HEALTH CARE REFORM

Patients Treated at Multiple Acute Health Care Facilities

Quantifying Information Fragmentation

Fabienne C. Bourgeois, MD, MPH; Karen L. Olson, PhD; Kenneth D. Mandl, MD, MPH

Background: Fragmentation of medical information places patients at risk for medical errors, adverse events, duplication of tests, and increased costs. We sought to quantify, at the population level, the burden of fragmentation in the acute care setting across the state of Massachusetts by measuring the rates at which individuals seek care across multiple sites.

Methods: A retrospective observational study of all adult patients with at least 2 visits or hospitalizations to the emergency departments, inpatient units, and observation units in Massachusetts from October 1, 2002, to September 30, 2007.

Results: The 3 692 178 adult patients who visited an acute care site during our study period accounted for 12 758 498 acute care visits. A total of 1 130 124 adult patients (31%) visited 2 or more hospitals during the study period, accounting for 56.5% of all acute care visits, while a subgroup of 43 794 patients (1%) visited 5 or more hospitals, contributing to almost one-tenth of all acute visits. Patients who visited multiple sites were younger ($P<.001$), more likely to be male ($P<.001$), more likely to have a primary psychiatric diagnosis ($P<.001$), and more frequently hospitalized ($P<.001$) and incurred higher charges than patients who used only a single site of care ($P<.001$).

Conclusions: A large number of patients seek care at multiple acute care sites. These findings provide one basis for assessing the value of an integrated electronic health information system for clinicians caring for patients across sites of care and therefore the return on investment in health information technology.

Arch Intern Med. 2010;170(22):1989-1995

Author Affiliations: Divisions of General Pediatrics (Dr Bourgeois) and Emergency Medicine (Drs Olson and Mandl) and Children's Hospital Informatics Program (Drs Olson and Mandl), Children's Hospital Boston, and Department of Pediatrics, Harvard Medical School (Drs Bourgeois, Olson, and Mandl), Boston, Massachusetts.

HEALTH CARE PROVIDERS require timely access to patients' health information to deliver effective and safe medical treatment. However, they frequently do not have access to complete medical information, particularly for patients who have been treated at other health care facilities. Therefore, providers often rely on fragmented and incomplete medical information to make complex management decisions. Treating patients without complete information poses an important challenge to patient safety, increasing the likelihood of medical errors, adverse events, duplication of laboratory tests and procedures, and increased health care costs.[1-3] This is particularly true for patients who have difficulty communicating, such as individuals facing language barriers or who suffer from psychiatric disorders.[4]

Studies have found high rates of missing medical information in a number of settings, with potentially detrimental consequences.[5-8] Smith et al[9] surveyed primary care providers in 32 primary care clinics and found that clinical information was missing in 13.6% of visits. More than half of the missing information resided outside the clinicians' practice or clinical system. Clinicians reported that missing information could adversely affect the patients in nearly 50% of cases and lead to delays in care or additional testing and visits in more than 50% of cases. This problem is compounded in the acute care setting, where the acuity and urgency of the decision-making process leaves little time to track down pertinent clinical information.[10]

We sought to quantify the degree of fragmentation of medical information across multiple acute health care facilities in the state of Massachusetts between fiscal years 2002 and 2007, a period that provided limited electronic health information exchange across acute care sites.

METHODS

STUDY DESIGN

We conducted a retrospective observational study of all adult acute care visits and admissions to emergency departments (EDs), inpatient units, and observation units in the state

of Massachusetts from October 1, 2002, to September 30, 2007, the latest year for which data were available. Data for this study were obtained from 3 databases that are compiled and managed on a quarterly basis by the Division of Health Care Finance and Policy in the state of Massachusetts: the Outpatient Hospital Emergency Database, the Outpatient Observation Database, and the Inpatient Hospital Discharge Database. The institutional review board of the Children's Hospital Boston classified the study as exempt.

SETTING AND STUDY POPULATION

The Health Care Finance and Policy databases contain comprehensive information documenting all ED visits, observation stays, and inpatient hospitalizations at the 77 nonfederal acute care hospitals and satellite emergency facilities in Massachusetts. The databases exclude information pertaining to visits to Veterans Affairs hospitals and other federal facilities. If a patient was initially seen in the ED or observation unit but was then admitted to the same hospital's inpatient unit, that visit only appears once within the Inpatient Hospital Discharge Database. The visit was flagged to denote the origin of the visit either in the ED or observation unit, thus preventing the duplication of visits across the databases.

We included all patients 18 years and older who presented at least twice to the EDs, observation units, or inpatient units and were assigned valid unique health identification numbers (UHINs). Patients whose UHIN only appeared once across the 3 databases were excluded. The UHIN is derived from social security numbers and identifies individual patients across the 3 databases, allowing all visits and hospitalizations by an individual patient to be linked across hospital sites. We excluded patients who were younger than 18 years because a disproportionate number of children had missing UHINs, likely owing to the unavailability of social security numbers at the time of their visit. Also, we excluded visits with identical UHINs where the patient's age in sequential visits was discrepant or inconsistent over the 5-year study period. This exclusion was based on the assumption that the discrepancy probably reflected visits by separate individuals who were assigned identical UHINs or by the same individual who had an incorrect age entered at separate visits into the database.

MEASUREMENTS

The main outcome variable was the use of more than 1 acute care site by a patient with at least 2 acute care visits during the 5-year study period. Patients who visited or were hospitalized at 2 or more sites of care during the study period were designated multisite users, while patients who attended only the same site of care were considered same-site users. The first acute care visit or hospitalization during the study period was considered the patient's first visit, and the corresponding hospital identification number represented the first site of care. Any subsequent visit or hospitalization by the patient to a health care facility was considered a repeat visit, and any subsequent visit to a health care facility with a new hospital identification number was considered a repeat visit to a new site of care.

We further identified 2 subgroups for additional analyses. The first group captured a subgroup of the multisite patient population, the high-intensity multisite users, who were seen at 5 or more different sites during the course of the study. This group was identified to examine the characteristics of patients who were at a higher risk of fragmentation. Also, to better compare acuity among multisite and same-site patients, we identified users with similar, high-acuity use patterns by analyzing patients who had 3 or more hospitalizations.

Additional independent variables included patients' demographic information, eg, age, race, and sex, as well as visit-specific data, including hospital identification code, location of visit (ED, inpatient unit, or observation unit), date of service, principal diagnosis codes based on the *International Classification of Diseases, Ninth Revision (ICD-9)*, insurance status, length of stay per hospitalization, charges, and total visits, which were calculated as the sum of all ED visits and hospitalizations. We were unable to assess mortality among our patient population, because several of the study hospitals incorrectly coded the discharge status during the study period.

Age was defined as the age of the patient at the time of his or her first visit during the study period. Hospitalizations were defined as any admission to an inpatient or observation unit during the study period. Insurance status was determined based on the primary insurance carrier for each patient at each visit and grouped based on insurance type (commercial, Medicare, Medicaid, free care, and self-pay.) Although some patients' insurance type changed between visits over the course of the study period, for purposes of the analysis, a patient was considered as having Medicaid or free care if they had used either of these insurance options at any 1 patient visit.

ANALYSIS

Logistic regression analysis identified patient characteristics associated with multisite users (≥2 different hospitals) compared with same-site users. An additional subgroup analysis was undertaken to examine high-intensity multisite users (≥5 different hospitals) compared with same-site users with similar health care use (≥5 visits). A similar logistic regression analysis was performed among the high-acuity group by identifying patient characteristics among high-acuity multisite users compared with same-site users with similar use patterns.

Predictors were chosen a priori and included sex, race, age, principal psychiatric diagnosis (*ICD-9* codes 295-316) at any 1 visit, payment type (Medicaid, free care, or other), mean ED charges per patient, mean hospitalization charges per patient, number of hospitalizations, mean length of stay for hospitalizations, and total number of ED visits and hospitalizations. Statistical significance was defined as $P < .05$ (2-tailed test). All statistical analyses were conducted using SAS version 9.1 (SAS Institute Inc, Cary, North Carolina).

RESULTS

PATIENT DEMOGRAPHICS AND VISIT CHARACTERISTICS

Multisite Users (≥2 Different Hospitals)

The 3 692 178 adult patients who visited an acute care site during our study period accounted for 12 758 498 acute care visits. Of these, 1 130 124 adult patients (30.6%) sought care at 2 or more hospitals in Massachusetts during the study period. They accounted for 56.5% of all ED, inpatient, and observation visits and hospitalizations. Their mean (SD) age was 47.7 (20.0) years. More than half (53.6%) were female and predominantly identified themselves as white (72.2%), with 8% identifying themselves as black and 7.3% as Hispanic (**Table 1**). More than one-third of the visits or hospitalizations (38.9%) represented the first visit to a hospital at which the patients had not yet been seen during the study period. The median number of ED visits at any hospital—including repeat visits to the same hospital—

Table 1. Characteristics of Patients With Repeat Visits to Acute Care Hospitals

Variable	Patients With Repeat Visits to the Same Site of Care (n=1 066 263)	Patients With Repeat Visits to ≥2 Sites of Care (n=1 130 124)	Patients With Repeat Visits to ≥5 Sites of Care (n=43 794)
Age, mean (SD), y	50.6 (21)	47.7 (20)	40.2 (15.8)
Sex, No. (%)			
Female	598 067 (56.1)	605 939 (53.6)	21 545 (49.2)
Incomplete	41 (0)	98 (0.01)	2 (0)
Race/ethnicity, No. (%)			
White	793 587 (74.4)	815 515 (72.2)	33 634 (76.8)
Black	61 008 (5.7)	89 227 (8.0)	4610 (10.5)
Hispanic	68 985 (6.5)	82 239 (7.3)	2473 (5.6)
Other	21 010 (2.0)	38 347 (3.4)	867 (2.0)
Incomplete	105 254 (9.9)	104 796 (9.3)	2210 (5.0)
Insurance, No. (%)			
Medicaid	95 427 (9.1)	145 910 (13.1)	15 255 (35.7)
Medicare	300 419 (28.5)	294 600 (26.4)	11 129 (26.1)
Free care	44 794 (4.2)	46 404 (4.2)	2243 (5.2)
Self-pay	60 179 (5.7)	68 866 (6.2)	2993 (7.0)
Commercial	553 143 (52.5)	559 575 (50.1)	11 046 (25.9)

Table 2. Characteristics of Repeat Visits to Acute Care Facilities

Variable	Patients With Repeat Visits to the Same Site of Care (n=1 066 263)	Patients With Repeat Visits to ≥2 Sites of Care (n=1 130 124)	Patients With Repeat Visits to ≥5 Sites of Care (n=43 794)
No. of visits			
No. of ED visits and hospitalizations at all hospitals	3 824 962	7 208 438	1 050 105
No. of ED visits and hospitalizations at different hospitals (% of total visits)[a]	NA	2 804 874 (38.9)	278 370 (26.5)
No. of ED visits, median (range)			
ED visits at all hospitals	2 (1-298)	3 (1-997)	12 (1-997)
ED visits at different hospitals[a]	NA	2 (1-60)	4 (1-60)
No. of hospitalizations, median (range)			
Hospitalizations at all hospitals	2 (0-79)	2 (0-187)	4 (0-187)
Hospitalizations at different hospitals[a]	NA	1 (0-24)	2 (0-24)
Length of time between visits and hospitalizations, mean (SD)			
Visits to all hospitals	329 (329)	297 (287)	99 (67)
Visits to different hospitals[a]	NA	482 (405)	234 (102)
Location of visit, No. (%)			
ED	2 676 380 (68.3)	4 893 872 (67.6)	801 633 (76.3)
Inpatient unit	1 068 747(27.3)[c]	2 024 563 (28.0)[b]	216 985 (20.7)[d]
Observation unit	175 488 (4.5)	315 849 (4.4)	31 487 (3.0)
Length of stay for hospitalizations, mean (SD), d	4.5 (4.5)	4.3 (4.3)	5.2 (4.8)
ED charges per patient, mean (SD), $	934 (1012)	1128 (1101)	20 106 (26 052)
Hospitalization charges per patient, mean (SD), $	7465 (15 645)	12 050 (21 270)	85 217 (147 211)

Abbreviations: ED, emergency department; NA, not applicable.
[a] Includes index hospital and all subsequent hospitals where patients had not been previously seen during the study period.
[b] The percentage of patients in the inpatient unit who were initially seen in the ED was 52.8%.
[c] The percentage of patients in the inpatient unit who were initially seen in the ED was 55.9%.
[d] The percentage of patients in the inpatient unit who were initially seen in the ED was 59.6%.

was 3 (range, 1-997 ED visits), while the median number of hospitalizations was 2 (range, 0-24 hospitalizations) (**Table 2**). The median number of distinct hospitals used by an individual patient for ED visits was 2 (range, 1-60 hospitals). The mean (SD) length of time between visits or hospitalizations was 297 (287) days, while the mean (SD) length of time between visits to different hospitals was 482 (405) days. The most common principal diagnoses billed for these patients included nonspecific symptoms (15.8%), joint sprains and strains (5.7%), mental disorders (4.8%), and dorsopathies (3.7%) (**Table 3**). The mean (SD) total ED charges were $1128 ($1101), while the mean (SD) total hospitalization charges were $12 050 ($21 270).

High Intensity Multisite Users (≥5 Different Hospitals)

There were 43 794 patients who presented to 5 or more different hospitals during the course of the study period and accounted for 1 050 105 (8.2%) of all adult patient visits and hospitalizations to acute care hospitals. These patients were generally younger, with a mean age of 40.2

Table 3. Frequent *International Classification of Diseases, Ninth Revision* (*ICD-9*), Code Subcategories

Diagnosis, *ICD-9* Codes	No. (%)		
	Repeat Visits to Same Site of Care	Repeat Visits to ≥2 Sites of Care	Repeat Visits to ≥5 Sites of Care
Symptoms, 780-789	605 030 (15.4)	1 139 212(15.8)	162 793 (15.5)
Sprains and strains of joints, 840-848	238 107 (6.1)	415 132 (5.7)	58 098 (5.5)
Mental disorders, 300-316	63 149 (1.6)	350 860 (4.8)	139 365 (13.3)
Dorsopathies, 720-724	112 145 (2.9)	268 984 (3.7)	56 755 (5.4)
Contusion with intact skin surface, 920-924	133 622 (3.4)	228 408 (3.2)	32 567 (3.1)
Acute respiratory infections, 460-466	133 767 (3.4)	194 364 (2.7)	20 464 (2.0)
Chronic obstructive pulmonary disease, 490-496	116 094 (3.0)	190 679 (2.6)	24 664 (2.4)
Other psychoses, 295-299	30 355 (0.8)	190 207 (2.6)	65 860 (6.3)
Other forms of heart disease, 420-429	101 890 (2.6)	176 568 (2.4)	9312 (0.9)
Other diseases of urinary system, 590-599	121 803 (3.1)	176 238 (2.4)	17 300 (1.6)

(15.8) years, and mostly white (76.8%), and about half were female (49.2%) (Table 1).The median number of ED visits for this subgroup was 12 (range, 1-997 ED visits), and the median number of different hospitals used was 4 (range, 1-60 hospitals). Patients in this group were hospitalized more often, with a median of 4 (range, 0-187) hospitalizations per patient. The mean total ED charges per patient averaged $20 106 ($26 052) and $85 217 ($147 211). The average length of time between visits was 99 (67) days (Table 2). Almost one-fifth of these patients (19.6%) presented with a principal diagnosis of a psychiatric disorder (Table 3).

Same-Site Users

There were 1 066 263 patients (28.9%) who were exclusively seen at the same hospital during the study period. Accounting for 30% of all visits and hospitalizations at acute care sites, this population had a mean age of 50.6 (21.0) years, and more than half (56.1%) were female. Most patients were white (74.4%), while 5.7% described themselves as black and 6.5% as Hispanic (Table 1). The median number of ED visits during the study period was 2 (range, 1-298 ED visits), and the median number of hospitalizations per patient was also 2 (range, 0-79 hospitalizations). On average, the length of time between visits was 329 (329) days (Table 2). The most common principal diagnoses were nonspecific signs and symptoms (15.4%), joint sprains and strains (6.1%), and contusions (3.4%) (Table 3). The mean total ED charges per patient were $934 ($1012), and the mean total hospitalization charges per patient were $7465 ($15 645).

MULTIVARIATE ANALYSIS

In an adjusted regression model, the multisite patients were less likely to be female (odds ratio [OR], 0.85; 95% confidence interval [CI], 0.84-0.85) and less likely to be white (OR, 0.88; 95% CI, 0.87-0.88) than the same-site patients. They had an almost 2-fold odds (OR, 1.90; 95% CI, 1.88-1.92) of having presented to an acute care site with a psychiatric diagnosis, were more likely to have been hospitalized (OR 1.86, 95% CI 1.85-1.88), and accrued significantly higher mean ED charges and hospitalization charges per patient ($P<.001$). The mean length of stay per hospitalization was slightly shorter for the multisite users than for the same-site users (**Table 4**).

In the adjusted model for the first subgroup analysis, the high-intensity multisite users were compared with a comparable group of frequent same-site users with similar acute care use patterns (≥5 ED visits or hospitalizations). The high-intensity multisite users were again less likely to be female (OR, 0.61; 95% CI, 0.59 -0.62), tended to be younger, and had substantially greater odds of having a primary psychiatric diagnosis (OR, 5.81; 95% CI, 5.64-5.98) at any 1 acute care visit. The mean ED charges and hospitalization charges per patient were significantly higher for the high-intensity multisite users than for the same-site users ($P<.001$). This subgroup of patients also had increased odds of being hospitalized (OR, 2.80; 95% CI, 2.70-2.90) and a longer mean length of stay per hospitalization (Table 4).

In the additional analyses, we compared high-acuity patients (≥3 hospitalizations) among the multisite users and the same-site users as well as among the high-intensity multisite users compared with the frequent same-site users (≥5 visits). The multisite users, including the high-intensity multisite users, were again significantly younger ($P<.001$) and less likely to be female (OR, 0.81; 95% CI, 0.80-0.82 for the multisite group; OR, 0.61; 95% CI, 0.59-0.64 for the high-intensity multisite group). The multisite users, particularly the high-intensity multisite users, had increased odds of having had at least 1 visit with a primary psychiatric diagnosis (OR, 8.25; 95% CI, 7.89-8.63) and accumulated significantly higher ED and hospitalization charges ($P<.001$). The mean length of stay per hospitalization was slightly longer among the multisite users ($P<.001$) but was not significantly different among the subgroup of high-intensity multisite users compared with the frequent same-site users ($P=.70$) (**Table 5**).

COMMENT

To our knowledge, this is the first study to quantify, at the population level, the degree to which individuals seek care at multiple sites. Previous studies have examined ED visits within hospital networks.[11-17] Finnell et al[18] examined patterns of patient visits to EDs within a hospital system, the Indiana Network for Patient Care, over a 1-year pe-

Table 4. Characteristics of Patients With Repeat Visits to Multiple Sites of Care Compared With Patients With Repeat Visits to the Same Site of Care

Variable	Patients With Multiple Visits to ≥2 Sites of Care[b] Compared With Patients With Multiple Visits to the Same Site of Care[a]		Patients With Multiple Visits to ≥5 Sites of Care[c] Compared With Patients With ≥5 Visits to the Same Site of Care[d]	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Age of patients, mean (SD), y				
Multiple visits to ≥2 sites of care	47.7 (20.0)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		40.2 (16.0)	
≥2 Visits to the same site of care	50.6 (21.0)		NA	
≥5 Visits to the same site of care	NA		53.2 (24.0)	
Sex				
Female	0.85 (0.84-0.85)	<.001	0.61 (0.59-0.62)	<.001
Race				
White	0.88 (0.87-0.88)	<.001	0.99 (0.96-1.03)	.62
Insurance				
Medicaid/free care	0.81 (0.81-0.82)	<.001	0.88 (0.85-0.91)	<.001
Psychiatric diagnosis				
Yes	1.90 (1.88-1.92)	<.001	5.81 (5.64-5.98)	<.001
ED charges per patient, mean (SD), $				
Multiple visits to ≥2 sites of care	1128 (1101)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		20 106 (26 052)	
≥2 Visits to the same site of care	934 (1012)		NA	
≥5 Visits to the same site of care	NA		5257 (5001)	
Hospitalization charges per patient, mean (SD), $				
Multiple visits to ≥2 sites of care	12 050 (21 270)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		85 217 (147 211)	
≥2 Visits to the same site of care	7465 (15 645)		NA	
≥5 Visits to the same site of care	NA		36 994 (78 282)	
Hospitalizations				
≥1 Hospitalization	1.86 (1.85-1.88)	<.001	2.80 (2.70-2.90)	<.001
Total No. of visits and hospitalizations	1.08 (1.08-1.08)	<.001	2.80 (2.70-2.90)	<.001
Length of stay for hospitalization, mean (SD), d				
Multiple visits to ≥2 sites of care	4.3 (4.3)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		5.2 (4.8)	
≥2 Visits to the same site of care	4.5 (4.5)		NA	
≥5 Visits to the same site of care	NA		4.5 (3.6)	

Abbreviations: CI, confidence interval; ED, emergency department; NA, not applicable; OR, odds ratio.
[a] Patients with repeat visits to the same site of care, n=1 066 263.
[b] Patients with repeat visits to 2 or more different sites of care, n=1 130 124.
[c] Patients with repeat visits to 5 or more different sites of care, n=43 794.
[d] Patients with 5 or more visits to the same site of care, n=225 517.

riod and found that 7.6% of all patients with 2 or more ED visits sought care at more than 1 hospital system, accounting for nearly one-fifth of all ED visits. During our 5-year study period, we found that almost one-third of all adults presenting to an acute care hospital in Massachusetts visited 2 or more sites and accounted for more than half of all acute care visits in the state of Massachusetts. The extended study period and the state-wide scope of our study allowed us to capture a larger proportion of patients who navigate multiple health care systems and are thus subject to the risks of fragmented medical documentation and medical care. We cannot differentiate whether the pattern of patient movement across sites of care resulted from patients relocating or transferring care; however, regardless of intent, the spatial dispersement of clinical information nonetheless raises a real risk of clinical information being unavailable at the point of care.

While we did not directly measure the consequences of care seeking across sites, a number of studies have found that patients in EDs and other acute care sites are particularly vulnerable to adverse events,[19-21] especially when health information is not readily available.[2] Electronic health information exchange results in improvements in communication,[22,23] efficient and nonduplicative laboratory test ordering,[24,25] costs,[26,27] and medication safety.[28]

Patients with mental illness,[11,29] who dominated in our high-intensity multisite user group, are at particularly high risk of adverse drug events as well as adverse medical and surgical events: mental illness has been shown to increase a patient's odds for an adverse event during hospitalization,[30,31] and psychotropic drugs are frequently implicated in adverse drug events.[19,31,32] This population would very likely benefit from an integrated source of medical record information and medical care. The most common principal diagnosis among the cohort was *symptoms* (*ICD-9* codes 780-789), which relates to complaints or findings that, in the course of treatment, did not result in a final diagnosis, such as a nonspecific diagnosis of abdominal pain. Many acute care visits may result in incomplete or unresolved medical issues as well as in results that are still pending at the time of discharge, requiring further evaluation and management.[33] Roy et al[34] found that 41% of patients who were

Table 5. Characteristics of High-Acuity Patients (≥3 Hospitalizations) With Repeat Visits to Multiple Sites of Care Compared With Patients With Repeat Visits to the Same Site of Care

Variable	High-Acuity Patients With Multiple Visits to ≥2 Sites of Care[b] Compared With Patients With Multiple Visits to the Same Site of Care[a]		High-Acuity Patients With Multiple Visits to ≥5 Sites of Care[c] Compared With Patients With ≥5 Visits to the Same Site of Care[d]	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Age of patients, mean (SD), y				
Multiple visits to ≥2 sites of care	60.8 (20.0)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		45.7 (17.0)	
>2 Visits to the same site of care	66.8 (21.0)		NA	
≥5 Visits to the same site of care	NA		67.9 (21.0)	
Sex				
Female	0.81 (0.80-0.82)	<.001	0.61 (0.59-0.64)	<.001
Race				
White	0.88 (0.86-0.89)	<.001	1.01 (0.95-1.06)	.80
Insurance				
Medicaid/free care	0.99 (0.96-1.01)	.30	1.09 (1.03-1.16)	.001
Psychiatric diagnosis				
Yes	2.45 (2.39-2.50)	<.001	8.25 (7.89-8.63)	<.001
ED charges per patient, mean (SD), $				
Multiple visits to ≥2 sites of care	6990 (13 168)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		23 738 (30 823)	
>2 Visits to the same site of care	2735 (4838)		NA	
≥5 Visits to the same site of care	NA		4216 (5657)	
Mean hospitalization charges per patient $				
Multiple visits to ≥2 sites of care	106 930 (130 806)	<.001	NA	<.001
Multiple visits to ≥5 sites of care	NA		133 362 (171 848)	
>2 Visits to the same site of care	71 814 (95 732)		NA	
≥5 Visits to the same site of care	NA		81 681 (108 129)	
Total No. of visits and hospitalizations	1.03 (1.02-1.03)	<.001	2.80 (2.70-2.90)	<.001
Length of stay for hospitalizations, mean (SD), d				
Multiple visits to ≥2 sites of care	5.2 (4.1)	<.001	NA	.70
Multiple visits to ≥5 sites of care	NA		5.5 (4.6)	
>2 Visits to the same site of care	5.0 (3.7)		NA	
≥5 Visits to the same site of care	NA		5.1 (3.5)	

Abbreviations: CI, confidence interval; ED, emergency department; NA, not applicable; OR, odds ratio.
[a] High-acuity patients with repeat visits to the same site of care, n=146 485.
[b] High-acuity patients with repeat visits to 2 or more different sites of care, n=301 677.
[c] High-acuity patients with repeat visits to 5 or more different sites of care, n=26 431.
[d] High-acuity patients with 5 or more visits to same site of care, n=89 371.

discharged from 2 large tertiary care centers had laboratory or radiology test results return after the time of discharge, 9.4% of which were deemed to be potentially actionable. These patients would also be beneficiaries of an integrated source of health information and comprehensive system of care.

As a retrospective study using an administrative database, our study has several limitations. First of all, we measured only acute care visits and did not characterize care patterns across outpatient sites. While we quantified the burden of fragmentation of acute care, we were not able to directly assess the consequences of the fragmentation. Also, some of the separate acute health care sites included facilities that were part of a network of hospitals that were connected by partial electronic health records; therefore, some patient information may have been available to partnering sites. Furthermore, some patients may be misidentified or misclassified because the database relies on social security numbers to create a unique health identifier, which may not always be available at the time of presentation or may be improperly assigned. Race and ethnicity were coded as being mutually exclusive during our study period, so race and ethnicity may have been incompletely captured. Furthermore, we relied on *ICD-9* codes for the principal diagnoses, which may not completely capture or describe a patient's visit or hospitalization.

CONCLUSIONS

Fragmentation of medical information and the resultant need to make critical management decisions with limited data have become growing areas of concern, because they expose patients to medical errors, adverse events, and increased costs.[12,35] Clinicians providing care in the acute care settings should be aware of the level of fragmentation of health documentation and medical care and should be attentive to the potential unintended consequences of incomplete medical information and dispersed medical care. Every attempt should be made to reconcile information across sites of care for each individual patient and to explore solutions to integrate patient care. Potential solutions include the creation of medical homes and the establishment of comprehensive care

networks to ensure that individual patients reliably receive care within the same integrated health care system, thereby minimizing the level of fragmentation and likely improving the quality of care.

Furthermore, efforts to stimulate electronic health record adoption and to create national interoperability for health information exchange, as well as integration of medical information through personally controlled health records,[36] have intensified substantially under the Health Information Technology for Economic and Clinical Health Act.[37] This study provides a quantitative justification for a single set of benefits: the potential of health information technology to reduce the fragmentation of medical records across sites of care for multisite users. Future endeavors should examine the impact of models of health information exchange at either the regional or the individual patient level and should focus on reducing the burden of fragmentation, thereby potentially improving the continuity and quality of care of patients.

Accepted for Publication: May 26, 2010.
Correspondence: Fabienne C. Bourgeois, MD, MPH, Division of General Pediatrics, Children's Hospital Boston, 300 Longwood Ave, Boston, MA 02115 (fabienne.bourgeois@childrens.harvard.edu).
Author Contributions: Dr Bourgeois had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Bourgeois, Olson, and Mandl. *Acquisition of data:* Bourgeois and Mandl. *Analysis and interpretation of data:* Bourgeois, Olson, and Mandl. *Drafting of the manuscript:* Bourgeois and Mandl. *Critical revision of the manuscript for important intellectual content:* Olson and Mandl. *Statistical analysis:* Bourgeois and Olson. *Obtained funding:* Bourgeois. *Administrative, technical, and material support:* Mandl. *Study supervision:* Mandl.
Financial Disclosure: None reported.
Funding/Support: This work was supported by T32HP10018-12 from the Health Resources and Service Administration, by P01HK000016 and P01HK000088-01 from the Centers for Disease Control and Prevention, and by 1U54RR025224-01 from the National Center for Research Resources, National Institutes of Health.

REFERENCES

1. Brailer DJ. Interoperability: the key to the future health care system. *Health Aff (Millwood).* 2005(suppl Web exclusives):W5-19-W5-21.
2. Leape LL, Bates DW, Cullen DJ, et al; ADE Prevention Study Group. Systems analysis of adverse drug events. *JAMA.* 1995;274(1):35-43.
3. Feied CF, Handler JA, Smith MS, et al. Clinical information systems: instant ubiquitous clinical data for error reduction and improved clinical outcomes. *Acad Emerg Med.* 2004; 11(11):1162-1169.
4. Bartlett G, Blais R, Tamblyn R, Clermont RJ, MacGibbon B. Impact of patient communication problems on the risk of preventable adverse events in acute care settings. *CMAJ.* 2008;178(12):1555-1562.
5. Gainsbury S. Missing: the notes of more than a million outpatients. *Health Serv J.* May 22, 2008:5.
6. Gibby GL, Schwab WK. Availability of records in an outpatient preanesthetic evaluation clinic. *J Clin Monit Comput.* 1998;14(6):385-391.
7. Miller DW Jr, Yeast JD, Evans RL. Missing prenatal records at a birth center: a communication problem quantified. *AMIA Annu Symp Proc.* 2005:535-539.
8. Gainsbury S. Neglect of records departments puts patient safety at risk. *Health Service Journal* Web site. http://www.hsj.co.uk/neglect-of-records-departments-puts- patient-safety-at-risk/1389201.article. Accessed April 5, 2009.
9. Smith PC, Araya-Guerra R, Bublitz C, et al. Missing clinical information during primary care visits. *JAMA.* 2005;293(5):565-571.
10. Finnell JT, Overhage JM, McDonald CJ. In support of emergency department health information technology. *AMIA Annu Symp Proc.* 2005:246-250.
11. Sun BC, Burstin HR, Brennan TA. Predictors and outcomes of frequent emergency department users. *Acad Emerg Med.* 2003;10(4):320-328.
12. Guly HR, Grant IC. Patients who attend two accident and emergency departments. *J Accid Emerg Med.* 1994;11(4):231-233.
13. Byrne M, Murphy AW, Plunkett PK, McGee HM, Murray A, Bury G. Frequent attenders to an emergency department: a study of primary health care use, medical profile, and psychosocial characteristics. *Ann Emerg Med.* 2003;41(3):309-318.
14. Cook LJ, Knight S, Junkins EP Jr, Mann NC, Dean JM, Olson LM. Repeat patients to the emergency department in a statewide database. *Acad Emerg Med.* 2004;11(3): 256-263.
15. Fuda KK, Immekus R. Frequent users of Massachusetts emergency departments: a statewide analysis. *Ann Emerg Med.* 2006;48(1):9-16.
16. Hansagi H, Olsson M, Sjöberg S, Tomson Y, Göransson S. Frequent use of the hospital emergency department is indicative of high use of other health care services. *Ann Emerg Med.* 2001;37(6):561-567.
17. Ruger JP, Richter CJ, Spitznagel EL, Lewis LM. Analysis of costs, length of stay, and utilization of emergency department services by frequent users: implications for health policy. *Acad Emerg Med.* 2004;11(12):1311-1317.
18. Finnell JT, Overhage JM, Dexter PR, Perkins SM, Lane KA, McDonald CJ. Community clinical data exchange for emergency medicine patients. *AMIA Annu Symp Proc.* 2003: 235-238.
19. Hafner JW Jr, Belknap SM, Squillante MD, Bucheit KA. Adverse drug events in emergency department patients. *Ann Emerg Med.* 2002;39(3):258-267.
20. Carroll AE, Tarczy-Hornoch P, O'Reilly E, Christakis DA. Resident documentation discrepancies in a neonatal intensive care unit. *Pediatrics.* 2003;111(5, pt 1):976-980.
21. Lazarou J, Pomeranz BH, Corey PN. Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies. *JAMA.* 1998;279(15):1200-1205.
22. Afilalo M, Lang E, Léger R, et al. Impact of a standardized communication system on continuity of care between family physicians and the emergency department. *CJEM.* 2007;9(2):79-86.
23. Lang E, Afilalo M, Vandal AC, et al. Impact of an electronic link between the emergency department and family physicians: a randomized controlled trial. *CMAJ.* 2006;174 (3):313-318.
24. Ramoska EA. Information sharing can reduce laboratory use by emergency physicians. *Am J Emerg Med.* 1998;16(1):34-36.
25. Wilson GA, McDonald CJ, McCabe GP Jr. The effect of immediate access to a computerized medical record on physician test ordering: a controlled clinical trial in the emergency room. *Am J Public Health.* 1982;72(7):698-702.
26. Overhage JM, Dexter PR, Perkins SM, et al. A randomized, controlled trial of clinical information shared from another institution. *Ann Emerg Med.* 2002;39(1):14-23.
27. Maass MC, Asikainen P, Mäenpää T, Wanne O, Suominen T. Usefulness of a Regional Health Care Information System in primary care: a case study. *Comput Methods Programs Biomed.* 2008;91(2):175-181.
28. Mahoney CD, Berard-Collins CM, Coleman R, Amaral JF, Cotter CM. Effects of an integrated clinical information system on medication safety in a multi-hospital setting. *Am J Health Syst Pharm.* 2007;64(18):1969-1977.
29. Hazlett SB, McCarthy ML, Londner MS, Onyike CU. Epidemiology of adult psychiatric visits to US emergency departments. *Acad Emerg Med.* 2004;11(2):193-195.
30. Daumit GL, Pronovost PJ, Anthony CB, Guallar E, Steinwachs DM, Ford DE. Adverse events during medical and surgical hospitalizations for persons with schizophrenia. *Arch Gen Psychiatry.* 2006;63(3):267-272.
31. Bates DW, Shore MF, Gibson R, Bosk C. Patient safety forum: examining the evidence: do we know if psychiatric inpatients are being harmed by errors? what level of confidence should we have in data on the absence or presence of unintended harm? *Psychiatr Serv.* 2003;54(12):1599-1603.
32. Queneau P, Bannwarth B, Carpentier F, et al; Association Pédagogique Nationale pour l'Enseignement de la Thérapeutique (APNET). Emergency department visits caused by adverse drug events: results of a French survey. *Drug Saf.* 2007;30(1):81-88.
33. Moore C, McGinn T, Halm E. Tying up loose ends: discharging patients with unresolved medical issues. *Arch Intern Med.* 2007;167(12):1305-1311.
34. Roy CL, Poon EG, Karson AS, et al. Patient safety concerns arising from test results that return after hospital discharge. *Ann Intern Med.* 2005;143(2):121-128.
35. Cordell WH, Overhage JM, Waeckerle JF; Information Management Work Group. Strategies for improving information management in emergency medicine to meet clinical, research, and administrative needs. *Acad Emerg Med.* 1998;5(2):162-167.
36. Mandl KD, Kohane IS. Tectonic shifts in the health information economy. *N Engl J Med.* 2008;358(16):1732-1737.
37. Blumenthal D. Stimulating the adoption of health information technology. *N Engl J Med.* 2009;360(15):1477-1479.