Association Between Physician Follow-Up and Outcomes of Care After Chest Pain Assessment in High-Risk Patients

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Background—Assessment of chest pain is one of the most common reasons for emergency department visits in developed countries. Although guidelines recommend primary care physician (PCP) follow-up for patients who are subsequently discharged, little is known about the relationship between physician follow-up and clinical outcomes.

Methods and Results—An observational study was conducted on patients with higher baseline risk, defined as having diabetes mellitus or established cardiovascular disease, who were evaluated for chest pain, discharged, and without adverse clinical outcomes for 30 days in Ontario from 2004 to 2010. Multivariable proportional hazard models were constructed to adjust for potential confounding between physician groups (cardiologist, PCP, or none). Among 56 767 included patients, 17% were evaluated by cardiologists, 58% were evaluated by PCPs alone, and 25% had no physician follow-up. The mean age was 66±15 years, and 53% were male. The highest rates of diagnostic testing, medical therapy, and coronary revascularization were seen among patients treated by cardiologists. At 1 year, the rate of death or MI was 5.5% (95% confidence interval, 5.0–5.9) in the cardiology group, 7.7% (95% confidence interval, 7.4–7.9) in the PCP group, and 8.6% (95% confidence interval, 8.2–9.1) in the no-physician group. After adjustment, cardiologist follow-up was associated with significantly lower adjusted hazard ratio of death or MI compared with PCP (hazard ratio, 0.85; 95% confidence interval, 0.78–0.92) and no physician (hazard ratio, 0.79; 95% confidence interval, 0.71–0.88) follow-up.

Conclusions—Among patients with higher baseline cardiovascular risk who were discharged from the emergency department after evaluation for chest pain in Ontario, follow-up with a cardiologist was associated with a decreased risk of all-cause mortality or hospitalization for MI at 1 year compared with follow-up with a PCP or no physician follow-up. **(*Circulation*. 2013;127:1386-1394.)**

Key Words: chest pain ■ emergency service, hospital ■ outcome assessment ■ physicians

Assessment of chest pain is one of the most common reasons for emergency department (ED) visits in developed countries. In the United States, it is estimated that >5 million ED visits each year are for chest pain assessment.[1] Prior studies in this patient population have focused primarily on diagnosing acute coronary syndrome and identifying patients at immediate risk of adverse clinical events.[2,3] Although patients deemed safe enough for discharge from the ED are still at risk for adverse outcomes,[4,5] relatively little is known about their optimal management at longer term. For example, practice guidelines currently recommend follow-up with a primary care physician (PCP) for patients with chest pain after discharge from the ED.[2] However, to the best of our knowledge, no study has evaluated the impact of physician follow-up and specialist care on outcomes.

Clinical Perspective on p 1394

Transition of care from hospital to home is an emerging focus for quality-of-care improvement because it has been shown to reduce repeat admissions and to improve clinical outcomes.[6,7] In the ambulatory care setting, our group has recently shown that cardiac specialist follow-up of heart failure patients after ED discharge is associated with improved clinical outcomes.[8] Given the large number of patients who present to the ED for the assessment of chest pain, addressing how best to manage patients after discharge may have a significant impact on healthcare delivery. Accordingly, the first objective of our study was to examine the patterns of physician follow-up among a cohort of chest pain patients at higher baseline risk after discharge from the ED. The second objective was to evaluate the relationship between physician follow-up and patterns of care and outcomes of care.

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Methods

System Context

The Ontario Ministry of Health and Long Term Care is the sole insurer for health care in the province of Ontario and reimburses all emergency care, diagnostic testing, and invasive procedures for its citizens. There are close to 200 EDs in Ontario serving a population of >13 million people. Prescription medications are provided for those >65 years of age at no cost.

Data Sources

The study cohort was created by linking together the following databases[4,8]: the National Ambulatory Care Reporting System Database, which contains information on all patient visits to the EDs in Ontario; the Ontario Registered Persons Database, which includes information on vital status; the Canadian Institute for Health Information Discharge Abstract Database, which contains information on all hospitalizations; the Ontario Health Insurance Plan physician claims database, which captures data on physician services such as consultations and diagnostic procedures; and the Ontario Drug Benefit prescription database, which includes information on outpatient prescription drug use and costs for all residents ≥65 years of age. Linkages of these databases were performed using unique encrypted patient identifiers to protect patient confidentiality. This study was approved by the Sunnybrook Health Sciences Center research ethics board. A waiver of informed consent is permitted under privacy laws in Ontario for use of administrative data for research purposes.

Study Sample

The study sample was restricted to patients >18 years of age who presented to any Ontario ED with a primary diagnosis of chest pain and were discharged after assessment from April 1, 2004, to March 31, 2010. Chest pain diagnoses were identified by use of the *International Classification of Disease*, 10th revision, codes (R07.1–R07.4, I20.0, I20.1, I20.8, I20.88, or I20.9) in the National Ambulatory Care Reporting System Database. We excluded patients with invalid Ontario healthcare numbers and those with incomplete records. Among patients who had multiple ED visits during the study period, the initial ED visit was considered the index event. We excluded patients who were hospitalized or died within 30 days of their ED visit and patients who had repeat presentation to the ED with chest pain within 30 days to identify a stabilized cohort and to limit the potential of survivorship bias because we categorized physician follow-up within 30 days after ED presentation. This bias describes a situation in which patients who survive longer have more opportunities to receive treatment, thus biasing against the no-treatment group.[9]

Definition of Patients With Higher Cardiovascular Risk

Higher baseline cardiovascular risk was defined as a prior history of the following: diabetes mellitus, chronic atherosclerosis, unstable angina, myocardial infarction (MI), heart failure, arrhythmias (atrial fibrillation and ventricular arrhythmias), peripheral vascular disease, cerebrovascular disease, or interventions (coronary artery bypass grafting surgery, percutaneous coronary intervention, or implantable cardiac defibrillator). This group of patients with higher baseline cardiovascular risk was prespecified in our study because the event rate for chest pain patients presenting to the ED without cardiac risks is exceedingly low and we would be unlikely to detect a difference between physician groups.[10]

Physician Follow-Up and Specialty

Physician follow-up within 30 days after discharge from the ED was categorized as cardiologist, PCP, or none. Patients who saw a cardiologist with and without seeing a PCP during this time period were categorized into the cardiology group. We predetermined a time period of 30 days to identify physician follow-up because it has been used as a clinical benchmark in other settings.[8,11] Physician information was obtained from the Institute of Clinical and Evaluative Sciences Physician Database. The Institute of Clinical and Evaluative Sciences Physician Database comprises information from the Ontario Health Insurance Plan Corporate Provider Database, Ontario Health Insurance Plan physician billing records, and data from the Ontario Physician Human Resource Data Center.[8,12] Physician specialty is determined by a combination of physician training, physician certification, and clinical practice identified by physicians via periodical telephone interviews (ie, an internist by certification can be categorized as a cardiologist if the physician identifies that the majority of the practice is related to the treatment of cardiac patients).

Patterns of Care

The use of medical therapy, diagnostic testing, and cardiac invasive procedures was determined within 100 days after discharge from the ED. We were unable to examine the use of aspirin accurately because it is commonly purchased over the counter, not through the Ontario Drug Benefit program. Diagnostic and invasive evaluations with echocardiograms, stress testing, cardiac catheterizations, and coronary revascularizations were also evaluated.

Outcomes

The primary outcome was a composite of all-cause mortality and recurrent hospitalization for MI at 1 year. Mortality was determined with the Ontario Registered Persons Database. Hospitalization for MI was identified from the Canadian Institute for Health Information Discharge Abstract Database (*International Classification of Diseases*, 10th revision, disease codes I21, I22), which has been validated in Ontario.[13] Complete follow-up data were available for all patients through March 31, 2011.

Statistical Analysis

We compared baseline demographics and clinical characteristics of patients who were assessed by cardiologists or PCPs or had no physician follow-up. We used the χ^2 test for categorical variables, 1-way ANOVA to compare mean values, and Kruskal-Wallis tests to compare median values. The use of medical therapy, diagnostic testing, and cardiac invasive procedures in physician groups was evaluated from the time of ED assessment, and the potential difference between physician groups was compared by use of the χ^2 test.

Multivariable proportional hazard models were used to account for the potential impact of confounding factors between the physician groups. Statistical significance was tested with the Wald χ^2 test. Separate models were constructed to examine the association of physician follow-up and death or MI, death alone, and MI. Time-to-event analyses began at the time of ED assessment but were essentially identical to starting from 30 days after ED assessment because there were no events during this study period. Variables in the hazard models included demographics (age, sex), cardiac risk factors (hypertension, diabetes mellitus, hyperlipidemia), prior cardiac conditions (chronic atherosclerosis, MI, unstable angina, heart failure, valvular heart disease, arrhythmia, shock), medical comorbidities (peripheral vascular disease, cerebrovascular disease, respiratory disease, peptic ulcer disease, rheumatologic disease, neurological disease, renal disease, cancer, anemia, trauma, depression), and hospital characteristics (teaching status, ED volume for chest pain). All analyses were adjusted for clustering at the hospital level with the use of robust sandwich variance estimates. Adjusted survival curves were generated from proportional hazard models to describe the anticipated outcomes of patients by physician groups. *P* values were not calculated because no statistical tests for significance are widely accepted.

A series of sensitivity analyses were undertaken to examine the robustness of our results. First, we performed propensity score–matching analyses comparing cardiologist and no physician or PCP follow-up, cardiologist and PCP follow-up, and cardiologist and no physician follow-up. Second, we repeated the proportional hazard models by including income status based on average household income of patients from Statistics Canada to adjust for the potential impact of socioeconomic status and ED location (rural versus urban) to account for potential differences in healthcare access and baseline

health status. In all of the above sensitivity analyses, our overall results did not change significantly.

Statistical significance was indicated by a 2-tailed value of $P<0.05$. All analyses were performed with SAS version 9.1.3 (SAS Institute Inc, Cary, NC).

Results

Study Sample

The creation of the study cohort is shown in Figure 1. From an initial 1 194 618 visits to an Ontario ED from April 1, 2004, to March 31, 2010, we excluded 388 858 patient visits because they did not meet our prespecified age criteria, were not the first ED visit, or had incomplete or invalid records. We also excluded 199 354 patients: 115 332 were hospitalized from the ED; within 30 days, 3903 were hospitalized with an ACS, 26 016 had visited the ED for chest pain, and 1626 had died; 56 patients had incomplete follow-up; and 52 421 patients could not be classified into a physician group. Among the 606 406 eligible patients, 56 767 patients had diabetes mellitus or existing cardiovascular diseases and were included in the study sample. The median follow-up duration was 3.7 years (interquartile range, 2.0–5.5 years).

Baseline Characteristics

In the study cohort, 17% of patients were categorized in the cardiology group and 58% in the PCP group (Table 1). The 25% of patients who had not seen a physician within 30 days of discharge were categorized in the no-physician group. Eighty percent of the cardiology group, 54% of the PCP group, and 51% of the no-physician group visited a cardiologist in the 3 years before ED assessment for chest pain. The mean age of the overall cohort was 66±15 years, and 53% of the patients were male. The prevalence of diabetes mellitus was 36% and of prior MI was 27%, and 23% had previous coronary revascularization. During the ED assessment, 5.7% in the cardiology group, 1.9% in the PCP group, and 1.8% in the no-physician group consulted a cardiologist. The median time from ED visit to follow-up was 7 days in the PCP group (interquartile range, 2–15 days) and 12 days (interquartile range, 5–20 days) in the cardiology group.

Patients in the cardiology group had the highest rate of previous cardiac conditions, including unstable angina, MI, and heart failure hospitalizations. Patients in this category also had undergone more prior cardiac testing and cardiac procedures and were on more cardiac medications than patients in the PCP and no-physician groups (Table 1). Table I in the online-only Data Supplement gives additional baseline characteristics and comorbidities.

Use of Medical Therapy, Diagnostic Tests, and Cardiac Procedures

Within 100 days of discharge from the ED for chest pain assessment, patients who had cardiologist follow-up underwent significantly more cardiac diagnostic testing and cardiac invasive procedures compared with other groups (Table 2). For example, 42.3% (95% confidence interval [CI], 41.3–43.2) received stress testing and 6.4% (95% CI, 5.9–6.9) received coronary revascularization in the cardiology group (Table 2). In the cardiology group, diagnostic tests were rarely performed in the ED; we observed that only 0.2% had echocardiography and 0.4% had stress testing in the ED. Instead, most of the diagnostic testing (90% of echocardiography and 89.2% of stress testing) occurred after the cardiologist visit.

Cardiac medications that were filled by patients >65 years of age are presented in Table 2. All cardiac medications were prescribed most frequently in the cardiology group, followed by the PCP group and finally the no-physician group. Statin use was 71.5% (95% CI, 70.3–72.7) in the cardiology group,

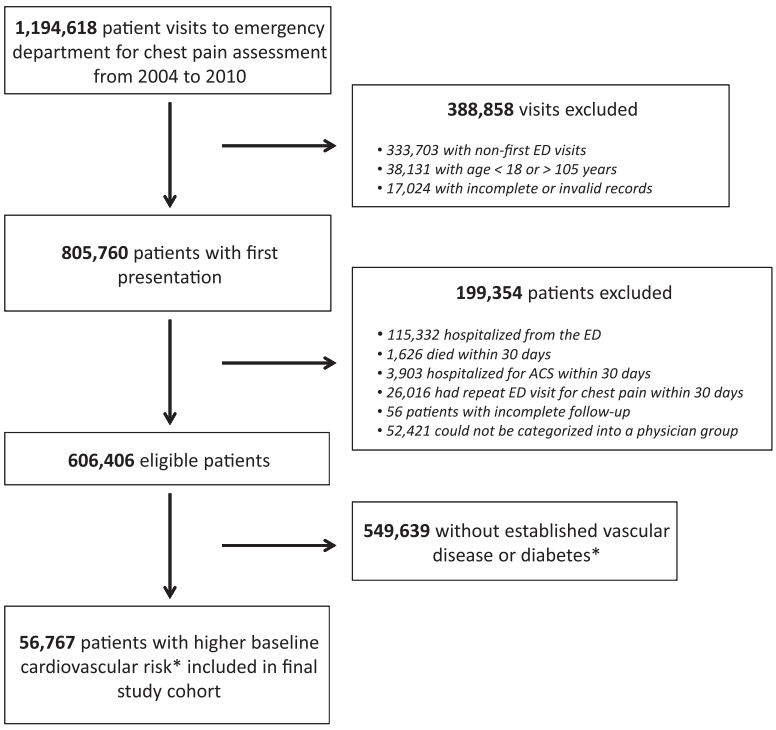

Figure 1. Creation of the study cohort. Flow chart details the creation of the study cohort. ACS indicates acute coronary syndrome; and ED, emergency department.

Table 1. Baseline Patient Characteristics According to Physician Follow-Up*

	No Physician (n=14 232), n (%)	Primary Care (n=32 725), n (%)	Cardiologist (n=9810), n (%)
Age, mean±SD, y	65.9±16.5	67.2±14.2	65.1±13.3
Male	7545 (53.0)	16 542 (50.5)	5809 (59.2)
Cardiac risk factors and prior cardiac and medical comorbidities			
Diabetes mellitus	5066 (35.6)	12 543 (38.3)	2954 (30.1)
Hypertension	5050 (35.5)	12 293 (37.6)	3728 (38.0)
Dyslipidemia	1835 (12.9)	4658 (14.2)	1864 (19.0)
Chronic atherosclerosis	6556 (46.1)	15 144 (46.3)	5743 (58.5)
Unstable angina	1880 (13.2)	4265 (13.0)	1438 (14.7)
Prior myocardial infarction	3979 (28.0)	8022 (24.5)	3064 (31.2)
Prior heart failure hospitalization	2531 (17.8)	5338 (16.3)	1791 (18.3)
Arrhythmias	3553 (25.0)	8234 (25.2)	2976 (30.3)
Atrial fibrillation	2291 (16.1)	5689 (17.4)	1950 (19.9)
Ventricular arrhythmias	272 (1.9)	532 (1.6)	347 (3.5)
Peripheral vascular disease	893 (6.3)	2280 (7.0)	574 (5.9)
Cerebrovascular disease	1830 (12.9)	3746 (11.4)	699 (7.1)
Renal disease	980 (6.9)	1862 (5.7)	557 (5.7)
Prior cardiac testing or procedures			
Echocardiogram	7480 (52.6)	18 780 (57.4)	7100 (72.4)
Stress testing (exercise or perfusion)	5706 (40.1)	14 595 (44.6)	5770 (58.8)
Cardiac catheterization	4735 (33.3)	11 241 (34.3)	5282 (53.8)
Percutaneous coronary intervention	2083 (14.6)	4662 (14.2)	2561 (26.1)
Coronary artery bypass artery grafting	851 (6.0)	2113 (6.5)	950 (9.7)
Permanent pacemaker	475 (3.3)	1200 (3.7)	543 (5.5)
Implantable cardioverter-defibrillator	169 (1.2)	235 (0.7)	262 (2.7)
Medication prescription before ED assessment n†	7902	19 649	5304
ACE inhibitor or ARB	4844 (61.3)	12 366 (62.9)	3601 (67.9)
Statins	4158 (52.6)	10 904 (55.5)	3505 (66.1)
β-Blocker	3728 (47.2)	9151 (46.6)	3002 (56.6)
Calcium channel blocker	2571 (32.5)	6956 (35.4)	1926 (36.3)
Thienopyridine	1061 (13.4)	2738 (13.9)	1051 (19.8)
Long-acting nitrates	1608 (20.3)	3554 (18.1)	961 (18.1)

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; and ED, emergency department.

*All baseline characteristics, prior cardiac testing, and procedures assessed 3 years before ED assessment. All characteristics were significantly different ($P<0.001$) between the groups.

†Medication prescriptions assessed 90 days before ED assessment for patients >65 years of age.

58.9% (95% CI, 58.2–59.6) in the PCP group, and 53.4% (95% CI, 52.2–54.5) in the no-physician group (Table 2).

Outcomes

At 1 year, unadjusted rates of all-cause mortality or hospitalization with MI were 5.5% (95% CI, 5.0–5.9) in the cardiology group, 7.7% (95% CI, 7.4–7.9) in the PCP group, and 8.6% (95% CI, 8.2–9.1) in the no-physician group (Figure 2). Adjusted Kaplan-Meier curves are shown in Figure 3 for death or MI and in Figure 4 for death alone. After adjustment for demographic, clinical, and hospital characteristics, cardiologist follow-up was associated with significantly lower adjusted hazard ratio of death or MI compared with no physician (hazard ratio, 0.79; 95% CI, 0.71–0.88; $P<0.001$) and PCP (hazard ratio, 0.85; 95% CI, 0.78–0.92; $P<0.001$) follow-up (Table 3). Patients in the PCP group also had a significantly lower adjusted hazard of death or MI (hazard ratio, 0.93; 95% CI, 0.87–0.99; $P=0.023$) compared with the no-physician group. There was no significant difference in the adjusted hazard of MI between all physician groups.

Subgroup Analysis of Patients With Cardiology and PCP Follow-up

Among patients in the cardiology group, 6452 patients (65.8%) had follow-up care by both cardiologists and PCPs and 4050 patients (62.8%) were evaluated first by a PCP and then by a cardiologist. Patterns of care and outcomes were similar to those in the cardiology group. The use of stress testing was 42.9% (95% CI, 41.7–44.1), and the use of coronary revascularization was 6.5% (95% CI, 5.9–7.2). At 1 year, the unadjusted rate of all-cause mortality or MI was 5.1% (95% CI, 4.5–5.6), the rate of all-cause mortality was 3.6% (95% CI, 3.2–4.1), and the rate of MI was 1.7% (95% CI, 1.4–2.0).

Table 2. Diagnostic Testing, Medical Therapy, and Cardiac Procedures Within 100 Days of ED Discharge*

	No Physician (n=14 232), n/% (95% CI)	Primary Care (n=32 725), n/% (95% CI)	Cardiologist (n=9810), n/% (95% CI)
Cardiac testing or procedures			
Echocardiogram	1407/9.9 (9.4–10.4)	5167/15.8 (15.4–16.2)	3815/38.9 (37.9–39.9)
Stress testing (exercise or perfusion)	1565/11.0 (10.5–11.5)	5787/17.7 (17.3–18.1)	4146/42.3 (41.3–43.2)
Cardiac catheterization	257/1.8 (1.6–2.0)	949/2.9 (2.7–3.1)	1372/14.0 (13.3–14.7)
Coronary revascularization†	139/1.0 (0.8–1.2)	614/1.9 (1.7–2.0)	624/6.4 (5.9–6.9)
Percutaneous coronary intervention	100/0.7 (0.6–0.9)	342/1.0 (0.9–1.2)	489/5.0 (4.6–5.4)
Coronary artery bypass artery grafting	40/0.3 (0.2–0.4)	289/0.9 (0.8–1.0)	151/1.5 (1.3–1.8)
Medication prescription, n‡	7902	19 649	5304
ACE inhibitor or ARB	4872/61.7 (60.6–62.7)	12 786/65.1 (64.4–65.7)	3820/72.0 (70.8–73.2)
Statins	4216/53.4 (52.2–54.5)	11 567/58.9 (58.2–59.6)	3793/71.5 (70.3–72.7)
β-Blocker	3839/48.6 (47.5–49.7)	9765/49.7 (49.0–50.4)	3297/62.2 (60.8–63.5)
Calcium channel blocker	2633/33.3 (32.3–34.4)	7365/37.5 (36.8–38.2)	2066/39.0 (37.6–40.3)
Thienopyridine	1103/14.0 (13.2–14.7)	2923/14.9 (14.4–15.4)	1213/22.9 (21.7–24.0)
Long-acting nitrates	1826/23.1 (22.2–24.1)	4129/21.0 (20.4–21.6)	1259/23.7 (22.6–24.9)

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; CI, confidence interval; and ED, emergency department.
*All characteristics were significantly different ($P<0.001$) between the groups.
†Coronary revascularization includes percutaneous coronary intervention and coronary artery bypass artery graft.
‡Medication use assessed for patients >65 years of age.

Discussion

The present study is, to the best of our knowledge, the first evaluation to demonstrate the importance of physician follow-up for chest pain patients after discharge from the ED. First, we found that 1 in 4 patients did not have any physician follow-up within 30 days after discharge from the ED. More important, not having follow-up care was strongly associated with an increased risk of dying at 1 year. In addition, we found that patients who were cared for by a cardiologist had the lowest risk of adverse clinical outcomes, with a 21% reduced hazard of death or MI compared with those with no physician follow-up and a 15% reduced hazard compared with those with PCP follow-up.

Although it has been suggested that a selection bias exists in which patients cared for by cardiologists have lower-risk characteristics resulting in improved outcomes,[14,15] many reasons led us to believe that our results are robust. First, we found a process-outcome relationship in which patients managed by cardiologists had the highest use rates of diagnostic testing, medical therapy, and coronary revascularization and subsequently had the best clinical outcome. Second, we observed a dose-response phenomenon in which care was applied least frequently in the no-physician group, was intermediate in the PCP group, and was highest in the cardiology group, mirroring clinical outcomes in which the no-physician group had the worst outcome, followed by the PCP group and the cardiology group. Finally, the availability of many clinical variables and a large sample size allowed us to perform a detailed adjusted analysis accounting for many important potential confounding variables. In fact, patients in the cardiology group were at higher risk and had the most cardiac risk factors, previous cardiac procedures, and cardiac comorbidities. However, we could not determine which

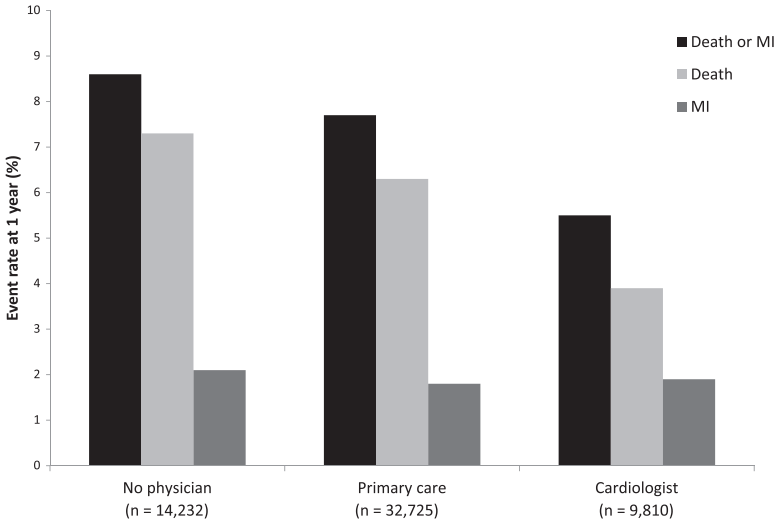

Figure 2. Unadjusted clinical outcomes by physician follow-up. The event rate in percentage is given on the *y* axis, and physician category is given on the *x* axis. Black bars indicate death or recurrent hospitalization for myocardial infarction (MI); light gray bars, death alone; and dark gray bars, recurrent hospitalization for MI alone.

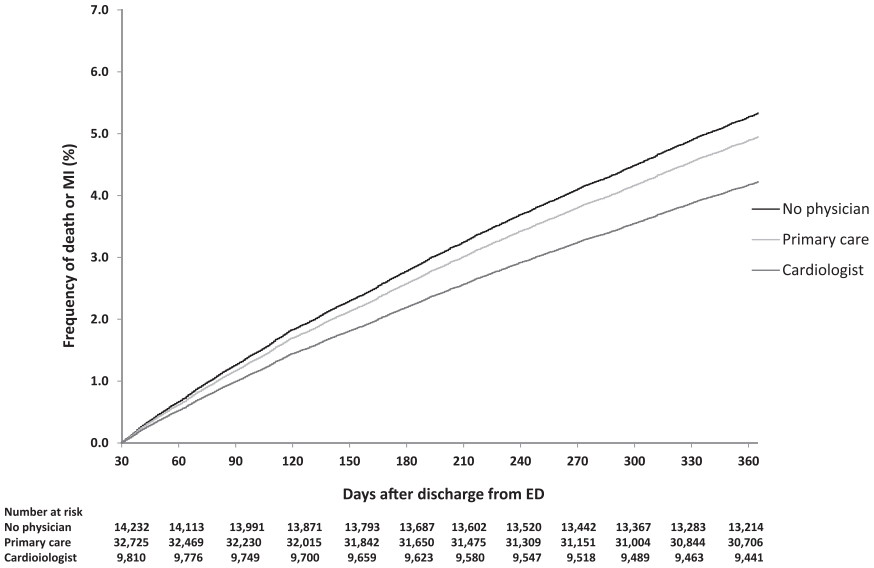

Figure 3. Death or myocardial infarction (MI) after emergency department (ED) assessment. Kaplan-Meier curves for death or recurrent hospitalization for MI. Dark gray line indicates the cardiology group; light gray line, the primary care physician group; and black line, the no-physician group. ED indicates emergency department.

component of the process measures is most beneficial; thus, our findings should not be interpreted as supporting the routine use of diagnostic testing and invasive procedures in all patients.

Although we did not have data to evaluate the appropriateness of, optimal duration of, or adherence to medications prescribed to patients after chest pain evaluation, we observed a significant variation in medication use among physician groups. Patients who had evaluation in the cardiology cohort received the highest rates of evidence-based therapies compared with the PCP and no-physician groups. Similar findings have been demonstrated in the Reduction of Atherothrombosis for Continued Health (REACH) Registry, in which Kumar and colleagues[16] evaluated 25 686 outpatients in the United States and observed that cardiologists were substantially more likely to be adherent to guideline recommendations and to prescribe evidence-based therapy more frequently.

Despite the higher use of medical therapy, diagnostic testing, and invasive therapy, it is difficult to ascertain whether those aspects of care are fully responsible for the outcome difference between physician groups. It is possible that having physician follow-up is a surrogate of many factors that we could not measure such as improved continuation of care and healthier behaviors, including better medication compliance or lifestyle. It is also possible that our results may be related in part to residual confounding, even though we attempted to fully adjust for differences in baseline characteristics in multivariable models and propensity analyses. However, we do not believe that our observation was due to a lack of access to health care because 95% of patients in the no-physician group had seen a PCP within the past 3 years.

We speculate that there are several reasons why we did not see a reduction in MI hospitalization associated with specialist care. First, we suspect that patients managed by cardiologists are more educated about the importance of chest pain and are more likely to be diagnosed accurately as having had an MI. Indeed, we found that the rate of repeat ED visits for chest pain assessment was significantly higher at 13.2% (95% CI, 12.6–13.9) in the cardiology group than in the no-physician group at 11.9% (95% CI, 11.4–12.5). Second, given that there was a difference in mortality between the physician groups, patients who survived in the no-physician group may have been healthier and at lower risk of having an MI than patients who survived in the cardiology group. Finally, these observations may be related to a difference in coronary revascularization, which is known to be associated with periprocedural MI.

Several reasons may explain why patients did not receive any physician follow-up after ED assessment. First, it is possible that patients and physicians were reassured by the assessment and did not feel the need for routine follow-up afterward. Second, it has been shown that access to urgent follow-up after ED visit is limited in the United States.[17] Similarly, because the majority of PCP and specialty practices in Ontario reside outside the hospital setting, most of the EDs do not have a coordinated system to refer patients for follow-up and consequently have no mechanism to ensure compliance. For follow-up with specialists, we observed that patients who had previously been seen or evaluated by a cardiologist in the ED had higher rates of follow-up. Our study implies that it is important to ensure follow-up of patients after chest pain assessment, particularly in those with no established relationship with cardiologists.

Several potential limitations of our study merit discussion. First, although one would expect the mortality benefits of specialty care to be largely mediated through reductions in cardiovascular death, we used all-cause mortality as our main outcome of interest because cause-specific deaths were not available. However, using all-cause mortality as an outcome is consistent with several high-impact publications that examined the importance of specialty care in cardiovascular medicine.[3,18] Furthermore, studies have found that the determination of cardiac death may be inaccurate and could potentially lead to misinterpretation of data.[19,20] Second, we prespecified a time period of 30 days to categorize physician follow-up on the basis of our clinical experience with the time required to gain access to specialists in Ontario and from studies of heart failure.[8,11] We recognize that an optimal period for follow-up after chest pain assessment has not been established. We were unable to use a shorter time period such as 14 days to

Table 3. Unadjusted Rates, Absolute Rate Reduction, and Adjusted Hazard Ratios for Clinical Outcomes at 1 Year After ED Discharge According to Physician Follow-up*,†

				Primary Care vs No Physician
	No Physician (n=14 232), n/% (95% CI)	Primary Care (n= 32 725), n/% (95% CI)	Cardiologist (n=9810), n/% (95% CI)	ARR, % (95% CI) [*P*]
Death or myocardial infarction	1231/8.6 (8.2 to 9.1)	2505/7.7 (7.4 to 7.9)	536/5.5 (5.0 to 5.9)	1 (0.5 to 1.5) [<0.001]
Death	1033/7.3 (6.8 to 7.7)	2052/6.3 (6.0 to 6.5)	380/3.9 (3.5 to 4.3)	1 (0.5 to 1.5) [<0.001]
Myocardial infarction	298/2.1 (1.9 to 2.3)	595/1.8 (1.7 to 2.0)	190/1.9 (1.7 to 2.2)	0.3 (0 to 0.6) [0.050]

ARR indicates absolute rate reduction; CI; confidence interval; ED, emergency department; and HR, hazard ratio.

*ARR calculated as the difference in unadjusted rate of events between physician follow-up groups.

†Variables in the adjusted hazard models included demographics (age, sex), cardiac risk factors (hypertension, diabetes mellitus, hyperlipidemia), prior cardiac conditions (chronic atherosclerosis, myocardial infarction, unstable angina, heart failure, valvular heart disease, arrhythmia, shock), medical comorbidities (peripheral vascular disease, cerebrovascular disease, respiratory disease, peptic ulcer disease, rheumatologic disease, neurological disease, renal disease, cancer, anemia, trauma, depression), and hospital characteristics (teaching status, ED volume for chest pain). HRs <1 in the comparison of primary care vs no physician follow-up indicates a lower hazard associated with the primary care group.

categorize physician follow-up because a large proportion of patients were evaluated between 14 and 30 days. Even after 30 days, we found that 12% in the no-physician group and 17% in the PCP group also visited a cardiologist between 30 and 90 days. However, such a misclassification bias would tend to minimize our ability to observe a difference in outcomes between the physician groups. Third, we predetermined the cardiology group as patients who saw a cardiologist with and without seeing a PCP because the care of diagnosing and treating newly diagnosed chest pain patients is driven primarily by specialists in Ontario. However, it was not our intent to minimize the role of PCPs given that the majority of patients in the cardiology follow-up group had PCP follow-up. In fact, our group has previously shown that heart failure patients managed by both a cardiologist and a PCP demonstrated the best outcome.[8] Finally, although our results suggest that routine specialist referral may improve outcomes, we did not estimate the economic burden or perform formal cost-effectiveness analysis. Those analyses are important for future healthcare planning to gain insights into whether implementation of cardiology follow-up for chest pain patients is feasible. It is also important to note, however, that we evaluated a specific cohort of patients with higher baseline cardiovascular risk; therefore, these results should not be generalized to all patients presenting with chest pain to the ED.

Conclusion

We demonstrated a significant gap in the transition of care for chest pain patients after discharge from the ED. Follow-up with a cardiologist within 30 days of ED visit was associated with a decreased risk of all-cause mortality or hospitalization for MI at 1 year compared with PCP or no physician follow-up.

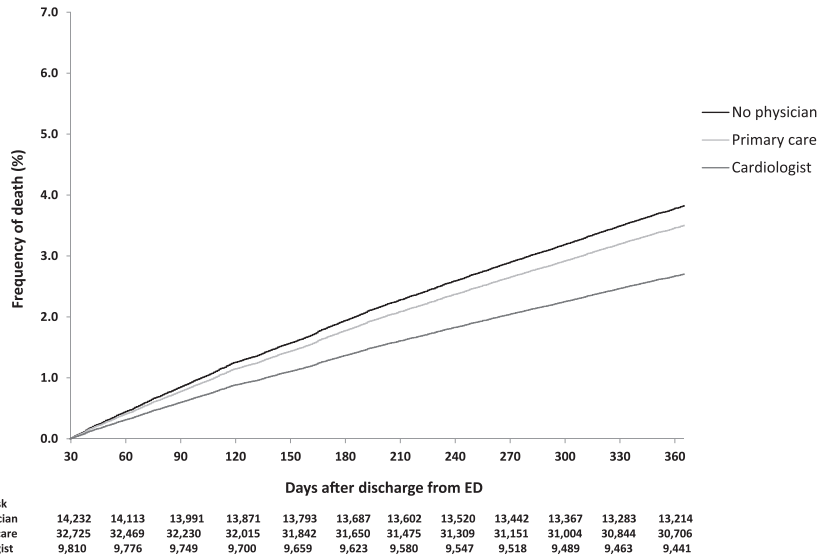

Figure 4. Death after emergency department (ED) assessment. Kaplan Meier curves for death according to the physician follow-up. Dark gray line indicates the cardiology group; light gray line, the primary care physician group; and black line, the no-physician group.

	Cardiologist vs No Physician		Cardiologist vs Primary Care	
HR (95% CI) [*P*]	ARR, % (95% CI) [*P*]	HR (95% CI) [*P*]	ARR, % (95% CI) [*P*]	HR (95% CI) [*P*]
0.93 (0.87 to 0.99) [0.023]	3.2 (2.5 to 3.8) [<0.001]	0.79 (0.71 to 0.88) [<0.001]	2.2 (1.7 to 2.7) [<0.001]	0.85 (0.78 to 0.92) [<0.001]
0.91 (0.85 to 0.98) [0.015]	3.4 (2.8 to 4.0) [<0.001]	0.70 (0.62 to 0.80) [<0.001]	2.4 (1.9 to 2.9) [<0.001]	0.77 (0.69 to 0.85) [<0.001]
0.91 (0.79 to 1.05) [0.20]	0.2 (−0.2 to 0.5) [0.39]	1.01 (0.83 to 1.23) [0.89]	−0.1 (−0.4 to −0.2) [0.45]	1.11 (0.95 to 1.29) [0.18]

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Disclosures

None.

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CLINICAL PERSPECTIVE

Chest pain is one of the most common reasons for visiting the emergency department in developed countries. However, little is known about the impact of physician follow-up and specialist care on outcomes after discharge from the emergency department. We evaluated the patterns of care and outcomes of chest pain patients at higher baseline cardiovascular risk after emergency department discharge in Ontario, Canada. Among 56 767 patients with diabetes mellitus or preexisting cardiovascular disease, 25% had no physician follow-up, 58% were evaluated by primary care physicians, and 17% were evaluated by cardiologists within 30 days of emergency department assessment. At 1 year, patients cared for by cardiologists had the lowest rate of death or myocardial infarction at 5.5%, followed by patients cared for by primary care physicians at 7.7%; patients who had no physician follow-up had the highest event rate at 8.6%. These differences remained significant after adjustment for clinical characteristics between physician groups. Our study demonstrated a significant gap in the transition of care for chest pain patients after discharge from the emergency department and emphasized the need to provide physician follow-up for higher-risk patients.

SUPPLEMENTAL MATERIAL

Supplemental Table 1. Detailed baseline patient characteristics according to physician follow-up

Supplemental Table 1. Detailed baseline patient characteristics according to physician follow-up

	No physician (n=14,232) n (%)	Primary care (n = 32,725) n (%)	Cardiologist (n = 9,810) n (%)
Age, mean ± SD, y	65.9 ± 16.5	67.2 ± 14.2	65.1 ± 13.3
Male	7,545 (53.0%)	16,542 (50.5%)	5,809 (59.2%)
Cardiac risk factors and prior cardiac and medical comorbidities			
Diabetes mellitus	5,066 (35.6%)	12,543 (38.3%)	2,954 (30.1%)
Hypertension	5,050 (35.5%)	12,293 (37.6%)	3,728 (38.0%)
Dyslipidemia	1,835 (12.9%)	4,658 (14.2%)	1,864 (19.0%)
Chronic atherosclerosis	6,556 (46.1%)	15,144 (46.3%)	5,743 (58.5%)
Unstable angina	1,880 (13.2%)	4,265 (13.0%)	1,438 (14.7%)
Prior myocardial infarction	3,979 (28.0%)	8,022 (24.5%)	3,064 (31.2%)
Prior heart failure hospitalization	2,531 (17.8%)	5,338 (16.3%)	1,791 (18.3%)
Valvular heart disease	651 (4.6%)	1,642 (5.0%)	663 (6.8%)
Arrhythmias	3,553 (25.0%)	8,234 (25.2%)	2,976 (30.3%)
Atrial fibrillation	2,291 (16.1%)	5,689 (17.4%)	1,950 (19.9%)
Ventricular arrhythmias	272 (1.9%)	532 (1.6%)	347 (3.5%)
Shock	358 (2.5%)	738 (2.3%)	262 (2.7%)
Peripheral vascular disease	893 (6.3%)	2,280 (7.0%)	574 (5.9%)
Cerebrovascular disease	1,830 (12.9%)	3,746 (11.4%)	699 (7.1%)
Respiratory disease	1,759 (12.4%)	4,280 (13.1%)	803 (8.2%)
Peptic ulcer disease	240 (1.7%)	661 (2.0%)	158 (1.6%)
Rheumatologic disease	170 (1.2%)	426 (1.3%)	94 (1.0%)
Neurologic disease	1,051 (7.4%)	1,095 (3.3%)	166 (1.7%)
Renal disease	980 (6.9%)	1,862 (5.7%)	557 (5.7%)
Cancer	693 (4.9%)	2,361 (7.2%)	520 (5.3%)
Anemia/blood disease	1,230 (8.6%)	2,758 (8.4%)	656 (6.7%)
Trauma	1,335 (9.4%)	2,416 (7.4%)	432 (4.4%)
Depression	748 (5.3%)	1,743 (5.3%)	295 (3.0%)
Hospital characteristics			
Teaching	2,456 (17.3%)	5,294 (16.2%)	2,265 (23.1%)
ED volume for chest pain per year			
Low	1,189 (8.4%)	1,982 (6.1%)	260 (2.7%)
Medium	3,170 (22.3%)	6,930 (21.2%)	1,258 (12.8%)
High	9,873 (69.4%)	23,813 (72.8%)	8,292 (84.5%)

Prior cardiac testing or procedures			
Echocardiogram	7,480 (52.6%)	18,780 (57.4%)	7,100 (72.4%)
Stress testing (exercise or perfusion)	5,706 (40.1%)	14,595 (44.6%)	5,770 (58.8%)
Cardiac catheterization	4,735 (33.3%)	11,241 (34.3%)	5,282 (53.8%)
Percutaneous coronary intervention	2,083 (14.6%)	4,662 (14.2%)	2,561 (26.1%)
Coronary artery bypass artery grafting	851 (6.0%)	2,113 (6.5%)	950 (9.7%)
Permanent pacemaker	475 (3.3%)	1,200 (3.7%)	543 (5.5%)
Implantable cardioverter defibrillator	169 (1.2%)	235 (0.7%)	262 (2.7%)
Medication prescription prior to ED assessment †	**(n = 7,902)**	**(n= 19,649)**	**(n= 5,304)**
ACE inhibitor or ARB	4,844 (61.3%)	12,366 (62.9%)	3,601 (67.9%)
Statins	4,158 (52.6%)	10,904 (55.5%)	3,505 (66.1%)
Beta-blocker	3,728 (47.2%)	9,151 (46.6%)	3,002 (56.6%)
Calcium channel blocker	2,571 (32.5%)	6,956 (35.4%)	1,926 (36.3%)
Thienopyridine	1,061 (13.4%)	2,738 (13.9%)	1,051 (19.8%)
Long acting nitrates	1,608 (20.3%)	3,554 (18.1%)	961 (18.1%)

† Medication prescriptions assessed for patients over 65 years of age.

Association Between Physician Follow-Up and Outcomes of Care After Chest Pain Assessment in High-Risk Patients

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