

Preventable Medical Injuries in Older Patients

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Injuries associated with hospitalization are more common in older (≥ 65 years) than in younger patients (< 65 years), and they may be more severe and more often preventable. The increasing age of the population magnifies the importance of this problem. In this review, we first consider medical injuries in general and then review the literature for 6 categories: adverse drug events, falls, nosocomial infections, pressure sores, delirium, and surgical and perioperative complications. For each of these categories, older patients appear to be at higher risk, ranging from a 2.2-fold increase for perioperative complications to a 10-fold increase for falling, based on Harvard Medical Practice Study rates. The main cause of these increased risks appears to be the diminished physiological reserve of elderly patients; however, age alone is a less important predictor of adverse events than comorbidities and functional status. Furthermore, many of these complications appear to be preventable, although the proportion preventable varies by type of complication. While some prevention strategies are specifically beneficial in older patients, many apply to all age groups. Geriatric care units and consultation systems have improved outcomes in some instances, although the data are mixed. The success of intervention varies by type of complications. For medications, various interventions have been successful, and fall prevention programs have been demonstrated to be effective in the nursing home and home.

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As the data about the frequency and consequences of iatrogenic injury have accumulated,¹ concern about injury in older patients (≥ 65 years) has increased. Older patients are at special risk, have special problems, and may require special measures to achieve acceptable levels of safety in health care. Demographic trends indicate that age-related health issues will be of increasing importance in all health care settings.

The population of Americans older than 65 years reached 34 million in 1997 and is expected to double by 2030.² In 1995, more than 40% of hospital admissions were in this age group. Because of their longer average length of stay (mean, 7.1 vs 5.4 days), hospital occupancy attributed to older patients is even greater:

49%.³ Nearly 2 million Americans live in nursing homes, and the figure is expected to reach 5 million by 2030.⁴ In recent years, the average nursing home resident has become older, sicker, and more functionally dependent.⁵ Shortage of nursing home beds, and increasing utilization constraints for hospitalized patients, has forced many patients who previously would have been institutionalized to receive care in the community.

Outpatient use of medical services also increases with age. Reasons for these trends include advances in medical technology, increased public awareness and preferences, growing populations of chronically ill survivors, concerns of the increased risks of hospitalization, and the increasing costs of hospital care.⁶ In 1995, persons older than 65 years averaged 11 physician contacts annually compared with 5 for younger patients. In 1993, 3 million Medicare recipients received 160 million home health care visits.⁷ In addition, the

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Table 1. Harvard Medical Practice Study: Injuries in Older Patients*

Variable	Age, y			Relative Risk (95% CI)†	Patients Aged ≥65 y		
	All	<65	≥65		65-74	75-84	≥85
Study population‡	100 (31 429)	83.3 (26 184)	16.7 (5245)	...	10.4 (3283)	4.5 (1421)	1.7 (541)
Diagnostic mishaps	3.0 (97)	2.7 (72)	4.8 (25)	1.73 (1.10-2.73)	3.7 (12)	6.3 (9)	7.4 (4)
Therapeutic mishaps	2.3 (73)	1.5 (40)	6.3 (33)	4.12 (2.60-6.52)	4.9 (16)	5.6 (8)	16.6 (9)
Drug complications	6.3 (199)	5.2 (135)	12.2 (64)	2.37 (1.76-3.18)	12.8 (42)	12.0 (17)	9.2 (5)
Falls	0.7 (21)	0.3 (7)	2.7 (14)	9.98 (4.03-24.72)	1.2 (4)	4.2 (6)	7.4 (4)
Operative complications	16.4 (515)	13.6 (355)	30.5 (160)	2.25 (1.87-2.70)	27.7 (91)	30.3 (43)	48.1 (26)

*Data are given as rate per 1000 (number of patients) unless otherwise indicated. CI indicates confidence interval; ellipses, data not applicable.

†The relative risk is the ratio of the incidence of injuries in those aged 65 years and older to those younger than 65 years.

‡Data are given as the percentage of the total (number of patients).

Table 2. Center for Health Systems Research and Analysis Multiple Data Set 2.0: Mean Prevalence Rates for Selected Quality Indicators

Quality Indicators	Year*				National Projected Estimates†
	1992	1993	1994	1995	
Any injury	0.14	0.16	0.17	0.16	320 000
Falls	0.15	0.16	0.15	0.14	280 000
Use of ≥9 medications	0.16	0.17	0.20	0.22	440 000
Indwelling catheters	0.07	0.07	0.07	0.08	160 000
Urinary tract infections	0.08	0.09	0.08	0.08	160 000
Antipsychotic agent use	0.13	0.13	0.12	0.11	220 000
Long-acting benzodiazepines	0.03	0.03	0.03	0.03	60 000
Daily physical restraints	0.18	0.17	0.15	0.13	260 000
Stage 1-4 pressure sore	0.10	0.12	0.06	0.11	220 000
No. of facilities reporting	785	793	802	464	...
Sample size (residents)	48 049	50 151	72 081	36 715	...

*Data are given as the percentage of residents who have the quality indicator on the most recent assessment unless otherwise indicated.

†Based on 1995 results representing a point in time from 4 states (not necessarily representative of the national nursing home population, estimated at 2 million residents and extrapolated to all [approximately 18 000] nursing homes).

use of high-technology care in the home is growing exponentially.⁸

THE EXTENT AND NATURE OF MEDICAL INJURY IN OLDER PATIENTS

Unintentional medical injuries are a serious public health problem. Data from hospital and nursing home studies⁹⁻¹¹ suggest that elderly patients are at particular risk. Less evidence is available concerning the extent and nature of medical injuries in the outpatient and home health settings, although it seems likely that older patients are at increased risk in these settings as well. Most studies targeting medical injuries in the older patients are recent, but several are from the early 1980s and may not reflect current conditions.

The Harvard Medical Practice Study¹² defined an *adverse event* as an unintended injury caused by

medical management that resulted in measurable disability. Such events occurred in nearly 4% of hospitalized patients. More than two thirds of these iatrogenic injuries were due to errors and were, therefore, potentially preventable.¹³ Adverse events were more common in patients aged 65 years and older, even after adjusting for comorbidities (**Table 1**).

Other studies suggest that the Harvard Medical Practice Study may have underestimated the frequency of iatrogenic injury. For example, in one of the earliest prospective studies of older patients, a 1962 prospective study¹⁴ of 500 consecutive admissions of elderly indigent patients admitted to a single medical service, it was found that 29% had complications as a result of hospitalization. In another hospital study,¹⁵ the complication rate for the younger group (mean age, 50.3 years) was

29% compared with 45% for the older group (mean age, 73.1 years).

Among nursing home patients, Gurwitz et al¹⁶ found 3890 reported events in a 1-year study in a 700-bed long-term care facility. The most common events were falls (n=2032), non-fall-related injuries (n=1631), and adverse drug events (ADEs) (n=180). Long-term care facilities have been required by the Omnibus Budget Reconciliation Act of 1987 to record more than 300 diagnostic, demographic, clinical, and treatment variables using the Minimum Data Set and the Resident Assessment Protocols.¹⁷ These quality indicators are organized into care domains, such as accidents, nutrition, skin care, infection control, and others.¹⁸⁻²⁰

Recently, the Center for Health Systems Research and Analysis at the University of Wisconsin-Madison has developed a modified Minimum Data Set (version 2.0) that it has used to record the care of nursing home residents from several regions.²¹ Data from this database for 4 midwestern states are shown in **Table 2** for selected events from 1992 to 1995; extrapolated nationwide estimates are also given. With the exception of restraint use (38% decline), there were few patterns of improvement during the 4-year study cycle.

SPECIFIC PROBLEMS

Adverse Drug Events

Adverse drug events are the most common type of adverse event in hospitalized patients, including patients aged 65 years or older.²² An ADE has been defined as an injury

Table 3. Falls, Pressure Sores, and Inpatient Delirium*

Source, y	No. of Patients Enrolled	Mean Age, y	Incidence, %	Location	Comments
Falls					
Tinnetti et al, ⁵⁴ 1988	336	78.3	32.0	Community	7.7% of the falls resulted in injuries
O'Loughlin et al, ⁴² 1993	409	74.8	29.1	Community	17.9% of the falls resulted in injuries
Thapa et al, ⁴⁸ 1996	1228	65-84: 49% ≥85: 41%	44.6	Nursing home	9.0% of the falls resulted in injuries
Morgan et al, ⁵² 1985	12 218	NA	1.9†	Hospital	0.025% of the falls resulted in injuries
Pressure Sores					
Allman et al, ¹⁰¹ 1995	286	73.7	12.9	Hospital	All had impaired mobility
Bianchetti et al, ⁴³ 1993	92	NA	22.8	Hospital	Increased risk factors
Moody et al, ¹⁴⁸ 1988	228	76.8	14.8	Hospital	After education, decreased incidence to 5.4%
Brandeis et al, ⁷¹ 1990	14 345	79.6	13.2	Nursing home	52 nursing homes
Brandeis et al, ⁴⁴ 1995	2011	84.3	6.2‡	Nursing home	270 nursing homes (Minimum Data Set resource)
Inpatient Delirium					
Schor et al, ⁴⁵ 1992	291	80.5	31.3	Medical-surgical service	...
Inouye et al, ⁸² 1993	281	78.7	19.9	Medical service	...
Marcantonio et al, ¹⁵⁰ 1994	1341	67.0	9.0	Noncardiac surgical service	...
Pompei et al, ⁷⁷ 1994	755	76.5	19.7	Medical-surgical service	...
Inouye and Charpentier, ⁴⁶ 1996	508	78.5	16.1	Medical service	...
Inouye et al, ⁷³ 1999	426	79.8	15.0	Medical service	...

*NA indicates data not available; ellipses, data not applicable.

†Value given for those aged 65 years or older. The fall frequency was determined by risk management reporting.

‡Self-reporting by institution.

resulting from the medical use of a drug.²³ Adverse drug events include preventable ADEs (those due to errors) and nonpreventable ADEs, also called adverse drug reactions.^{16,24-28} In one large study²⁹ of older patients admitted to 41 clinical centers, 5.8% were identified as having an ADE during their hospital course. However, Gray et al³⁰ found a 14.8% incidence of ADEs among hospitalized older patients (mean age, 78.2 years), considerably greater than the ADE rates of 2.0% to 6.5% in larger studies^{31,32} that were not restricted to elderly patients.

In addition to these ADEs that occur during hospitalization, these events are also an important cause of admission to the hospital in older patients. In 1969, Hurwitz³³ observed that ADEs contributed to the need for hospitalization in 15% of patients aged 60 years or older, which was 2.5 times the rate in younger patients. In a study of 2000 geriatric admissions, Williamson and Chopin³⁴ found that ADEs were responsible for 10.5% of the admissions.

Adverse drug events are also common in nursing homes. In one prospective study³⁵ over a 4-year period, 217 (65.4%) of 332 nursing

home residents had 444 ADEs. Also, an 18-month retrospective study³⁶ of veterans admitted to a nursing home found that 32% had ADEs.

The outpatient setting poses difficult challenges for researchers investigating ADEs in elderly patients. Most outpatient studies have relied on patient self-reporting. In one study³⁷ of mostly older patients interviewed by telephone, 30% described at least one medication causing undesirable symptoms. In contrast, in a 1-year study³⁸ of outpatients in which ADEs were detected by medical record review, a 10% incidence of ADEs was found. Prescription of multiple drugs has also been associated with a higher frequency of ADEs. Among 167 elderly veterans taking a minimum of 5 medications each (mean, 8 drugs per patient), 35% reported having had at least one ADE in the prior year. A quarter of those ADEs resulted in an emergency department visit or hospitalization.²⁶

Most ADEs are unpredictable and unpreventable, at least given the present state of knowledge. However, among hospital patients in one study,³¹ 28% were judged preventable; this study did not consider inappropriate prescribing, so the total figure may be higher. In the

outpatient setting, studies³⁹⁻⁴¹ have found that 7.5% to 23.5% of patients receive inappropriate or contraindicated drugs.

Falls and Restraints

Falls are a major source of morbidity and mortality in older patients (**Table 3**).⁴⁷⁻⁵¹ In 1985, falls resulted in more than 2 million injuries, 369 000 hospital admissions, and nearly 9000 deaths. In a study⁵² of hospitalized patients of all age groups, the incidence of falls for elderly patients was 1.9%. In another inpatient study²³ not limited to older patients, the estimated incidence of falls and injurious falls was 0.66% and 0.04%, respectively. Like many other studies of falls, this one was limited by its dependence on incident reports. Among nursing home patients, approximately half fall each year, and 9% sustain serious injury.⁵³ The 1-year incidence of falls among elderly patients living in the community is 32%, with resultant serious injuries in 24% of those who fall.⁵⁴ Recent estimates for fall-related hip fractures are 250 000 annually, a figure that is expected to double by the year 2040.⁵⁵

Patients at risk for falling pose difficult management issues. Re-

straint use (physical and chemical) has become controversial in recent years.⁵⁶ Furthermore, the effectiveness of physical restraint in reducing falls or preventing injury is questionable.⁵⁶⁻⁵⁸ In fact, restraints in hospitalized patients have been associated with increased mortality rates, longer lengths of stays, pressure sore development, increased incidence of nosocomial infections, and emotional distress.^{48,57,59}

Nosocomial Infections

Hospitalized older patients appear to be particularly susceptible to nosocomial infections.^{60,61} The incidence of hospital-acquired nosocomial infections in older patients ranges from 5.9 to 16.9 per 1000 hospital days.⁶² A retrospective review⁶³ of 1200 nosocomial infections found the risk in the 70 to 79 years age group to be 10 times that for the 40 to 49 years age group. Nosocomial infections in the nursing home setting are also a major problem. In a study⁶⁴ of 4259 residents in 53 nursing homes, the 1-day prevalence rate for newly acquired nosocomial infections was 4.4%. One kind of nosocomial infection, pneumonia, accounts for 29% of hospital admissions of patients from nursing homes.^{65,66}

Pressure Sores

Frail individuals are especially vulnerable to pressure sores (Table 3).⁶⁷⁻⁶⁹ Approximately 5% of hospitalized patients acquire pressure sores during their stay, resulting in 1.7 million hospital-related cases per year.⁴ Among high-risk hospitalized older patients, the incidence ranges up to 30%.⁷⁰ In nursing homes, a 51-site study⁷¹ of nearly 20000 residents revealed that 11% already had a pressure sore on admission, and for the remainder, the subsequent 1-year incidence was 13%. Another nursing home study⁷² found that among newly admitted high-risk patients, the incidence for acquiring a new pressure sore within 8 weeks climbs to 74%.

Delirium

Hospital-acquired delirium, especially after surgery, is predomi-

nantly a disease of elderly patients, and complicates 2.3 million admissions annually.^{73,74} Delirium at the time of admission is an independent predictor of poor hospital outcome.⁷⁴ 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 3).^{67,74-78} Postoperative delirium is associated with prolonged length of hospital stay, increased costs, morbidity, and mortality.⁷⁴

Surgical and Perioperative Complications

In the Harvard Medical Practice Study,²² postoperative complications accounted for half of all adverse events and were nearly twice as frequent among older patients. In a more recent study⁷⁹ of surgical adverse events in Colorado and Utah, after adjusting for comorbidities, age remained a risk factor for preventable events. Elderly patients account for half of all surgical emergencies and three quarters of operative deaths.¹⁰ In a study⁸⁰ of 613 surgical patients older than 70 years, mortality was significantly higher for emergency operations (21%) compared with elective cases (1.9%).

WHY ARE OLDER PATIENTS MORE AT RISK OF INJURY?

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

Endogenous Factors

Older patients have diminished reserves, especially in cognitive, renal, and hepatic function. *Cascade iatrogenesis* is especially frequent in elderly patients; it is the serial development of multiple medical complications associated with reduced mechanisms for coping with external stresses.⁸¹ An example is a patient with postopera-

tive pain who was oversedated, leading to respiratory failure that required mechanical ventilation, who subsequently developed ventilator-associated pneumonia.

The development of adverse events or disability during hospitalization in older patients is strongly associated with a poorer prognosis following hospital discharge.³ Risk factors predicting postdischarge functional decline include preexisting bedsores, poor scores on the Mini-Mental State Examination, impairment in activities of daily living, and reduced social activity.^{3,82} The Hospital Outcomes Project for the Elderly found that, following discharge from hospitalization, a third of patients declined in at least one of their activities of daily living. The causes of functional decline include the effects of illness itself, treatment, adverse events, and deconditioning.⁸³ In these patients, subsequent risks of falls, rehospitalization, institutionalization, and dying are substantially increased.³

Exogenous Factors

In addition to an increased rate of complications from usual medical therapy, such as bed rest, older patients have iatrogenic injuries from inappropriate care. For example, congestive heart failure is the most common reason for hospitalization of elderly patients, responsible for more than 500000 admissions per year.⁸⁴ In a prospective observational study,⁸⁴ 7% of admissions for congestive heart failure were found to be the result of improper treatment, including fluid overload, procedures, and misuse of drugs. Hospital mortality for this group with congestive heart failure was much greater, 32%, as opposed to 9% in the group without iatrogenic injuries. In a prospective study⁸⁵ of inpatient renal service consultations for predominantly older patients, the most common causes for acute renal failure were iatrogenic: drugs, errors in perioperative care, dehydration, and contrast dye.

Underdiagnosis and delayed diagnosis of illnesses are more common in elderly patients.¹⁰ Factors associated with underdiagnosis include the following: patient-related causes, such as symptom denial, symptom

attribution to old age, and patient passivity during physician encounters; systems-related causes, such as inadequate medical access and disincentives from reimbursement inadequacies for time-intensive needs of complex older patients; and physician-related causes.¹⁰ Underdiagnosis in older patients appears more likely to occur when a nongeriatric physician cares for the patient. For example, some data suggest that patient assessments by non-geriatric-trained providers may be deficient in diagnosing gait disturbances, metabolic problems, early cancers, the presence of untreated infections, and reversible causes of incontinence and dementia.⁸⁶

One of the reasons for underdiagnosis of illness in elderly patients is atypical presentation. For example, patients may present with signs and symptoms that are remote from the diseased organ system, masking important diagnostic clues. The “weakest link” construct holds that illness will often present as failure of the most vulnerable organ system. Impairment usually predates the new physiologic challenge. For example, delirium, depression, urinary incontinence, or near syncope are not uncommonly associated with remote insults to other organ systems.⁸³

SPECIFIC PROBLEMS AND RISK OF INJURY

Adverse Drug Events

While the relation between ADE rates and growing older is strong, it is less clear that age is an independent risk factor beyond the increase in illness associated with growing older. Gurwitz and Avorn⁸⁷ have suggested that while an association does exist for certain medications, many studies addressing this relation fail to account for the confounding effects of increased coexisting illnesses and multiple drug use. One recent study⁸⁸ addressing this issue in hospitalized patients found no increased risk after controlling for these factors.⁸³

Falls

Age, female sex, and living alone are all associated with increased rates of

falling.⁸⁹ Environmental factors are more important causes of falling for younger elderly patients, while host-related factors (decreased mobility, visual impairment, dizziness, and neurologic or cardiovascular disease) play a more significant role for the more senior and frail elderly patients.⁹⁰ Nonenvironmental risk factors most associated with falling in long-term care facilities include a history of falling, the ability to walk, dementia, and drug use, particularly sedative-hypnotics, vasodilators, antidepressants (including newer psychotropics), and diuretics.^{47,91-93}

Nosocomial Infections

Nosocomial pneumonia among inpatients occurs twice as often in older patients and is associated with poorer outcomes.⁹⁴⁻⁹⁶ Older patients are predisposed to pneumonia because of decreased lung capacity, cough reflex, and immunity. Independent risk factors include poor nutritional status, neuromuscular disease, and witnessed aspiration events.⁹⁴ Pneumonia and urinary tract infections account for approximately half of nosocomial infections in long-term care facilities.^{97,98} Risk factors responsible for nosocomial infections include urinary catheterization, fecal and urinary incontinence, recent antibiotic use, intravenous lines, nasogastric tubes, and corticosteroid use.⁹⁹ Nursing homes are also potentially hazardous for acquiring communicable diseases such as tuberculosis. For individuals aged 65 years or older, tuberculosis rates are 4-fold higher in nursing homes than for elderly persons living at home.¹⁰⁰

Pressure Sores

Older patients at greatest risk for pressure sores are bedridden or chair bound. Risk factors include fecal incontinence, long lengths of hospital stay, traumatic injuries, neuromuscular diseases, malnutrition, lymphopenia, decreased body weight, dry skin, and an altered level of consciousness.^{67,101} Skin breakdown develops in the setting of moisture, friction, shearing forces, and pressure.¹⁰² Treatment variables that predispose to pressure ulcer development in-

clude type of surface support, nurse staffing ratios, frequency of patient repositioning, and certain medications.⁷⁰

Delirium

The most common causes for delirium are medications, infections, metabolic derangements, and alcohol or drug withdrawal.⁷⁵ Predisposing factors include age, comorbid conditions, and preexisting cognitive or functional impairment. External influences include insufficient social support, sleep deprivation, unfamiliar environments, pain, and stimuli reduction. In postoperative patients, there is no clear-cut correlation between the route of anesthesia (general, epidural, or regional) and the incidence of postoperative delirium.^{103,104} The method of pain management may be less significant than the quality of postoperative analgesia as a determinant of developing delirium.¹⁰⁵ Physicians fail to diagnose 30% to 50% of delirious patients.¹⁰⁶ Reasons include poor patient-physician communication, misdiagnosis as dementia or depression, overlooking delirium while attending to other diseases, and mistakenly attributing the behavior to normal aging.¹⁰⁷

Surgical and Perioperative Complications

Age alone is not an important risk factor for many types of surgery. The oldest patients with few comorbid conditions and nonemergency operations have outcomes comparable to younger age groups.¹⁰⁸ Studies¹⁰⁹⁻¹¹¹ from the National Veterans Affairs Surgical Quality Improvement Program database have demonstrated that age, as an independent variable, is less important in predicting postoperative outcome than complexity scores, functional status, emergency nature of cases, or the preoperative anesthesia risk assessment scores. Still, the rate of surgical complications consistently increased with age, with 3 to 4 times as many of the oldest patients having more than one complication (**Table 4**). Following surgery, iatrogenic injury involving the lungs, kidneys, and cardiovascular sys-

Table 4. VA National Surgical Quality Improvement Program: Incidence of Selected Risk Factors and Outcomes*

Variable	Age, y			
	≤64 (n = 52 718)	65-74 (n = 27 113)	75-84 (n = 14 544)	≥85 (n = 1117)
Functional health status†				
Independent	92.0 (48 503)	84.7 (22 974)	77.5 (11 276)	61.3 (685)
Partially dependent	6.5 (3440)	12.2 (3312)	17.2 (2505)	28.6 (319)
Totally dependent	1.5 (775)	3.0 (827)	5.3 (763)	10.1 (113)
Emergency cases (% of all operations)	7.0 (3703)	7.5 (2021)	9.7 (1413)	14.2 (159)
No. of complications				
1	5.3 (2785)	8.5 (2298)	9.9 (1437)	11.5 (128)
2	1.0 (543)	2.3 (611)	2.9 (416)	3.4 (38)
≥3	0.7 (389)	1.8 (485)	2.5 (360)	2.8 (31)

*Data are given as percentage (number) of patients. VA indicates Veterans Affairs.

†Percentages may not total 100 because of rounding.

Table 5. VA National Surgical Quality Improvement: Incidence of Selected Postoperative Complications After Major Surgery Among Veterans (Fiscal Year 1998)*

Postoperative Complication	Age, y			
	≤64 (n = 52 718)	65-74 (n = 27 113)	75-84 (n = 14 544)	≥85 (n = 1117)
Pneumonia	1.0 (529)	2.5 (680)	3.5 (512)	4.7 (53)
Pulmonary embolism	0.1 (43)	0.2 (57)	0.2 (25)	0.5 (6)
Failure to wean >48 h	1.0 (520)	2.2 (582)	2.7 (394)	2.8 (31)
Reintubation	0.8 (426)	1.9 (529)	2.3 (336)	3.2 (36)
Renal insufficiency	0.2 (99)	0.4 (114)	0.7 (96)	0.7 (8)
Acute renal failure	0.2 (78)	0.3 (90)	0.5 (73)	0.3 (3)
Urinary tract infection	1.0 (516)	2.4 (651)	3.8 (546)	4.9 (55)
Cardiac arrest needing CPR	0.3 (177)	1.0 (286)	1.4 (202)	2.0 (22)
Myocardial infarction	0.2 (83)	0.6 (158)	0.9 (124)	0.8 (9)
Systemic sepsis	0.5 (258)	1.2 (319)	1.5 (219)	1.6 (18)

*Data are given as percentage (number) of 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. VA indicates Veterans Affairs; CPR, cardiopulmonary resuscitation.

tem increased several-fold with aging (**Table 5**). Surgeons' reluctance to perform early elective surgery based on chronological age alone may be a factor that has contributed to increased surgical mortality in older patients.¹¹²⁻¹¹⁴ When surgeons delay operating on elderly patients until nonsurgical treatments have failed, the perioperative risk is often increased.¹¹⁵

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

In the Harvard Medical Practice Study,¹² two thirds of adverse events in hospitalized patients were judged to be preventable. Efforts to prevent medical errors in elderly patients begin with the same principles used successfully in caring for patients of all ages. Four general strategies with promise for reducing accidental injury in older pa-

tients are presented, followed by specific recommendations (**Table 6**).

Application of Lessons in Error Prevention From Other Industries

Successful programs to reduce adverse events should take advantage of techniques from cognitive science and human factors research, systems theory, institutionalizing safety, and cultural shifts.¹³ High-reliability organizations (such as aviation) emphasize management of work flow and schedules to prevent fatigue and stress and provide extensive training in teamwork and individual responsibility for safety.

The principles of total quality management, including interdisciplinary approaches, are important for preventing errors in the care of elderly patients.^{13,31,116-120} Leape et al¹⁷ have outlined several human factors' concepts for medical error re-

duction that should be built into the design of all systems: simplify, standardize, stratify (customization of care), improve communication, properly use defaults, carefully automate, use affordances and natural mapping, understand limitations of attention and vigilance, and encourage the reporting of errors in a nonpunitive environment. Safety design characteristics also include improving information access, error proofing (including use of forcing functions), reducing reliance on memory, training, and the use of buffers or redundancy to intercept inevitable errors.¹³

Reducing Variability in the Treatment of Older Patients

Older patients often benefit greatly from interventions, even though their risk is higher.¹²¹ For example, for those with atrial fibrillation, older patients benefit the most from an-

Table 6. Error Prevention Strategies for Older Patients (≥65 Years)

Problem	Reason	Intervention
Adverse drug events	Multiple drug use	Review medication indications ¹³⁵
	Aging-related physiologic alterations in metabolism, excretion, or drug effects	Appropriate dose adjustments and decisions based on comorbidities, not chronological age ^{26,135,136}
Falls	Drug knowledge dissemination, allergy checking, and dispensing	Computerization, physician order entry, decision support, and bar-coding technology ^{31,132,134}
	Underprescribing	Avoid age bias ¹²⁴
	Medications	Limit psychoactive pharmacotherapy ^{91,93}
	Physical restraints	Restraint use guidelines ⁵⁶
Pressure sores	Immobility	Modify for elderly or handicapped persons; ergonomic aids ^{50,125}
	Malnutrition	Training and exercise programs, assistive devices, risk assessment, ^{53,141,143} and reduce unnecessary bed rest
Nosocomial infections	Local factors	Increase mobility and scheduled turning ⁶²
	Aspiration	Nutritional assessment and treatment ⁶⁷
Delirium	Antibiotic resistance	Risk assessment; skin care; mattress changes; and address incontinence and moisture ^{148,149}
	Instrumentation	Aspiration precautions ^{65,96}
Surgical and perioperative complications	Medications	Restrict broad-spectrum therapy ^{62,146}
	Environmental	Minimize duration, catheter care guidelines, and hand-washing ¹⁴⁷
	Analgia or pain	Appropriate drug and dosing indications and nonpharmacological approaches to insomnia ^{82,137}
	Postoperative	Physical modifications, staff education, and minimize isolation ⁷³
Functional decline	Wound infections	Pain management guidelines and behavioral approaches ⁹²
	Thromboembolic events	Anesthetic and perioperative care adjustments ^{105,152}
	Excessive mortality rates	Diligent wound care
Diagnostic errors	Prolonged hospitalization	Early mobilization and prophylactic therapy
	Prolonged bed rest	Improve patient selection and minimize emergency cases when electively indicated ¹⁵²
	Inappropriate transfer	Geriatric risk assessment and interdisciplinary team care ^{3,127}
	Underdiagnosed or missed diagnosis	Early mobilization and rehabilitation and improved use of nonhospital care settings ¹²⁶
	Systems failures	Stabilize before transfer and discharge planning and follow-up ¹³⁰
		Geriatric assessment, understanding elderly pathophysiological features and altered disease presentations, and discontinuing unproved or refuted chronological age-based algorithms ^{124,129,130}
		Improve medical access, correct reimbursement deficiencies, reorganize care structures and processes, and information management solutions ^{12,118,132}

ticoagulation, although their risk of complications is highest.¹²² Inappropriate care of older patients is associated with underuse, overuse, and misuse of acute care medical services, including procedures.¹²³ Many important therapies, including some with increased risks, are actually more effective in elderly patients because the consequences of the untreated conditions are more severe.¹²⁴

Role of Geriatric Specialists and Geriatric Care Units

Some data, although not all, suggest that outcomes may be better when geriatric physician and nurse specialists care for older patients compared with routine care. In one study⁹⁵ of patients with nursing home-acquired pneumonia, those cared for by physicians with a Certificate of Added Qualifications in

Geriatrics had a 3-fold greater likelihood of achieving cure than patients whose physicians did not have this certificate. In this study, the geriatric physicians had direct patient responsibility and participated in policy decisions.

Also, in geriatric units in which structural and process-oriented factors have been reorganized and directed toward the needs of older patients, care has improved.¹²⁵ Clinical

trials in a hospital medical unit, which was physically redesigned along with a multidisciplinary approach to elderly care and injury prevention, have demonstrated improved functional outcomes while saving costs.¹²⁶⁻¹²⁸ “Acute care for elders units” are team directed and function focused and use nontraditional biopsychosocial models.¹²⁶ The success of acute care for elders units emphasizes the importance of remodeling processes of care and strategies using specialized teams of providers (physicians, nurse practitioners, and physician assistants) with direct responsibilities in patient care. In models that focus on a team approach, it may be the team rather than the attending physician who has the major impact.

In contrast is the lack of benefit seen with geriatric consultation teams. In a Veteran’s Administration study,¹²⁵ the incidence of hospital-acquired complications (38%) was not reduced by the use of the geriatric team. On analysis, the failure appeared to be due to limiting them to a consultative role. Similarly, other comprehensive geriatric assessment studies¹²⁹ that did not result in concurrent institutional reengineering have had disappointing results.

Risk Profiling and Discharge Planning

Assessing the risk profile of older patients at the time of admission can identify patients at risk for functional decline after hospitalization. The most important independent predictors are advanced age, reduced preadmission independent function as measured by activities of daily living, and cognitive impairment.³ Follow-up patient assessments during the hospital stay are also important in reducing medical complications in patients following transfer or discharge from the hospital to home. In particular, ensuring physiologic stability on discharge from hospitalization improves outcome. Naylor et al^{130,131} have demonstrated the short-term effectiveness of comprehensive discharge planning for hospitalized elderly patients and the value of intensive follow-up of patients at risk for poor outcomes.

SPECIFIC PROBLEMS

Adverse Drug Events

Reducing ADE rates in older patients will require 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 the following methods.

New Information Technology. Information science solutions to the ADE problem have been successfully implemented in several academic centers and are expected to soon gain widespread acceptance.²⁴ Computerized physician order entry with decision support reduced the incidence of serious medication errors by 55% in one study.¹³² Outpatient pharmacotherapy in elderly patients can be improved with on-line drug utilization review interventions.¹³³ Potentially inappropriate geriatric prescribing was changed in 24% of pharmacy orders after computer-generated alerts.¹³⁴

Increasing Physician Prescribing Knowledge. Beers¹³⁵ led a panel of nationally recognized experts who developed explicit criteria of inappropriate drug use in elderly patients. His group outlined 2 classes of drugs that are frequently associated with adverse outcomes: those that are potentially injurious for many in the general geriatric population (independent of diagnosis) and those that are hazardous only under certain conditions. The former include propoxyphene, indomethacin, flurazepam, methyldopa, and chlorpropamide. An example of the latter is prescribing drugs with anticholinergic properties to men with benign prostatic hypertrophy.

Early Recognition. Physicians often fail to recognize ADEs, leading to continuing injury and unnecessary additional therapy and tests. Rochon and Gurwitz¹³⁶ have described the “prescribing cascade,” which occurs when an ADE is misinterpreted as a newly acquired illness. This can lead to additional prescribed therapy for this “new illness,”

which places the patient at risk for additional harm from the use of drugs. An example is extrapyramidal symptoms developing after initiating metoclopramide therapy, which leads to drug therapy for (erroneously) presumed parkinsonism.

Reducing Unnecessary Drug Use and Substitution With Safer Treatments. Reducing the excessive use of medications requires periodic reviews of medications. Nonpharmacological sleep protocols for inpatients, for example, are an effective means of reducing ADEs.¹³⁷

Increased Utilization of Pharmacists. Pharmacists are an underused resource for preventing medication errors. Pharmacists provide important safeguards for older patients in hospitals and nursing homes.^{138,139} Their roles should be expanded to other settings.

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.¹⁴⁰ Initially, 6 drug categories will require this labeling improvement: psychotropic agents, nonsteroidal anti-inflammatory agents, certain cardiac drugs, oral hypoglycemic agents, anticoagulants, and quinolone antibiotics.

Falls and Restraints

Fall consultation services have reduced nursing home falls by 19% and fall-related injuries by 31%.⁵³ Successful fall prevention programs target high-risk patients and are cost-effective.¹⁴¹⁻¹⁴⁴ In the home setting, Tinetti et al¹⁴¹ achieved a 31% reduction in fall rates 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. Some geriatric clinics have used computerized fall risk factor databases to improve identification of

patients in greatest need of fall prevention efforts.¹⁴⁵

Nosocomial Infections

The prevention of nosocomial infections in older patients requires following sound health care principles that are applicable to all ages: frequent hand washing, appropriate wound and skin care, immunization, and isolation of contagious individuals. Decreasing prolonged use of broad-spectrum antibiotics or invasive devices (endotracheal tubes, nasogastric tubes, indwelling urinary catheters, and central venous catheters) can reduce infections.^{62,146,147}

Pressure Sores

Pressure sore prevention begins with early risk assessment to identify patients most likely to benefit from prevention strategies.⁶⁷ Commonly used risk assessment tools are the Norton and Braden Scales. Staff education alone can reduce hospital-acquired pressure sores by more than half.¹⁴⁸ Prevention addresses mechanical loading due to immobility, the nature of support surfaces, skin care, moisture, incontinence, nutrition, earlier clinical recognition, improved wound care, and education. On-line decision support systems to assist in documentation and provide guideline-based recommendations have resulted in a 60% reduction in pressure sores during a 6-month period.¹⁴⁹

Delirium

Hospital-acquired delirium, especially for postoperative patients, is amenable to prevention. Risk assessment, as for other types of preventable injuries, allows for programs to efficiently target high-risk elderly patients. Several delirium prediction models have been developed.^{82,150,151} In a prospective study, Inouye et al⁷³ found a one third reduction in delirium for hospitalized older patients who undergo a multicomponent intervention to reduce risk factors. A geriatric-anesthesiologist team intervention program has also been able to reduce the incidence of postoperative delirium.⁹²

Surgical and Perioperative Complications

The prevention of surgical complications requires attention to all phases of treatment, beginning with preoperative determination of the appropriateness for the planned procedure. Elderly patients require careful medical assessment by the surgeon, primary care provider, and anesthesiologist.¹⁵² Collaboration by such physician teams should continue throughout the hospitalization. Preoperative preparation includes stabilization of active medical problems. Intraoperative management requires attention to proved age-adjusted approaches.¹⁵³ The postoperative period is particularly prone to complications that are a consequence of bed rest, pain management, and several predictable physiologic responses.

Effective pain management in older patients requires recognition of and adjustment to differences in pharmacological metabolism, excretion, and sensitivity.¹⁵² Patient-controlled analgesia has been successively demonstrated to reduce complications in elderly persons, including those who are frail.¹⁵⁴

CONCLUSIONS

Even though medical therapy is beneficial in the aggregate for elderly patients, the risks of accidental injury are high, especially for certain complications and injuries. However, these risks can be greatly reduced by application of principles and techniques that have been learned in recent years from error prevention and geriatric research. Major improvements could be realized if these principles and techniques were applied more widely in all care settings. As the recent Institute of Medicine report outlines, building a safer health system will require a national comprehensive strategic agenda.¹ With careful and expert care, older patients can achieve better health outcomes. Improving our systems to provide that care is a major challenge to medicine.

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