN, Ray BJ, Banerjee SN, et al.: Bloodstream infection associated with needleless device use and the importance of infection-control practices in the home health care setting. *J.Infect.Dis* 1999;179:442-448.
- Dodds C, Allison J: Post-operative cognitive deficit in the elderly surgical patient. *Br.J.Anaesth.* 1998;81:449-462.
- Dorken E, Grzybowski S, Allen EA: Significance of the tuberculin test in the elderly. *Chest* 1987;92:237-240.
- Dreyer, P. Guidelines for the Use of Restraints in LTCFs. www.state.ma.us/dph/rstraint. [cited: 10-9-1998].
- Dyer CAE, Watkins CL, Gould C, Rowe J: Risk-factor assessment for falls: from a written

- checklist to the penless clinic. *Age.Ageing* 1998;27:569-572.
- Edwards AE, Seymour DG, McCarthy JM, Crumplin MK: A 5-year survival study of general surgical patients aged 65 years and over. *Anaesthesia* 1996;51:3-10.
- Egbert AM, Parks LH, Short LM, Burnett ML: Randomized trial of post-operative patient-controlled analgesia vs. intramuscular narcotics in frail elderly men. *Arch.Intern.Med.* 1990;150:1897-1903.
- Elie M, Cole MG, Primeau FJ, Bellavance F: Delirium risk factors in elderly hospitalized patients. *J.Gen.Intern.Med.* 1998;13:204-212.
- Evans JM, Chutka DS, Fleming KC, Tangalos EG, Vittone J, Heathman JH: Medical care of nursing home residents. *Mayo Clin.Proc.* 1995;70:694-702.
- Evans JM, Andrews KL, Chutka DS, Fleming KC, Garness SL: Pressure ulcers: prevention and management. *Mayo Clin.Proc.* 1995;70:789-799.
- Evans LK, Strumpf NE: Tying down the elderly. A review of the literature on physical restraint. *J.Am.Geriatr.Soc.* 1989;37:65-74.
- Evans RS, Pestotnik SL, Classen DC, et al.: A computer-assisted management program for antibiotics and other antiinfective agents. *N.Engl.J.Med.* 1998;338:232-238.
- Farber BF, Brennen C, Puntereri AJ, Brody JP: A prospective study of nosocomial infections in a chronic care facility. *J.Am.Geriatr.Soc.* 1984;32:499-502.
- Fihn SD, Callahan CM, Martin DC, McDonell MB, Henikoff JG, White RH: The risk for and severity of bleeding complications in elderly patients treated with warfarin. The National Consortium of Anticoagulation Clinics. *Ann.Intern.Med.* 1996;124:970-979.
- Fisher BW, Flowerdew G: A simple model for predicting post-operative delirium in older patients undergoing elective orthopedic surgery. *J.Am.Geriatr.Soc.* 1995;43:175-178.
- Fisher ES, Welch HG: Avoiding the unintended consequences of growth in medical care. How might more be worse? *JAMA* 1999;281:446-453.
- Fowkes FG, Lunn JN, Farrow SC, Robertson IB, Samuel P: Epidemiology in anaesthesia. III: Mortality risk in patients with coexisting physical disease. *Br.J.Anaesth.* 1982;54:819-825.
- Francis J: Delirium in older patients. *J.Am.Geriatr.Soc.* 1992;40:829-838.
- Franson TR, Duthie EHJ, Cooper JE, Van Oudenhoven G, Hoffmann RG: Prevalence survey

- of infections and their predisposing factors at a hospital-based nursing home care unit. *J.Am.Geriatr.Soc.* 1986;34:95-100.
- Frengley JD, Mion LC, Mahoney JE: Physical restraints in the acute care setting: issues and future direction immobility and falls. *Clin.Geriatr.Med.* 1998;14:727-743.
- Fried LP, Storer DJ, King DE, Lodder F: Diagnosis of illness presentation in the elderly. *J.Am.Geriatr.Soc.* 1991;39:117-123.
- Gambassi G, Landi F, Peng L, et al.: Validity of diagnostic and drug data in standardized nursing home resident assessments: potential for geriatric pharmacoepidemiology. *Med.Care* 1998;36:167-179.
- Ganz DA, Lamas GA, Goldman L, Gutierrez PR, Mangione CM: Age-related differences in management of heart disease: A study of cardiac medication use in an older cohort. *J.Am.Geriatr.Soc.* 1999;47:145-150.
- Gerety MB, Cornell JE, Plichta DT, Eimer M: Adverse events related to drugs and drug withdrawal in nursing home residents. *J.Am.Geriatr.Soc.* 1993;41:1326-1332.
- Gillick MR, Serrell NA, Gillick LS: Adverse consequences of hospitalization in the elderly. *Soc.Sci.Med.* 1982;16:1033-1038.
- Gollub, SB: Is intensive drug therapy appropriate for older patients? [Commentary]. *Lancet* 1999; 353:940-941.
- Gorbien MJ, Bishop J, Beers MH, Norman D, Osterweil D, Rubenstein LZ: Iatrogenic illness in hospitalized elderly people. *J.Am.Geriatr.Soc.* 1992;40:1031-1042.
- Graves T, Hanlon JT, Schmader KE, et al.: Adverse events after discontinuing medications in elderly outpatients. *Arch.Intern.Med.* 1997;157:2205-2210.
- Gray SL, Sager M, Lestico MR, Jalaluddin M: Adverse drug events in hospitalized elderly. *J.Gerontol.A.Biol.Sci.Med.Sci.* 1998;53:M59-M63.
- Gross PA, Rapuano C, Adrignolo A, Shaw B: Nosocomial infections: decade-specific risk. *Infect.Control.* 1983;4:145-147.
- Guralnik JM, Harris TB, White LR, Cornoni-Huntley JC: Occurrence and predictors of pressure sores in the National Health and Nutrition Examination survey follow-up. *J.Am.Geriatr.Soc.* 1988;36:807-812.
- Gurwitz JH, Sanchez-Cross MT, Eckler MA, Matulis J: The epidemiology of adverse and unexpected events in the long-term care setting. *J.Am.Geriatr.Soc.* 1994;42:33-38.
- Gurwitz JH, Avorn J: The ambiguous relation between aging and adverse drug reactions.

- Ann.Intern.Med.* 1991;114:956-966.
- Gurwitz JH, Soumerai SB, Avorn J: Improving medication prescribing and utilization in the nursing home. *J.Am.Geriatr.Soc.* 1990;38:542-552.
- Gustafson Y, Brannstrom B, Berggren D, et al.: A geriatric-anesthesiologic program to reduce acute confusional states in elderly patients treated for femoral neck fractures. *J.Am.Geriatr.Soc.* 1991;39:655-662.
- Guttman R, Altman, RD, Karlan MS, et al.: Report of the Council on Scientific Affairs. Use of restraints for patients in nursing homes. *Arch. Fam. Med.* 1999;8:101-105.
- Hanlon JT, Schmader KE, Koronkowski MJ, et al.: Adverse drug events in high risk older outpatients. *J.Am.Geriatr.Soc.* 1997;45:945-948.
- Hanson LC, Weber DJ, Rutala WA: Risk factors for nosocomial pneumonia in the elderly. *Am.J.Med.* 1992;92:161-166.
- Hebert PC, Well G, Blajchman MA, et al.: A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. *N.Engl.J.Med.* 1999;340:409-417.
- Hoffman-Terry ML, Fraimow HS, Fox TR, Swift BG, Wolf J.E.: Adverse effects of outpatient parenteral antibiotic therapy. *Am.J.Med.* 1999;106:44-49.
- Hsia DE, Rubenstein LZ, Choy GS: The benefits of in-home pharmacy evaluation for older persons. *J.Am.Geriatr.Soc.* 1997;45:211-214.
- Hurwitz N: Predisposing factors in adverse reactions to drugs. *Br.Med.J.* 1969;1:536-539.
- Hussain M, Oppenheim BA, O'Neill P, Trembath C, Morris J, Horan MA: Prospective survey of the incidence, risk factors and outcome of hospital-acquired infections in the elderly. *J.Hosp.Infect.* 1996;32:117-126.
- Hutchinson TA, Flegel KM, Kramer MS, Leduc DG, Kong HH: Frequency, severity and risk factors for adverse drug reactions in adult out-patients: a prospective study. *J.Chronic.Dis.* 1986;39:533-542.
- Inouye SK, Bogardus ST, Charpentier PA, et al.: A multicomponent intervention to prevent delirium in hospitalized older patients. *N.Engl.J.Med.* 1999;340:669-676.
- Inouye SK, Schlesinger MJ, Lydon, TJ: Delirium: A symptom of how hospital care is failing older persons and a window to improve quality of hospital care. *Am. J. Med* 1999; 106: 565-573.
- Inouye SK: Delirium in hospitalized older patients. *Clin.Geriatr.Med.* 1998;14:745-764.

- Inouye SK, Rushing JT, Foreman MD, Palmer RM, Pompei P: Does delirium contribute to poor hospital outcomes? A three-site epidemiologic study. *J.Gen.Intern.Med.* 1998;13:234-242.
- Inouye SK, Charpentier PA: Precipitating factors for delirium in hospitalized elderly persons. Predictive model and interrelationship with baseline vulnerability. *JAMA* 1996;275:852-857.
- Inouye SK: The dilemma of delirium: clinical and research controversies regarding diagnosis and evaluation of delirium in hospitalized elderly medical patients. *Am.J.Med.* 1994;97:278-288.
- Inouye SK, Viscoli CM, Horwitz RI, Hurst LD, Tinetti ME: A predictive model for delirium in hospitalized elderly medical patients based on admission characteristics. *Ann.Intern.Med.* 1993;119:474-481.
- Jahnigen D, Hannon C, Laxson L, LaForce FM: Iatrogenic disease in hospitalized elderly veterans. *J.Am.Geriatr.Soc.* 1982;30:387-390.
- Jha AK, Kuperman GJ, Teich JM, et al.: Identifying adverse drug events: development of a computer-based monitor and comparison with chart review and stimulated voluntary report. *J.Am.Med.Assoc.* 1998;5:305-314.
- Johnson JA, Bootman JL. Drug-related morbidity and mortality: a cost-of-illness model. *Arch Intern. Med.* 1995; 155:1949-1956.
- Kannus P, Parkkari J, Koskinen S, et al.: Fall-induced injuries and deaths among older adults. *JAMA* 1999; 281: 1895-1899.
- Keating HJ: Major surgery in nursing home patients: procedures, morbidity, and mortality in the frailest of the frail elderly. *J.Am.Geriatr.Soc.* 1992;40:8-11.
- Keller SM, Markovitz LJ, Wilder JR, Aufses AHJ: Emergency and elective surgery in patients over age 70. *Am.Surg.* 1987;53:636-640.
- Kemper P, Murtaugh CM: Lifetime use of nursing home care *N.Engl.J.Med.* 1991;324:595-600.
- Khuri SF, Daley J, Henderson W, et al.: Risk adjustment of the post-operative mortality rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J.Am.Coll.Surg.* 1997;185:315-327.
- Khuri SF, Daley J, Henderson W, et al.: The National Veterans Administration Surgical Risk Study: risk adjustment for the comparative assessment of the quality of surgical care.

- J.Am.Coll.Surg.* 1995;180:519-531.
- King MB, Tinetti ME: Falls in community-dwelling older persons. *J.Am.Geriatr.Soc.* 1995;43:1146-1154.
- Klein LE, German PS, Levine DM, Feroli ERJ, Ardery J: Medication problems among outpatients. A study with emphasis on the elderly. *Arch.Intern.Med.* 1984;144:1185-1188.
- Kniffin WDJ, Baron JA, Barrett J, Birkmeyer JD, Anderson FAJ: The epidemiology of diagnosed pulmonary embolism and deep venous thrombosis in the elderly. *Arch.Intern.Med.* 1994;154:861-866.
- Kovner C, Gergen PJ. Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image* 1998; 30:315-321.
- Kreševic D, Holder C, Murtaugh CM, Kemper P, Spillman BC, Carlson BL: Interdisciplinary Care: The amount, distribution, and timing of lifetime nursing home use. *Clin.Geriatr.Med.* 1998;14:787-798.
- Lamy PP: The elderly and drug interactions. *J.Am.Geriatr.Soc.* 1986;34:586-592.
- Landefeld CS, Palmer RM, Kreševic DM, Fortinsky RH, Kowal J: A randomized trial of care in a hospital medical unit especially designed to improve the functional outcomes of acutely ill older patients. *N.Engl.J.Med.* 1995;332:1338-1344.
- Leape LL, Kabacene A, Bewick D, Rossener J: *Reducing Adverse Drug Events*, Boston, MA, Institute for Healthcare Improvement; 1998.
- Leape LL, Woods DD, Hatlie MJ, Kizer KW, Schroeder SA, Lundberg GD: Promoting patient safety by preventing medical error [editorial]. *JAMA* 1998;280:1444-1447.
- Leape LL, Bates DW, Cullen DJ, et al.: Systems analysis of adverse drug events. ADE Prevention Study Group. *JAMA* 1995;274:35-43.
- Leape LL: Error in medicine. *JAMA* 1994;272:1851-1857.
- Leape LL, Brennan TA, Laird N, et al.: The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *N.Engl.J.Med.* 1991;324:377-384.
- Lefevre F, Feinglass J, Potts S, et al.: Iatrogenic complications in high-risk, elderly patients. *Arch.Intern.Med.* 1992;152:2074-2080.
- Leff B, Burton JR: Acute medical care in the home [editorial]. *J.Am.Geriatr.Soc.* 1996;44:603-605.

- Linn BS, Linn MW, Wallen N: Evaluation of results of surgical procedures in the elderly. *Ann.Surg.* 1982;195:90-96.
- Lubin MF: Is age a risk factor for surgery? *Med.Clin.North Am.* 1993;77:327-333.
- Lynch EP, Lazor MA, Gellis JE, Orav J, Goldman L, Marcantonio ER: The impact of post-operative pain on the development of post-operative delirium. *Anesth.Analg.* 1998;86:781-785.
- Magaziner J, Tenney JH, DeForge B, Hebel JR, Muncie HLJ, Warren JW: Prevalence and characteristics of nursing home-acquired infections in the aged. *J.Am.Geriatr.Soc.* 1991;39:1071-1078.
- Mahoney JE, Tinetti ME: Immobility and Falls: factors associated with serious injury during falls by ambulatory nursing home residents. *Clin.Geriatr.Med.* 1998;14:699-726.
- Marcantonio ER, Goldman L, Orav EJ, Cook EF, Lee TH: The association of intraoperative factors with the development of post-operative delirium. *Am.J.Med.* 1998;105:380-384.
- Marcantonio ER, Goldman L, Mangione CM, et al.: A clinical prediction rule for delirium after elective noncardiac surgery. *JAMA* 1994;271:134-139.
- McCrary DC, Matchar DB, Samsa G, Sanders LL, Pritchett EL: Physician attitudes about anticoagulation for nonvalvular atrial fibrillation in the elderly. *Arch.Intern.Med.* 1995;155:277-281.
- McDowell JA, Mion LC, Lydon TJ, Inouye SK: A nonpharmacologic sleep protocol for hospitalized older patients. *J.Am.Geriatr.Soc.* 1998;46:700-705.
- Medina-Walpole AM, McCormick WC: Provider practice patterns in nursing home-acquired pneumonia. *J.Am.Geriatr.Soc.* 1998;46:187-192.
- Meehan M: National pressure ulcer prevalence survey. *Adv.Wound.Care* 1994;7:27-28.
- Michocki RJ, Lamy PP: A "risk" approach to adverse drug reactions. *J.Am.Geriatr.Soc.* 1988;36:79-81.
- Miller MB, Elliott DF: Errors and omissions in diagnostic records on admission of patients to a nursing home. *J.Am.Geriatr.Soc.* 1976;24:108-116.
- Moller JT, Cluitmans P, Rasmussen LS, et al.: Long-term post-operative cognitive dysfunction in the elderly ISPOCD1 study. ISPOCD investigators. International Study of Post-operative Cognitive Dysfunction. *Lancet* 1998;351:857-861.

- Monane M, Matthias DM, Nagle BA, Kelly MA: Improving prescribing patterns for the elderly through an online drug utilization review intervention: a system linking the physician, pharmacist, and computer. *JAMA* 1998;280:1249-1252.
- Monane M, Avorn J: Medications and falls. Causation, correlation, and prevention. *Clin.Geriatr.Med.* 1996;12:847-858.
- Montalto M: How safe is hospital-in-the-home care? *Med.J.Aust.* 1998;168:277-280.
- Moody BL, Fanale JE, Thompson M, Vaillancourt D, Symonds G, Bonasoro C: Impact of staff education on pressure sore development in elderly hospitalized patients. *Arch.Intern.Med.* 1988;148:2241-2243.
- Morgan VR, Mathison JH, Rice JC, Clemmer DI: Hospital falls: a persistent problem. *Am.J.Public Health* 1985;75:775-777.
- Morrison RS, Chassin MR, Siu AL: The medical consultant's role in caring for patients with hip fracture. *Ann.Intern.Med.* 1998;128:1010-1020.
- Muder RR: Pneumonia in residents of long-term care facilities: epidemiology, etiology, management, and prevention. *Am.J.Med.* 1998;105:319-330.
- Muder RR, Brennen C, Swenson DL, Wagener M: Pneumonia in a long-term care facility. A prospective study of outcome. *Arch.Intern.Med.* 1996;156:2365-2370.
- Murray AM, Levkoff SE, Wetle TT, et al.: Acute delirium and functional decline in the hospitalized elderly patient. *J.Gerontol.* 1993;48:M181-M186.
- Murtaugh CM, Kemper P, Spillman BC, Carlson BL: The amount, distribution, and timing of lifetime nursing home use. *Med.Care* 1997;35:204-218.
- Myers AH, Baker SP, Van Natta ML, Abbey H, Robinson EG: Risk factors associated with falls and injuries among elderly institutionalized persons. *Am.J.Epidemiol.* 1991;133:1179-1190.
- Naylor M, Brooten D, Campbell R, et al.: Comprehensive discharge planning and home follow-up of hospitalized elders. A randomized clinical trial. *JAMA* 1999;281:613-620.
- Naylor M, Brooten D, Jones R, Lavizzo-Mourey R, Mezey M, Pauly M: Comprehensive discharge planning for the hospitalized elderly. A randomized clinical trial. *Ann.Intern.Med.* 1994;120:999-1006.
- Norman DC, Castle SC, Cantrell M: Infections in the nursing home. *J.Am.Geriatr.Soc.*

- 1987;35:796-805.
- O'Loughlin JL, Robitaille Y, Boivin JF, Suissa S: Incidence of and risk factors for falls and injurious falls among the community-dwelling elderly. *Am.J.Epidemiol.* 1993;137:342-354.
- Omori DM, Potyk RP, Kroenke K: The adverse effects of hospitalization on drug regimens. *Arch.Intern.Med.* 1991;151:1562-1564.
- Ouslander JG: Medical care in the nursing home. *JAMA* 1989;262:2582-2590.
- Palmer RM: Acute Hospital Care, in Cassel CK, Cohen HJ, Larson EB, et al. (eds): *Geriatric Medicine*. New York City, Springer; 1997:119-129.
- Palmer RM, Landefeld CS, Kresevic D, Kowal J: A medical unit for the acute care of the elderly. *J.Am.Geriatr.Soc.* 1994;42:545-552.
- Parikh SS, Chung F: Post-operative delirium in the elderly. *Anesth.Analg.* 1995;80:1223-1232.
- Perry BC: Falls among the elderly: a review of the methods and conclusions of epidemiologic studies. *J.Am.Geriatr.Soc.* 1982;30:367-371.
- Pestotnik SL, Classen DC, Evans RS, Burke JP: Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann.Intern.Med.* 1996;124:884-890.
- Pick N, McDonald A, Bennett N, et al.: Pulmonary aspiration in a long-term care setting: clinical and laboratory observations and an analysis of risk factors. *J.Am.Geriatr.Soc.* 1996;44:763-768.
- Pompei P, Foreman M, Rudberg MA, Inouye SK, Braund V, Cassel CK: Delirium in hospitalized older persons: outcomes and predictors. *J.Am.Geriatr.Soc.* 1994;42:809-815.
- Potts S, Feinglass J, Lefevre F, Kadah H, Branson C, Webster J: A quality-of-care analysis of cascade iatrogenesis in frail elderly hospital patients. *QRB.Qual.Rev.Bull.* 1993;19:199-205.
- Province MA, Hadley EC, Hornbrook MC, et al.: The effects of exercise on falls in elderly patients. A preplanned meta-analysis of the FICSIT Trials. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *JAMA* 1995;273:1341-1347.
- Radecki SE, Kane RL, Solomon DH, Mendenhall RC, Beck JC: Are physicians sensitive to the special problems of older patients? *J.Am.Geriatr.Soc.* 1988;36:719-725.

- Ray WA, Taylor JA, Meador KG, et al.: A randomized trial of a consultation service to reduce falls in nursing homes. *JAMA* 1997;278:557-562.
- Reichel W: Complications in the care of five hundred elderly hospitalized patients. *J.Am.Geriatr.Soc.* 1965;13:973-981.
- Resnick NM, Marcantonio ER: How should clinical care of the aged differ? *Lancet* 1997;350:1157-1158.
- Rich MW, Shah AS, Vinson JM, Freedland KE, Kuru T, Sperry JC: Iatrogenic congestive heart failure in older adults: clinical course and prognosis. *J.Am.Geriatr.Soc.* 1996;44:638-643.
- Richards SH, Coast J, Gunnell DJ, Peters TJ, Pounsford J, Darlow MA: Randomised controlled trial comparing effectiveness and acceptability of an early discharge, hospital at home scheme with acute hospital care. *BMJ.* 1998;316:1796-1801.
- Riedinger JL, Robbins LJ, Bergstrom NI: Prevention of iatrogenic illness: adverse drug reactions and nosocomial infections in hospitalized older adults, strategies for preventing pressure ulcers. *Clin.Geriatr.Med.* 1998;14:681-698.
- Rizzo JA, Friedkin R, Williams CS, Nabors J, Acampora D, Tinetti ME: Health care utilization and costs in a Medicare population by fall status. *Med.Care* 1998;36:1174-1188.
- Rizzo JA, Baker DI, McAvay G, Tinetti ME: The cost-effectiveness of a multifactorial targeted prevention program for falls among community elderly persons. *Med.Care* 1996;34:954-969.
- Robbins AS, Rubenstein LZ, Josephson KR, Schulman BL, Osterweil D, Fine G: Predictors of falls among elderly people. Results of two population-based studies. *Arch.Intern.Med.* 1989;149:1628-1633.
- Roberts MS, King M, Stokes JA, et al.: Medication prescribing and administration in nursing homes. *Age.Ageing* 1998;27:385-392.
- Rochon PA, Gurwitz JH: Optimising drug treatment for elderly people: the prescribing cascade. *BMJ.* 1997;315:1096-1099.
- Rothkopf MM, Rothkopf GS: *Standards and Practice of Homecare Therapeutics*, Baltimore, MD, Williams & Wilkins; 1997:10.
- Rubenstein LZ, Robbins AS, Schulman BL, Rosado J, Osterweil D, Josephson KR: Falls and instability in the elderly. *J.Am.Geriatr.Soc.* 1988;36:266-278.

- Rubin CD, Sizemore MT, Loftis PA, Adams-Huet B, Anderson RJ: The effect of geriatric evaluation and management on Medicare reimbursement in a large public hospital: a randomized clinical trial. *J.Am.Geriatr.Soc.* 1992;40:989-995.
- Sager MA, Rudberg MA, Jalaluddin M, et al.: Hospital admission risk profile (HARP): identifying older patients at risk for functional decline following acute medical illness and hospitalization. *J.Am.Geriatr.Soc.* 1996;44:251-257.
- Sattin, RW. Falls among older persons: A public health perspective. *Annu. Rev. Public Health* 1992; 13; 489-508.
- Saviteer SM, Samsa GP, Rutala WA: Nosocomial infections in the elderly. Increased risk per hospital day. *Am.J.Med.* 1988;84:661-666.
- Schiff GD, Rucker TD: Computerized prescribing: building the electronic infrastructure for better medication usage. *JAMA* 1998;279:1024-1029.
- Schneider JK, Mion LC, Frengley JD: Adverse drug reactions in an elderly outpatient population. *Am.J.Hosp.Pharm.* 1992;49:90-96.
- Schor JD, Levkoff SE, Lipsitz LA, et al.: Risk factors for delirium in hospitalized elderly. *JAMA* 1992;267:827-831.
- Shaughnessy PW, Kramer AM: The increased needs of patients in nursing homes and patients receiving home health care. *N.Engl.J.Med.* 1990;322:21-27.
- Shepperd S, Harwood D, Gray A, Vessey M, Morgan P: Randomised controlled trial comparing hospital at home care with inpatient hospital care. II: cost minimization analysis. *BMJ.* 1998;316:1791-1796.
- Skolnick AA: FDA sets geriatric drug use labeling deadlines. *JAMA* 1997;278:1302.
- Stead WW, Lofgren JP, Warren E, Thomas C: Tuberculosis as an endemic and nosocomial infection among the elderly in nursing homes. *N.Engl.J.Med.* 1985;312:1483-1487.
- Steel K, Gertman PM, Crescenzi C, Anderson J: Iatrogenic illness on a general medical service at a university hospital. *N.Engl.J.Med.* 1981;304:638-642.
- Stewart RB, Hale WE: Acute confusional states in older adults and the role of polypharmacy. *Annu.Rev.Public Health* 1992;13:415-430.
- Stuck AE, Aronow HU, Steiner A, et al.: A trial of annual in-home comprehensive geriatric assessments for elderly people living in the community. *N.Engl.J.Med.* 1995;333:1184-1189.

- Stuck AE, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, Beck JC: Inappropriate medication use in community-residing older persons. *Arch.Intern.Med.* 1994;154:2195-2200.
- Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ: Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet* 1993;342:1032-1036.
- Svarstad BL, Mount JK: Nursing home resources and tranquilizer use among the institutionalized elderly. *J.Am.Geriatr.Soc.* 1991;39:869-875.
- Thapa PB, Gideon P, Cost TW, Milam AB, Ray WA: Antidepressants and the risk of falls among nursing home residents. *N.Engl.J.Med.* 1998;339:875-882.
- Thapa PB, Brockman KG, Gideon P, Fought RL, Ray WA: Injurious falls in nonambulatory nursing home residents: a comparative study of circumstances, incidence, and risk factors. *J.Am.Geriatr.Soc.* 1996;44:273-278.
- Thapa PB, Gideon P, Fought RL, Ray WA: Psychotropic drugs and risk of recurrent falls in ambulatory nursing home residents. *Am.J.Epidemiol.* 1995;142:202-211.
- Thomas DR, Goode PS, Tarquine PH, Allman RM: Hospital-acquired pressure ulcers and risk of death. *J.Am.Geriatr.Soc.* 1996;44:1435-1440.
- Tinetti ME, Doucette JT, Claus EB: The contribution of predisposing and situational risk factors to serious fall injuries. *J.Am.Geriatr.Soc.* 1995;43:1207-1213.
- Tinetti ME, Baker DI, McAvay G, et al.: A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *N.Engl.J.Med.* 1994;331:821-827.
- Tinetti ME, Liu WL, Ginter SF: Mechanical restraint use and fall-related injuries among residents of skilled nursing facilities. *Ann.Intern.Med.* 1992;116:369-374.
- Tinetti ME, Speechley M, Ginter SF: Risk factors for falls among elderly persons living in the community. *N.Engl.J.Med.* 1988;319:1701-1707.
- Vaz FG, Seymour DG: A prospective study of elderly general surgical patients: I. Pre-operative medical problems. *Age.Ageing* 1989;18:309-315.
- Vroman G, Kohen I, Volkman N: Misinterpreting cognitive decline, in Bogner MS (ed): *Human Error in Medicine*. Hillsdale, NJ, Lawrence Erlbaum Associates; 1994:
- Welch HG, Albertsen PC, Nease RF, Bubolz TA, Wasson JH: Estimating treatment benefits for the elderly: the effect of competing risks. *Ann.Intern.Med.* 1996;124:577-584.

- Welch HG, Wennberg DE, Welch WP: The use of Medicare home health care services. *N.Engl.J.Med.* 1996;335:324-329.
- White RH, McBurnie MA, Manolio T, et al.: Oral anticoagulation in patients with atrial fibrillation: Adherence with guidelines in an elderly cohort. *Am.J.Med.* 1999;106:165-171.
- Willcox SM, Himmelstein DU, Woolhandler S: Inappropriate drug prescribing for the community-dwelling elderly. *JAMA* 1994;272:292-296.
- Williams MV, Parker RM, Baker DW, et al.: Inadequate functional health literacy among patients at two public hospitals. *JAMA* 1995;274:1677-1682.
- Williams-Russo P, Urquhart BL, Sharrock NE, Charlson ME: Post-operative delirium: predictors and prognosis in elderly orthopedic patients. *J.Am.Geriatr.Soc.* 1992;40:759-767.
- Williamson J, Chopin JM: Adverse reactions to prescribed drugs in the elderly: a multicentre investigation. *Age.Ageing* 1980;9:73-80.