

The Incidence and Severity of Adverse Events Affecting Patients after Discharge from the Hospital

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Background: Studies of hospitalized patients identify safety as a significant problem, but few data are available regarding injuries occurring after discharge. Patients may be vulnerable during this transition period.

Objective: To describe the incidence, severity, preventability, and "ameliorability" of adverse events affecting patients after discharge from the hospital and to develop strategies for improving patient safety during this interval.

Design: Prospective cohort study.

Setting: A tertiary care academic hospital.

Patients: 400 consecutive patients discharged home from the general medical service.

Measurements: The three main outcomes were *adverse events*, defined as injuries occurring as a result of medical management; *preventable adverse events*, defined as adverse events judged to have been caused by an error; and *ameliorable adverse events*, defined as adverse events whose severity could have been decreased. Posthospital course was determined by performing a

medical record review and a structured telephone interview approximately 3 weeks after each patient's discharge. Outcomes were determined by independent physician reviews.

Results: Seventy-six patients had adverse events after discharge (19% [95% CI, 15% to 23%]). Of these, 23 had preventable adverse events (6% [CI, 4% to 9%]) and 24 had ameliorable adverse events (6% [CI, 4% to 9%]). Three percent of injuries were serious laboratory abnormalities, 65% were symptoms, 30% were symptoms associated with a nonpermanent disability, and 3% were permanent disabilities. Adverse drug events were the most common type of adverse event (66% [CI, 55% to 76%]), followed by procedure-related injuries (17% [CI, 8% to 26%]). Of the 25 adverse events resulting in at least a nonpermanent disability, 12 were preventable (48% [CI, 28% to 68%]) and 6 were ameliorable (24% [CI, 7% to 41%]).

Conclusion: Adverse events occurred frequently in the peridischarge period, and many could potentially have been prevented or ameliorated with simple strategies.

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Patient safety is a public concern that has received substantial attention, especially since the release of two reports from the U.S. Institute of Medicine. The first of these, "To Err Is Human," reviewed the literature on adverse events, or injuries resulting from medical care (1). On the basis of data from two large population-based chart review studies, the report estimated that adverse events occur in 2.9% (2) to 3.7% (3) of hospitalizations. The first of these studies (2) found that although most injuries are minor, approximately 1 in 10 results in death. The researchers determined that approximately half of the adverse events were caused by errors (1, 3, 4). The second report, "Crossing the Quality Chasm," which proposes strategies for improving the health system, declared patient safety a fundamental component of care quality (5).

However, the estimated incidence of adverse events quoted in "To Err Is Human" may underestimate the overall safety problem, since injuries occurring after discharge were not included in the evaluation. Patients may be especially vulnerable to injuries during this period because they may still have functional impairments and because discontinuities may occur at the interface of acute and ambulatory care (6). These discontinuities may be worsened by the current health care environment, in which patients are leaving the hospital "quicker and sicker" (7) and may receive care from hospitalists rather than their primary care physicians (8).

Despite these theoretical concerns, few studies are available to estimate the extent of the problem. Several

studies have determined the risk for postdischarge wound infections in surgical patients (9, 10), but this is a specific type of safety problem and the risk cannot be generalized. Other studies have used readmission rates to identify poor-quality hospital care (11). However, this outcome is an insensitive and nonspecific marker of quality in general (11) and safety in particular. Information on the incidence and type of adverse events is vital for improving postdischarge safety.

We wanted to determine the incidence and severity of adverse events affecting patients after discharge from the hospital to home. In addition, we wanted to identify the incidence of preventable and ameliorable adverse events, classify types of adverse events, and identify system improvements to reduce the incidence and severity of adverse events after discharge.

METHODS

Overview

To determine the rate of adverse events, we first created a case summary of every patient's posthospital course by performing a medical record review and a telephone interview approximately 3 weeks after discharge. Using this information, we created event summaries, which two board-certified internists independently reviewed to determine whether medical management caused an injury and, if so, whether it was preventable or ameliorable. The insti-

Context

Research on patient safety has focused on adverse events in hospitalized patients. Adverse events following hospitalization have received little attention.

Contribution

Among 400 consecutive patients discharged from the general medical service of an academic hospital, 76 had adverse events during the 2 weeks following hospital discharge. Of the adverse events, the researchers categorized 23 as preventable, 24 as ameliorable, and the remainder as neither. Adverse drug events were the most frequent occurrence.

Implications

Interventions to maximize patient safety should consider the vulnerable transition from hospital to home.

—The Editors

tutional review board at the study hospital approved the protocol.

Definitions

Adverse outcomes were any of the following patient experiences after discharge: new or worsening symptoms, unanticipated visits to health facilities for tests or treatments, or death. An *adverse event* was an injury resulting from medical management rather than the underlying disease. We evaluated all injuries resulting in symptoms after discharge, regardless of when the events occurred. Thus, we included adverse events that occurred in the hospital and after discharge as long as symptoms persisted until the patient went home. A *preventable adverse event* was an injury that could have been avoided, that is, an injury judged to probably be the result of an error or a system design flaw. An *ameliorable adverse event* was an injury whose severity could have been substantially reduced if different actions or procedures had been performed or followed.

Patient Sample

We used a prospective cohort design to study adult medical patients at an 800-bed urban academic teaching hospital. Patients were included if they went home from the general medical service during a sequential 81-day period, had telephone service, and could complete a telephone interview in English. Patient surrogates were permitted to complete the interview if the patient could not.

Telephone Interview

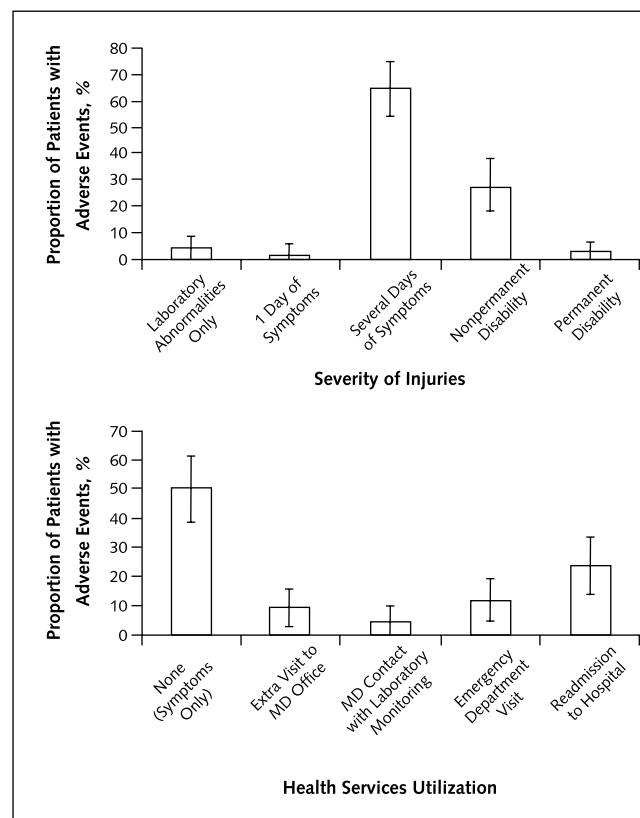
A board-certified internist contacted patients by telephone within 2 to 5 weeks of discharge. If the patient was eligible and consented, he or she underwent a semi-structured interview over the telephone. If the patient was not available, we made up to 20 attempts to contact him or her at different times of the day and week. If the patient declined to participate or we were unable to contact him or her after 5 weeks, we rated the patient as a nonresponder.

Responders underwent a telephone interview that had several components (**Appendix Figure**, available at www.annals.org). The principal component assessed the patient's condition since discharge by using a full review of organ systems. If patients answered "yes" to any question, the interviewer asked them to elaborate about the symptom's severity, timing in relation to hospitalization and treatments, and resolution. The survey also determined patients' use of health services since discharge, including home care services, physician services, visits to laboratories, and readmissions to the hospital.

Preparation of Case Summaries

To create a case summary, the internist combined the information from the telephone interview with information obtained from a review of the patient's electronic medical record. This computerized clinical record contains "handover" notes from the hospitalization; discharge summaries; previous orders and written instructions; emergency department and clinic notes; operative and procedure notes; and all laboratory results, including results of radiography, electrocardiography, and pathologic examination. If necessary, the paper chart was also reviewed to clarify information that was in the discharge summary or handover notes. If patients returned to the study hospital after discharge, we were able to validate their history by

Figure. Severity of injuries and health service utilization in patients with adverse events.



reviewing their records. However, for patients receiving care elsewhere, we had to rely on firsthand accounts.

Preparation of Event Summaries

The internist reviewed every patient's case summary for adverse outcomes. If any were found, an event summary that consisted of a detailed description of each outcome, including its onset, its severity, the health services used during its treatment, and its resolution, was created for each one. If there were no adverse outcomes, then the event summary consisted of the case summary.

Determination of Adverse Events

Two other board-certified internists independently rated each event summary by using standard techniques as described elsewhere (3). Each event summary was evaluated separately. Reviewers first rated on a scale of 1 to 6 their confidence that medical management caused an injury. If their rating was 5 or 6, indicating that the injury was probably or definitely caused by management, the event was considered an adverse event. For adverse events, the internists used implicit criteria to determine their preventability and "ameliorability." The two reviewers' assessments were then compared for causality, preventability, and ameliorability. If there was disagreement, the two reviewers discussed the case to attempt to come to consensus. If they did not agree, a third board-certified internist rated the event independently.

Next, reviewers rated injury severity, health services used, type of injury, and location. Injury severity was categorized as serious laboratory abnormality only, one day of symptoms, several days of symptoms, nonpermanent disability, permanent disability, or death. Differentiation between several days of symptoms and nonpermanent disability relied on evidence that symptoms interfered with patients' activities of daily living. We categorized health services used as none, additional visit to a physician, additional visit for laboratory testing in addition to a physician visit, visit to an emergency department, readmission to the hospital, or death. We were able to determine whether health services were "additional" because during the interview we asked whether the health service was arranged before discharge or specifically for the particular symptom. We used a standard approach to classify the type of injury (2, 3), categorizing each as an adverse drug event, a procedure-related injury, a nosocomial infection, a fall, or other.

We also classified the location of adverse events. Our primary objective was to evaluate adverse events affecting patients after discharge from the hospital to home. We felt that most of these events would occur after the patient went home, but we recognized a priori that some adverse events could occur in the hospital but lead to morbidity after discharge because of the severity of the injury or because health providers did not recognize the problem at discharge. Examples of injuries occurring in the hospital but affecting patients after discharge include pressure ulcers, missed diagnoses, and erroneous drug prescriptions. If

Table 1. Characteristics of the Study Sample*

| Characteristic | Responders (n = 400) | Nonresponders (n = 181) |
|--------------------------|-------------------------|----------------------------|
| Women, % | 61 | 57 |
| Mean age \pm SD, y | 57 \pm 17 | 57 \pm 17 |
| Ethnicity, % | | |
| White | 64 | 59 |
| African American | 24 | 29 |
| Hispanic | 7 | 8 |
| Other | 5 | 4 |
| Discharge diagnosis, % | | |
| Pulmonary disorders | 17 | 17 |
| Pneumonia | 6 | 8 |
| Obstructive lung disease | 6 | 5 |
| Cardiovascular disorders | 15 | 15 |
| Congestive heart failure | 5 | 6 |
| Coronary artery disease | 4 | 6 |
| Arrhythmia and other | 6 | 4 |
| Payer, %† | | |
| Medicare | 45 | 37 |
| Managed care | 38 | 39 |
| Medicaid | 10 | 11 |
| Fee for service | 6 | 10 |
| Free care | 2 | 3 |

* No statistically significant differences were seen between the characteristics of responders and nonresponders. One hundred twenty-one nonresponders did not consent to the interview; the remainder could not be contacted within 5 weeks.

† Values sum to >100% because of rounding.

it was determined that the adverse event occurred in the hospital, we examined whether the injury was recognized before discharge and, if so, whether definitive management was instituted at that time.

To develop strategies to prevent injuries or reduce their severity, we studied all of the preventable and ameliorable adverse events. For each of these, the internists were asked how the adverse event could have been prevented or ameliorated; who could have intervened; and whether system problems contributed to the occurrence or severity of the injury. If the internists felt system problems were involved, they were also asked which processes were most responsible for the system failure (Appendix Table 1, available at www.annals.org). As in previous studies (12), we synthesized both reviewers' responses into common themes using a qualitative approach.

Statistical Analysis

We determined the percentage of patients with adverse events and the percentage of patients with preventable or ameliorable adverse events. We also determined the injury severity, health services used, and location and type of all adverse events. We tested whether patient demographic characteristics (age, sex, marital status, Charlson Comorbidity Index score, ethnicity, and insurance class) were associated with occurrence of adverse events by using the chi-square statistic for categorical variables and the *t*-test for continuous variables. Finally, we developed a multivariate logistic model assessing these variables' association with occurrence of adverse events. Reliability was assessed by using the κ statistic for the reviewers' initial rating of adverse events, preventability, and ameliorability. We used

Table 2. Type of Injury and Incidence of All Adverse Events, Preventable Adverse Events, and Ameliorable Adverse Events*

| Type of Adverse Event | Incidence <i>n/n (%)</i> | Type of Injury | | | | |
|-----------------------|-----------------------------|--------------------|-------------------|----------------------|-------|---------|
| | | Adverse Drug Event | Procedure Related | Nosocomial Infection | Fall | Other |
| All | 76/400 (19 [15–23]) | 50 (66) | 13 (17) | 4 (5) | 3 (4) | 11 (15) |
| Preventable | 23/400 (6 [4–8]) | 12 (50) | 2 (8) | 0 (0) | 2 (8) | 9 (38) |
| Ameliorable | 24/400 (6 [4–8]) | 19 (76) | 3 (12) | 1 (4) | 0 (0) | 2 (8) |

* Seventy-eight adverse events occurred in 76 patients. Twenty-four adverse events in 23 patients were preventable, and 24 adverse events in 24 patients were ameliorable. Most injuries were adverse drug events. Each row identifies the number of adverse events occurring within each type of injury. The number of adverse events across each row exceeds the number of patients with adverse events because patients could have more than one adverse event (two patients) and the types of injuries were not mutually exclusive. For example, for the patient who developed a nosocomial infection after a procedure, the type of injury was categorized as both procedure related and as a nosocomial infection. Values in square brackets are 95% CIs.

SAS, version 8.1, for all analyses (SAS Institute, Inc., Cary, North Carolina).

Role of the Funding Source

The funding source had no role in the design, conduct, and reporting of the study or in the decision to submit the results for publication.

RESULTS

Six hundred seventy-seven patients were discharged home, and 581 were eligible for our study. Patients were excluded because they could not speak English ($n = 47$) or did not have a valid telephone number ($n = 49$). We were able to complete interviews for 400 eligible patients (response rate, 69%) (Table 1).

We completed the telephone interviews an average of 24 days (5th to 95th percentile, 14 to 36 days) after discharge. Patients were on average 57 years of age, and 61% were women. Respiratory and cardiovascular disorders were the most prevalent discharge diagnoses. Sixty-four percent of the cohort classified their ethnicity as white, 24% as African American, 7% as Hispanic, and the remainder as Asian or other. Medicare or commercial managed care plans covered most patients' health care costs. The responders and nonresponders did not differ statistically, and no substantive differences between them were noted.

After discharge, 76 patients had symptoms related to injuries from medical care. Thus, the incidence of adverse events was 19% (95% CI, 15% to 23%) (Tables 2 and 3, Appendix Table 2 [available at www.annals.org]). Of these 76 patients, 23 had preventable adverse events (6% [CI, 4% to 9%]) and 24 had ameliorable adverse events (6% [CI, 4% to 9%]). There were 78 adverse events among the 76 patients because two patients had two injuries (Table 2): One had two preventable injuries, while the other had a preventable injury and a nonpreventable, nonameliorable injury.

All of the adverse events affected patients after discharge and most often occurred after patients left the hospital. However, 20 adverse events that occurred before discharge led to significant morbidity after discharge. Ten of

these events were identified and appropriately managed before discharge but still led to significant symptoms after the patients went home; the other 10 were not identified before discharge. An example of the former was a pressure ulcer that developed in the hospital and was diagnosed before discharge but still led to significant morbidity at home (Table 3). An example of the latter was a complication of an invasive treatment that became apparent only after discharge (Table 3). The remaining 58 adverse events occurred after patients were discharged.

Sixty-six percent (CI, 55% to 76%) of the adverse events were adverse drug events, 17% (CI, 8% to 26%) were related to procedures, and a few resulted from nosocomial infections and falls (Table 2). A few adverse events, resulting from missed diagnoses or incorrect treatment, were not classified as belonging to any of these categories. The most common drugs causing adverse events were antibiotics (38%), corticosteroids (16%), cardiovascular drugs (14%), analgesics (including opiates) (10%), and anti-coagulants (8%).

Adverse event severity varied from laboratory abnormalities only to permanent disability (Figure). Two patients (3% of patients with adverse events) had laboratory abnormalities only, and one patient (1%) had a single day of symptoms. Forty-nine patients (64%) experienced several days of symptoms, such as a rash secondary to antibiotics, insomnia because of corticosteroid use, and constipation because of opioid analgesics. Twenty-three patients (30%) had a nonpermanent disability, such as severe dehydration and abdominal pain due to *Clostridium difficile* diarrhea and severe pain after a fall that resulted in rib fractures. Two patients (3%) had permanent disabilities. The proportion of adverse events resulting in nonpermanent or permanent disabilities was greater for preventable adverse events than for ameliorable and nonpreventable, nonameliorable ones (Table 4).

The types of health services used by patients varied from none to hospital readmission (Figure). Fifty percent of patients experiencing an adverse event did not use extra health care services; the remainder did. Nine percent made an additional visit to one of their physicians, 5% required

laboratory monitoring in addition to their physician care, 11% went to an emergency department, and 24% were readmitted to the hospital.

System problems contributed to all of the preventable and ameliorable adverse events. The most common deficit in the provision of discharge care was poor communication between the hospital caregivers and either the patient or the primary care physician (59% of preventable and ameliorable adverse events). Four principal aspects of the system were identified as requiring improvement: assessment and communication of unresolved problems at the time of discharge, patient education regarding medications and other therapies, monitoring of drug therapies after discharge, and monitoring of overall condition after discharge.

In univariate analyses, age, sex, marital status, Charlson Comorbidity Index score, ethnicity, and insurance class were not associated with adverse event occurrence ($P > 0.20$). These variables were forced into a multivariate logistic model, and none of the coefficients were statistically significant ($P > 0.2$). Physician-reviewers had moderate to high reliability in their judgments. For adverse event judgments, the reviewers agreed 87% of the time on initial review, with a corresponding κ value of 0.61. For the remaining 13% of cases, consensus was achieved 80% of the time and one third were judged adverse events. A third reviewer reviewed the remaining cases, of which one third were judged to be adverse events. Reviewers had 82% agreement and a κ value of 0.60 for preventability and 78% agreement and a κ value of 0.51 for ameliorability.

DISCUSSION

We found that nearly one in five patients experienced an adverse event during the transition from the hospital to home. These injuries ranged in significance from serious laboratory abnormalities to permanent disabilities. One third of the adverse events were preventable. Another third were ameliorable, that is, although they were unavoidable, their severity could have been decreased by earlier corrective actions. We identified four aspects of discharge care that could benefit from system design modifications to improve patient safety.

Few data are available regarding adverse events occurring in the posthospital period. Investigators have previously focused on adverse events in the hospital and found rates considerably lower than ours (2, 3). Although these other investigators particularly wanted to identify compensable events (3), we were primarily interested in quality improvement (2). Therefore, our definition of an injury was more inclusive because we did not require disability or rehospitalization. Also, our study specifically addressed injuries after hospitalization. We also reviewed every case, whereas other studies reviewed cases only if one or more screening criteria were present. Despite these differences, several important messages were the same: Adverse events

Table 3. Selected Examples of Adverse Events

| | |
|---|--|
| Preventable diagnostic error occurring in the hospital and unrecognized at discharge | A patient with abdominal pain and a markedly elevated lipase level was misdiagnosed as having mild pancreatitis and sent home on the basis of a "normal" radiographic study. The patient was readmitted 4 days later with worsened symptoms, including pain, inability to tolerate oral fluids, and an even higher lipase level. Official reading of the initial radiographic study showed clear evidence of pancreatic inflammation. |
| Nonpreventable and nonameliorable procedure-related injury and nosocomial infection occurring in the hospital and unrecognized at discharge | A patient was admitted with upper gastrointestinal bleeding. During the hospital course, the patient required a nasogastric tube. After getting home, but within a few days of nasogastric tube removal, the patient developed a headache, diagnosed as a sinus infection. Despite oral antibiotics, his symptoms progressed. He subsequently underwent surgery to drain a sinus abscess. |
| Nonpreventable and nonameliorable adverse drug event occurring after discharge | A patient with skin abscess was sent home with a course of oral dicloxacillin. One day after the patient's discharge, a generalized rash developed. The patient called the primary care physician and was seen immediately. The rash resolved with a change in anti-infective therapy. |
| Preventable adverse drug event occurring after discharge | A patient with congestive heart failure started receiving spironolactone in the hospital. The patient was sent home with a prescription for this medication in addition to previous use of ramipril, furosemide, and potassium supplements. Electrolytes were not monitored after discharge. Two weeks later, the patient developed extreme weakness and anorexia. Blood work at that time demonstrated a serum potassium level over 7.5 mmol/L. |
| Ameliorable adverse drug event occurring after discharge | An asthmatic patient was admitted with non-Q-wave myocardial infarction. The patient was prescribed a β -blocker in the hospital and had no problems. However, at home, she developed wheezing and a cough. The patient continued to have these symptoms until seen by a cardiologist 2 weeks later. The symptoms resolved immediately after therapy with the β -blocker was discontinued. |
| Preventable fall occurring after discharge | An elderly frail patient was admitted with pneumonia. On previous occasions, the patient went to caregiver's home with services or other rehabilitative care. This time, such services were not arranged and within days of discharge, the patient fell in the bathroom and fractured two ribs. |
| Preventable therapeutic error occurring in the hospital and recognized before discharge | A normally independent and active patient was admitted for an abdominal condition. During admission, the patient developed a pressure ulcer. |

occurred often, adverse drug events accounted for most nonsurgical adverse events, many adverse events were preventable, and systems of care delivery need to be improved (3, 4).

We identified 24 adverse events whose severity could have been decreased. We believe that these ameliorable adverse events are very relevant to safety in general but especially in the postdischarge period because they highlight the difficulties in providing care during the transition from the hospital to home. While patients are in the hospital, their condition and therapy are assessed frequently. However, after they go home, there are fewer opportunities for routine monitoring. Moreover, routine monitoring is often

Table 4. Severity of Adverse Events Compared with Judgments of Preventability and Ameliorability*

| Type of Adverse Event | Laboratory Abnormalities Only or Only 1 Day of Symptoms | Several Days of Symptoms | Nonpermanent or Permanent Disability |
|--------------------------------|--|-----------------------------|---|
| | ←————— n (%) —————→ | | |
| Nonpreventable, nonameliorable | 0 (0) | 23 (47) | 7 (28) |
| Ameliorable | 1 (25) | 17 (35) | 6 (24) |
| Preventable | 3 (75) | 9 (18) | 12 (48) |
| Total | 4 (100) | 49 (100) | 25 (100) |

* One preventable adverse event and one nonpreventable, nonameliorable adverse event resulted in permanent disability; the remainder resulted in nonpermanent disability. Of the 25 adverse events resulting in at least a nonpermanent disability, 12 were preventable (48% [95% CI, 28% to 68%]) and 6 were ameliorable (24% [CI, 7% to 41%]). The severity of the injuries resulting from the 78 adverse events differed among preventable adverse events; ameliorable adverse events; and nonpreventable, nonameliorable adverse events, based on the Fisher exact test ($P = 0.02$). More injuries that resulted in some degree of disability were preventable.

performed by someone other than the hospital care provider and may not be done even when possible because it is poorly reimbursed.

All of the preventable and ameliorable adverse events in our study were associated with one or more deficiencies in system design. This finding is consistent with other studies of hospital adverse events (4, 12). One problem, ineffective communication, contributed to many of the preventable and ameliorable adverse events, despite the fact that our hospital already sends an electronic message to a patient's primary care physician at the time of discharge (if an e-mail address is available) detailing the new medication regimen. On the basis of our findings, this communication should also contain specific information about what the follow-up physicians need to do, when they should do it, and what they should watch for. In addition, more effort must be made to effectively communicate this information to the patient.

Our study suggests that system modifications could improve quality of care. One potential improvement is the introduction of discharge planning. However, a recent Cochrane review did not demonstrate that this approach was efficacious for reducing unplanned hospital admissions (13). We speculate that the interventions in this review may have been ineffective because they did not specifically address the deficiencies we identified and the outcome was an insensitive marker of care quality. Other possible interventions could include a follow-up visit with the hospitalist within a week of discharge or follow-up telephone contact with a clinical pharmacist within 5 days of discharge.

Our study has several limitations. We may have experienced selection bias because we were not able to assess nonresponders. We believe that this biases our results toward a lower incidence of adverse events, since we compensated for the difficulty in contacting well patients who had returned to work or other activities by calling them repeatedly. The sicker patients who were disgruntled with hospital care, were too ill to speak on the phone for 20 minutes, were readmitted to the hospital, or had died either declined or were incapable of responding. Furthermore, there is no reason to believe that non-English-speaking patients or those without valid telephone lines would be less likely to have adverse events. In fact, considering

our finding that communication is important, we would expect their rates to be higher. Even if we assume that none of the nonresponders had an adverse event, the event rate would still be 11%.

Recall bias may have been introduced because the interview took place a variable amount of time after discharge. We do not think that this had a major effect, since a person's recollection of symptoms and treatments probably does not change very much over a 3-week period. Furthermore, we observed no relationship between adverse event occurrence and interview date.

We used implicit review to categorize events. Although this method is somewhat controversial (14) and has clear limitations (15, 16), the process for judging adverse events is generally accepted (2–4, 12, 17, 18). We used implicit judgments for causality, preventability, and ameliorability because it would be impossible to generate explicit criteria for the many types of adverse events we identified. This process resulted in reasonable interrater agreement, with κ values that were consistent with those in other studies of this nature and higher than those for assessments of preventable death (2, 4).

We conclude that many patients have adverse events during the transition of care from the hospital to home. System modifications could improve patient safety during this period. These system changes should focus on four areas: evaluating patients at the time of discharge; teaching patients about drug therapies, side effects, and what to do if specific problems develop; improving monitoring of therapies; and improving monitoring of patients' overall condition.

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Administrative, technical, or logistic support: A.J. Forster, D.W. Bates.
Collection and assembly of data: A.J. Forster.

*Appendix Table 1. Deficits in the Delivery of Care**

| |
|---|
| Inadequate patient education regarding the medical condition or its treatment |
| Poor communication between patient and physician |
| Poor communication between hospital and community physicians |
| Inadequate monitoring of the patient's illness after discharge |
| Inadequate monitoring of the patient's treatment after discharge |
| No emergency contact number given to the patient to call about problems |
| Patient problems getting prescribed medications immediately |
| Inadequate home services |
| Delayed follow-up care |
| Premature hospital discharge |
| Other |

* Reviewers were asked whether they felt that system problems contributed to the occurrence or severity of the adverse event. If so, they were asked to identify deficits in the delivery of care as described above.

Appendix Table 2. Adverse Events*

| Adverse Event Number | History | Ameliorable or Preventable | Severity | Type | Location |
|----------------------|--|----------------------------|-------------------------------|-----------------|----------------------------|
| 1 | The patient was discharged with diagnosis of noncardiac chest pain; nevertheless, the β -blocker dose was increased. The patient had nonspecific symptoms that resolved when the medication was changed to preadmission doses. | Neither | More than 1 day of symptoms | ADE | Posthospital |
| 2 | The patient had known seizure disorder and began taking an antibiotic known to potentially alter levels of antiepileptic drugs. No monitoring was performed in or out of the hospital, and the patient presented with generalized seizure shortly after discharge. Blood levels of antiepileptic drugs were subtherapeutic. | Neither | Nonpermanent disability | ADE | Posthospital |
| 3 | The patient was discharged despite clinical instability and required readmission. | Preventable | Nonpermanent disability | Therapy | In hospital, unrecognized† |
| 4 | The patient had a known allergy to a specific agent but was given that agent despite protesting and developed a pruritic rash. | Preventable | More than one day of symptoms | Therapy | In hospital, unrecognized† |
| 5 | The patient developed drug-induced diabetes, was not monitored, and required readmission for life-threatening instability. | Preventable | Nonpermanent disability | Diagnostic | In hospital, unrecognized† |
| 6 | The patient developed life-threatening electrolyte abnormality and severe symptoms after receiving a medication that often causes this problem. No monitoring was done for 2 weeks. | Preventable | Nonpermanent disability | ADE | Posthospital |
| 7 | The patient was discharged despite clinical instability and required readmission. | Preventable | Nonpermanent disability | Fall | Posthospital |
| 8 | The patient was receiving antibiotics and developed diarrhea in the hospital, which persisted for several days after discharge. The stool tested negative for <i>Clostridium difficile</i> toxin in the hospital, and symptoms resolved at home once antibiotics were discontinued. | Neither | More than one day of symptoms | ADE + infection | In hospital, recognized‡ |
| 9 | The patient was discharged unwell with an undiagnosed problem. Several days later, the condition had progressed to becoming life-threatening. No follow-up was arranged before discharge. | Ameliorable | Nonpermanent disability | Diagnostic | Posthospital |
| 10 | The patient was admitted with new-onset congestive heart failure, and no follow-up was arranged at discharge. The patient was readmitted for congestive heart failure due to nonadherence to therapy. | Preventable | Nonpermanent disability | Therapy | Posthospital |
| 11 | Pressure ulcer developed in the hospital in a previously ambulatory patient. The ulcer was noted in the hospital, and a visiting nurse arranged for dressing changes after hospitalization. | Preventable | Nonpermanent disability | Therapy | In hospital, recognized‡ |
| 12 | The patient experienced nausea as a result of antibiotics prescribed for urinary tract infection. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 13 | The patient was prescribed very high doses of corticosteroid and developed a generalized anxiety reaction. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 14 | The patient was prescribed narcotics with no teaching about constipating effects or co-prescription of stool softener. After several days of progressive symptoms, the patient came to the emergency department for treatment of severe constipation and vomiting. The patient responded to intravenous fluids, enemas, and antiemetic agents. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 15 | The patient developed nausea, diarrhea, and arthralgia during antibiotic use. Symptoms resolved with discontinuation of medication. | Neither | More than one day of symptoms | ADE | Posthospital |

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Appendix Table 2—Continued

| Adverse Event Number | History | Ameliorable or Preventable | Severity | Type | Location |
|----------------------|---|----------------------------|-------------------------------|-----------------|--------------------------|
| 16 | The patient was taking antibiotics and developed diarrhea in the hospital that persisted for several days after discharge. The stool tested negative for <i>C. difficile</i> toxin in the hospital, and symptoms resolved at home once antibiotics were discontinued. | Ameliorable | More than one day of symptoms | ADE | In hospital, recognized‡ |
| 17 | The patient was discharged while receiving antibiotics and developed diarrhea after going home. Several days later (with no intervening follow-up), the patient returned to the emergency department with pancolitis and was readmitted. The diagnosis was <i>C. difficile</i> colitis. | Ameliorable | Nonpermanent disability | ADE + infection | Posthospital |
| 18 | The patient had renal insufficiency and was prescribed a β -blocker and a calcium-channel blocker concomitantly at discharge. The patient was readmitted with life-threatening bradycardia. | Neither | Nonpermanent disability | ADE | Posthospital |
| 19 | The patient was discharged while taking corticosteroids and developed sleeplessness, poor glycemic control, polyuria, bilateral ankle swelling, and acne. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 20 | The patient developed <i>Candida</i> infection as a result of antibiotic use. | Neither | More than one day of symptoms | ADE | Posthospital |
| 21 | One day after discharge, the patient developed swelling and erythema where the intravenous line was located. | Neither | More than one day of symptoms | Procedure | Posthospital |
| 22 | The patient developed a rash secondary to a medication. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 23 | The patient was prescribed a β -blocker at discharge despite a history of asthma. The patient was not warned of potential side effects and developed wheezing and coughing at home. Symptoms resolved with discontinuation of drug. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 24 | The patient had a severe, chronic medical condition that was not followed after discharge. Symptoms recurred, and the patient was not able to arrange follow-up for several weeks. The patient was eventually readmitted for symptoms. | Neither | Nonpermanent disability | Therapy | Posthospital |
| 25 | The patient developed <i>Candida</i> infection as a result of antibiotic use. The infection spread, and the patient went to the emergency department without calling the primary care physician. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 26 | The patient developed a rash secondary to a medication. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 27 | The patient developed nonspecific symptoms related to a medication prescribed in doses greater than the recommended dose. Symptoms were not addressed by follow-up care, but the patient decreased the dose with resolution of symptoms. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 28 | The patient was taking warfarin and was discharged with inappropriate dosing and inappropriate follow-up of INR. No bleeding ensued, but the INR exceeded 10. | Preventable | Laboratory | ADE | Posthospital |
| 29 | The patient was injured while being pushed in a wheelchair. | Preventable | Nonpermanent disability | Procedure | In hospital, recognized‡ |
| 30 | The patient developed nausea and vomiting secondary to a medication. Symptoms were not addressed by follow-up care. | Ameliorable | One day of symptoms | ADE | Posthospital |
| 31 | The patient was prescribed caffeine-containing medication and developed insomnia. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |

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Appendix Table 2—Continued

| Adverse Event Number | History | Ameliorable or Preventable | Severity | Type | Location |
|----------------------|---|----------------------------|-------------------------------|-----------------------|----------------------------|
| 32 | The patient developed a complication related to a procedure that resulted in severe pain. After discharge, the patient experienced more pain and was not able to use the left arm without extreme discomfort. Ultimately, it was determined that the pain was attributable to the procedure, which had to be repeated to correct the problem. Afterward, the symptoms resolved. | Neither | Nonpermanent disability | Procedure | In hospital, recognized‡ |
| 33 | The patient was prescribed narcotics with no teaching about constipating effects or co-prescription of stool softener. The patient developed constipation, nausea, and poor oral intake. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 34 | The patient received a diagnosis of urinary tract infection after discharge within days of removal of the Foley catheter. | Neither | More than one day of symptoms | Procedure + infection | Posthospital |
| 35 | The patient had life-threatening complications of a biopsy procedure in the hospital. Symptoms persisted after discharge. | Neither | Nonpermanent disability | Procedure | In hospital, recognized‡ |
| 36 | The patient developed problems in the hospital related to an interstitial intravenous line and a reaction to the adhesive tape. Skin breakdown required dressing changes after discharge. | Neither | More than one day of symptoms | Procedure | In hospital, recognized‡ |
| 37 | The patient developed a hoarse voice after being discharged with a prescription for an inhaled steroid. The patient did not recall being taught about gargling or rinsing after using the inhaled steroid. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 38 | The patient developed a rash from a medication. | Neither | More than one day of symptoms | ADE | Posthospital |
| 39 | The patient was admitted for endovascular procedure. Limitations of activities post-procedure were not taught, and a groin hematoma developed after the patient squatted to lift a heavy object within days of discharge. | Preventable | More than one day of symptoms | Procedure | Posthospital |
| 40 | The patient had viral meningitis and was not followed after discharge. The patient developed severe symptoms and was not able to be seen. An invasive procedure was eventually required to identify and definitively treat the problem. | Preventable | More than one day of symptoms | Therapy | Posthospital |
| 41 | The patient developed edema while taking a corticosteroid. | Neither | More than one day of symptoms | ADE | Posthospital |
| 42 | The patient was taking warfarin and was discharged with inappropriate dosing and inappropriate follow-up of INR. No bleeding ensued, but the patient had to go to the emergency department for vitamin K injection. | Preventable | Laboratory | ADE | Posthospital |
| 43 | The patient was discharged despite developing post-ERCP abdominal pain. Symptoms were not addressed by follow-up care, and the patient was readmitted to the hospital. | Ameliorable | Nonpermanent disability | Procedure | In hospital, unrecognized† |
| 44 | The patient developed a cough after an angiotensin-converting enzyme inhibitor was prescribed. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 45 | The patient experienced cough because an antiasthmatic medication was not prescribed at discharge. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 46 | A diagnosis was missed because of an erroneous reading of initial abdominal imaging study. The patient returned with worsening of original condition several days later. | Preventable | Nonpermanent disability | Diagnostic | In hospital, unrecognized† |
| 47 | Diarrhea associated with iron supplements developed postdischarge and resolved when supplements were discontinued. | Neither | More than one day of symptoms | ADE | Posthospital |

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Appendix Table 2—Continued

| Adverse Event Number | History | Ameliorable or Preventable | Severity | Type | Location |
|----------------------|--|----------------------------|-------------------------------|-----------------------|------------------------------|
| 48 | Acute interstitial nephritis developed post-hospitalization, related to antibiotic prescribed at discharge. The patient had renal insufficiency and required kidney biopsy. | Neither | Nonpermanent disability | ADE | Posthospital |
| 49 | The patient developed a rash in the hospital related to antibiotics. The rash persisted after discharge. | Neither | More than one day of symptoms | ADE | In hospital, recognized‡ |
| 50 | The patient was being treated for cancer and did not receive an antiemetic agent at the outpatient pharmacy (it was not in stock). It took 24 hours to obtain the drug, during which time the patient had moderate nausea. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 51 | The patient was sent home with a prescription for ipratropium and developed dysgeusia. Symptoms resolved after the patient called the physician and the pharmacist and was told to discontinue the medication. | Neither | More than one day of symptoms | ADE | Posthospital |
| 52 | Diagnosis of thrombosis of two large veins was missed because of failure to perform appropriate imaging studies. The patient had several weeks of symptoms before the correct test was performed and the diagnosis was made. | Ameliorable | Nonpermanent disability | Diagnostic | In hospital, unrecognized‡ |
| 53 | The patient developed nausea, anorexia, and retching while taking an antibiotic. Symptoms persisted for nearly 2 weeks before the antibiotic was discontinued and they resolved. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 54 | The patient was diuresed vigorously and experienced postural symptoms. There was no history of falls. | Neither | More than one day of symptoms | ADE | Posthospital |
| 55 | The patient, who was receiving palliative care, was sent home with pain control prescribed but inadequate teaching about pain management. The patient experienced excruciating pain and returned to the emergency department with family. Once the patient was taught about how to deal with "breakthrough pain," analgesia was adequate and the patient remained comfortable. | Preventable | Nonpermanent disability | Therapy | Posthospital |
| 56 | The patient had previous disease in the affected area and developed an infection in the same location. The patient was discharged home even though unable to bear weight. Results of a subsequent diagnostic procedure more than a week later were positive and required a definitive procedure, which left the patient with a permanent disability. | Ameliorable | Permanent disability | Diagnostic | In hospital, not recognized‡ |
| 57 | The patient, who was elderly, developed constipation after being discharged while taking verapamil. | Neither | More than one day of symptoms | ADE | Posthospital |
| 58 | The patient had chronic pain and was discharged home while taking several benzodiazepines and narcotics. Three weeks later, the patient was admitted with stupor due to overuse of psychotropic medications. | Preventable | Nonpermanent disability | ADE + therapy | Posthospital |
| 59 | The patient was taking warfarin and was discharged with inappropriate dosing and inappropriate follow-up of INR. No bleeding ensued, but INR exceeded 8. | Preventable | Laboratory | ADE | Posthospital |
| 60 | The patient developed a thrombosed temporary access catheter after discharge. | Neither | More than one day of symptoms | Procedure | Posthospital |
| 61 | The patient had a life-threatening complication of an invasive procedure after discharge. The complication was not recognized before discharge. | Neither | Nonpermanent disability | Procedure + infection | In hospital, unrecognized |

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Appendix Table 2—Continued

| Adverse Event Number | History | Ameliorable or Preventable | Severity | Type | Location |
|----------------------|--|----------------------------|-------------------------------|-----------|----------------------------|
| 62 | The patient developed a rash at the site of low-molecular-weight-heparin injections after going home. | Neither | More than one day of symptoms | ADE | Posthospital |
| 63 | The patient was sent home with a prescription for clonidine for treatment of hypertension. After discharge, the patient could not urinate. The physician was called, and clonidine was discontinued. The problem resolved. | Neither | More than one day of symptoms | ADE | Posthospital |
| 64 | The patient was sent home while taking a corticosteroid and subsequently developed generalized weakness and abdominal bloating. Problems resolved after the prednisone was discontinued. | Neither | More than one day of symptoms | ADE | Posthospital |
| 65 | The patient was sent home while taking a corticosteroid and developed insomnia. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 66 | The patient developed <i>Candida</i> infection in the hospital while taking a corticosteroid. Despite a prescription for an antifungal agent, the problem continued after discharge. | Neither | More than one day of symptoms | ADE | In hospital, recognized‡ |
| 67 | The patient had pain secondary to newly diagnosed cancer that was inappropriately treated at discharge. This pain was well controlled after an appointment at a cancer center and adjustments in analgesia. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 68 | The patient, who was elderly and frail, was not provided with home services or rehabilitative care and suffered a fall and fractured ribs. | Preventable | Nonpermanent disability | Fall | Posthospital |
| 69 | The patient was taking warfarin and was discharged with inappropriate dosing and inappropriate follow-up of INR. No bleeding ensued, but the INR exceeded 9. | Preventable | More than one day of symptoms | ADE | Posthospital |
| 70 | The patient developed a skin rash after taking an antibiotic. | Neither | More than one day of symptoms | ADE | Posthospital |
| 71 | The patient developed serious drug toxicity resulting in permanent disability. The toxicity was caused by intravenous medication given at home that should have been monitored; no drug levels were done after discharge. | Preventable | Permanent disability | ADE | Posthospital |
| 72 | The patient was taking antibiotics and developed diarrhea in the hospital that persisted for several days after discharge. The stool tested negative for <i>C. difficile</i> toxin in the hospital, and symptoms resolved at home once antibiotics were discontinued. Symptoms persisted and were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | In hospital, recognized‡ |
| 73 | The patient was readmitted for gastritis secondary to concomitant aspirin and corticosteroid use. Symptoms persistent for weeks and were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | ADE | Posthospital |
| 74 | The patient was injured because of physical restraints, but the injury was not recognized until after discharge. | Ameliorable | Nonpermanent disability | Procedure | In hospital, unrecognized† |
| 75 | The patient was treated with radiation therapy and developed skin irritation and burning over the radiation field as well as general discomfort. | Neither | More than one day of symptoms | Procedure | Posthospital |
| 76 | The patient, who had several medical problems, fell days after being discharged and went to the emergency department. | Neither | More than one day of symptoms | Falls | In hospital, unrecognized† |
| 77 | The patient developed radiating back pain after a difficult lumbar puncture procedure. Symptoms were not addressed by follow-up care. | Ameliorable | More than one day of symptoms | Procedure | Posthospital |
| 78 | The patient developed nausea related to treatment with metronidazole. | Neither | More than one day of symptoms | ADE | Posthospital |

* To be included in the study, adverse events had to affect patients after hospital discharge. However, events were included even if they occurred while the patient was still in the hospital if they resulted in postdischarge morbidity. If events occurred while the patient was in the hospital, we determined whether the injury was identified before discharge. ADE = adverse drug event; ERCP = endoscopic retrograde cholangiopancreatography; INR = international normalized ratio.

† The injury was recognized and managed before discharge.

‡ The injury was not recognized before discharge.

Appendix Figure. Summarized version of the telephone interview.

Please list the physicians you have seen since your discharge from the hospital and answer the following questions regarding the visits.

| | Name | Specialty | Have you seen him/her since discharge? 1 = Yes 2 = No 3 = NA | If yes, did he/she know of your hospitalization? 1 = Yes 2 = No 3 = NA | If no, what is the date of your next appointment with him/her? MM/DD/YY | In your opinion, would an earlier appointment have been helpful? 1 = Yes 2 = No 3 = NA |
|----|------|-----------|---|---|--|---|
| 1. | (a) | (b) | (c) | (d) | (e) | (f) |
| 2. | (a) | (b) | (c) | (d) | (e) | (f) |

3. Have you received home care services (like a visiting nurse) since returning home?

(a) Yes (b) No

4. If you answered no, do you feel you needed them?

(a) Yes (b) No

5. Have you returned to the emergency department since your discharge from the hospital?

(a) Yes (b) No

6. If so, why? _____

7. Did you require readmission to the hospital since your initial visit?

(a) Yes (b) No

8. If so, why? _____

| | Symptom | How long ago did this symptom start? | If it started before discharge, has it gotten worse since getting home? | Is this symptom related to your recent hospitalization? | Have you discussed it with your doctor? | Did your doctor do anything in response? | What did he/she do? | Did this symptom require an additional visit to a medical facility? |
|-----|--|--------------------------------------|---|---|---|--|---------------------|---|
| | | 1 = No 2 = Yes 3 = DK | 1 = After discharge 2 = During admission 3 = <1 month before admission 4 = >1 month before admission | 1 = No 2 = Yes 3 = DK | 1 = No 2 = Yes 3 = DK | 1 = No 2 = Yes | 1 = No 2 = Yes | 1 = Arrange visit with him/herself 2 = Change treatment over telephone 3 = Arrange visit with other health provider 4 = Arrange referral to the emergency department 1 = No 2 = Clinic visit 3 = Emergency department visit 4 = Hospitalization 5 = Other |
| 9. | Fever | | | | | | | |
| 10. | Pain or discomfort (specify location: 1 = Head 2 = Chest 3 = Abdomen 4 = Back 5 = Extremity) | | | | | | | |
| 11. | Inability to eat | | | | | | | |
| 12. | Nausea or vomiting | | | | | | | |
| 13. | Diarrhea | | | | | | | |
| 14. | Shortness of breath | | | | | | | |
| 15. | Cough | | | | | | | |
| 16. | Skin breakdown (specify location: 1 = Back 2 = Lower extremity 3 = Other) | | | | | | | |
| 17. | Rash | | | | | | | |
| 18. | Falls | | | | | | | |
| 19. | Swollen legs | | | | | | | |
| 20. | Urinary frequency | | | | | | | |
| 21. | Dysuria | | | | | | | |
| 22. | Other (please specify) | | | | | | | |

DK = don't know; NA = not available.