Acute treatment of myocardial infarction in Canada 1999-2002

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BACKGROUND: Therapy for management of acute myocardial infarction (AMI) varies according to patient, prescriber and geographical characteristics.
OBJECTIVES: To describe the in-hospital use of reperfusion therapy for ST elevation MI (STEMI) and discharge use of acetylsalicylic acid, beta-blockers, angiotensin-converting enzyme inhibitors (ACEIs) and statins in patients presenting with either STEMI or non-STEMI in Canada from 1999 to 2002.
METHODS: Four Canadian registries (FASTRAK II, Canadian Acute Coronary Syndromes, Enhanced Feedback for Effective Cardiac Treatment and Improving Cardiovascular Outcomes in Nova Scotia) were used to identify patients with AMI in Canada and to measure in-hospital reperfusion and medication use. Use rates were compared by age, sex, time period and geographical area, according to available data.
RESULTS: Use rates for reperfusion in STEMI patients ranged from 60% to 70%, primarily representing fibrinolytic therapy. A delay in presentation to hospital after symptom onset represented an impediment to timely therapy, which was particularly pronounced for women and elderly patients. Overall, less than 50% of patients met the door-to-needle target of less than 30 min. Medication use rates at discharge increased from 1999/2000 to 2000/2001 across the different data sources: acetylsalicylic acid, 83% to 88%; beta-blockers, 74% to 89%; ACEIs, 54% to 67%; statins, 41% to 53%; and calcium antagonists, 21% to 32%.
CONCLUSIONS: Canadian and provincial rates of use of evidence-based medications for the treatment of AMI have increased over time, although there remains room for improvement. A single, comprehensive data source would supply better insights into the management of AMI in Canada.

Key Words: *Drug therapy; Fibrinolytic; Myocardial infarction; Practice pattern; Quality of care; Reperfusion*

Traitement de l'infarctus du myocarde en phase aiguë au Canada entre 1999 et 2002

CONTEXTE : La prise en charge de l'infarctus aigu du myocarde (IAM) varie selon les patients, les médecins prescripteurs et les régions géographiques.
BUT : Décrire le recours à la reperfusion dans les cas d'IAM avec sus-décalage du segment ST pendant le séjour à l'hôpital ainsi qu'à l'acide acétylsalicylique (AAS), aux bêta-bloquants, aux inhibiteurs de l'enzyme de conversion de l'angiotensine (ECA) et aux statines au moment du congé chez les patients traités pour un IAM avec ou sans sus-décalage du segment ST au Canada entre 1999 et 2002.
MÉTHODE : Quatre registres canadiens (FASTRAK II, *Canadian Acute Coronary Syndromes, Enhanced Feedback for Effective Cardiac Treatment* et *Improving Cardiovascular Outcomes in Nova Scotia*) ont servi à repérer les patients traités pour un IAM au Canada et à mesurer le recours à la reperfusion et l'utilisation des médicaments pendant le séjour à l'hôpital. Les taux d'utilisation ont été comparés selon l'âge, le sexe, le temps écoulé et la région géographique, suivant la disponibilité des données.
RÉSULTATS : Les taux de recours à la reperfusion chez les patients présentant un IAM avec sus-décalage du segment ST variaient entre 60 et 70 %; il s'agissait surtout du traitement fibrinolytique. Le temps écoulé entre l'apparition des symptômes et la consultation à l'hôpital s'est révélé un obstacle au traitement rapide, particulièrement chez les femmes et les personnes âgées. En effet, l'intervalle de moins de 30 minutes entre le transport à l'hôpital et l'administration de médicaments par injection a été respecté dans moins de 50 % des cas, dans l'ensemble. Quant aux taux d'utilisation des médicaments au moment du congé, ils ont augmenté entre 1999-2000 et 2000-2001, d'après toutes les sources de données : ainsi, l'AAS est passé de 83 à 88 %; les bêta-bloquants, de 74 à 89 %; les inhibiteurs de l'ECA, de 54 à 67 %; les statines, de 41 à 53 % et les inhibiteurs calciques, de 21 à 32 %.
CONCLUSIONS : Les taux d'utilisation des médicaments, fondés sur des preuves, dans le traitement de l'IAM ont augmenté au fil du temps dans l'ensemble du pays et dans les provinces, même s'il reste encore place à l'amélioration. La constitution d'une seule base générale de données permettrait de dresser un portrait plus précis de la situation au Canada.

Several clinical trials have determined that certain medications reduce morbidity and mortality in acute myocardial infarction (AMI) during the initial period of hospitalization, with many of these medications also having a sustained long-term benefit. Practice guidelines (1-4) based on evidence from clinical trials support the use of primary percutaneous coronary intervention (PCI), fibrinolytics, acetylsalicylic acid (ASA), angiotensin-converting enzyme inhibitors (ACEIs), beta-blockers and statins in eligible patients. There is no evidence to support the early use of calcium antagonists in AMI.

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TABLE 1
Comparison of Canadian acute myocardial infarction (AMI) registry databases used for analysis

Characteristic	EFFECT (Ontario)	ICONS (Nova Scotia)	FASTRAK II	CACS
Sample size	11,510 patients during 1999/2000 to 2000/2001.	4020 patients with discharge diagnosis of AMI during 1999/2000 to 2000/2001.	9228 patients for period of study (2000/2001 to 2001/2002).	4505 patients for 1999/2000 to 2000/2001 for analysis of current study.
Sampling method	All hospitals in Ontario that treated 30 or more AMI/CHF patients in fiscal 1999/2001. Up to 125 patients per hospital. Retrospective cohort.	All patients discharged with AMI. Retrospective cohort.	All cardiac patients admitted to CCU at participating centre. Prospective cohort.	First 10 consecutive patients with suspected ACS per month in the CCU/ICU. Prospective cohort.
Source of data	Ontario hospitals – chart abstraction by cardiology nurse abstractors.	Chart abstraction of discharged patients from Nova Scotia hospitals by trained ICONS staff.	Participating hospitals in Canada. Nurse completes data form at each hospital.	Abstraction of data from medical record onto case report form by study coordinators of principal investigators.
Number of sites	103	35	78	51
Geographical representation	All Ontario hospitals except the very smallest.	All Nova Scotia.	Across Canada.	All provinces except Newfoundland. Majority of patients from British Columbia, Ontario and Quebec.
AMI definition	ICD-9 code 410 as most responsible diagnosis and meet the ACC/ESC definition of AMI.	All NSTEMI and STEMI according to clinical diagnosis by physician, defined by ICD-9-CM codes 410.	Chest pain >30 min believed to be secondary to AMI with ECG changes or enzyme changes diagnostic of AMI.	ACS within 24 h. Discretion of site for final ACS diagnosis.
Types of ACS included in registry database	AMI (NSTEMI and STEMI)	AMI (NSTEMI and STEMI)	AMI (NSTEMI and STEMI); note: only STEMI patients used for this study.	NSTEMI, STEMI and unstable angina
Population-based sampling frame	Yes	Yes	No	No

ACC American College of Cardiology; ACS Acute coronary syndromes; CACS Canadian Acute Coronary Syndromes; CCU Coronary care unit; CHF Congestive heart failure; ECG Electrocardiogram; EFFECT Enhanced Feedback for Effective Cardiac Treatment; ESC European Society of Cardiology; ICD-9-CM International Classification of Diseases, 9th revision, Clinical Modification*; ICONS Improving Cardiovascular Outcomes in Nova Scotia; ICU Intensive care unit; NSTEMI Non-ST elevation myocardial infarction; STEMI ST elevation myocardial infarction*

Previously published reports (5-9) from Canada, the United States and other countries indicate that use rates of these evidence-based medications remain low. In addition, studies (10-14) have found variations in the patterns of medication use based on patient, prescriber, hospital and regional characteristics. Most consistently, age- and sex-related differences in prescribing have been reported (6-14). The optimal use of evidence-based medications in hospital have important implications for the outcomes of patients with AMI (15-17). One study (18) that compared the outcomes of "ideal" AMI patients admitted to America's "best" hospitals versus other hospitals found that mortality differences were primarily due to the higher use of simple interventions, ASA and beta-blockers in the "best" hospitals, rather than to the use of more complex interventions, such as cardiac catheterization. The prompt administration of fibrinolytics is associated with decreased mortality (19,20). Although standards for time to treatment with fibrinolytics have been established and published, time intervals have been reported to be longer than the established goals (21). To encourage the use of evidence-based therapies for AMI, patterns of use must be analyzed and reports published over time to provide practitioners with feedback (15). Therefore, we sought to describe current in-hospital treatment of patients with AMI across Canada.

METHODS

Data sources

The Canadian Acute Coronary Syndromes (CACS), Improving Cardiovascular Outcomes in Nova Scotia (ICONS), Enhanced Feedback for Effective Cardiac Treatment (EFFECT) and FASTRAK II databases were used as the data sources for the analyses (Tables 1 and 2). The CACS and FASTRAK II databases are voluntary, prospectively collected registries from coronary care units (CCUs)/cardiac wards across Canada. FASTRAK II collects quantitative data on the demographics, treatments and outcomes of all patients with acute coronary syndrome (ACS) admitted to CCUs at participating hospitals. To focus analyses on the use of myocardial reperfusion strategies, only those 9228 patients who had an ST elevation MI (STEMI) were included from the FASTRAK II registry from April 1, 2000, to March 31, 2002.

The CACS registry has data pertaining to patients with ACS from 51 hospital sites across Canada, excluding Newfoundland. Most sites were located in British Columbia, Ontario and Quebec, and these sites were asked to provide data relating to the first 10 consecutive patients admitted with suspected ACS each month, including all types of AMI. From 1999/2000 to 2000/2001, there were 1173 patients with STEMI available for analysis of reperfusion strategies. There were 4505 AMI patients available for analysis of treatment at hospital discharge.

TABLE 2
Comparison of patient characteristics in Canadian acute myocardial infarction registry databases

Characteristic (%)	EFFECT (Ontario)	ICONS (Nova Scotia)	FASTRAK II	CACS
Age (mean years)	68	68	65	65
Sex (% male)	64	62	69	68
History of myocardial infarction	23	24	31	33
History of percutaneous coronary intervention	3	4	5	14
History of coronary artery bypass surgery	7	6	4	12
Hypertension	45	53	N/A	49
Dyslipidemia	30	35	N/A	43
Smoking	32	34	N/A	28
Diabetes	26	27	17	24

CACS Canadian Acute Coronary Syndromes; EFFECT Enhanced Feedback for Effective Cardiac Treatment; ICONS Improving Cardiovascular Outcomes in Nova Scotia; N/A Not available

The EFFECT study database includes retrospectively collected hospital-level data from charts of patients with AMI from acute care hospitals in Ontario from 1999/2000 to 2000/2001. All hospitals in Ontario that treated 30 or more AMI cases were invited to participate, and 103 of the 104 hospitals agreed. Hospitals were representative of the province in terms of type, size and geography. For each participating hospital, a target of up to 125 AMI charts were abstracted from each hospital, including a comprehensive set of clinical risk factors and quality indicators. AMI charts were identified using the *International Classification of Diseases, 9th revision* code 410 (22). If the hospital identified more than 125 charts with AMI during the study period, a random sample of 125 charts was abstracted. If the hospital identified 125 or fewer charts, all charts were abstracted. There were 5506 patients with STEMI available for analysis of reperfusion strategies and 11,510 total AMI patients available for analysis of treatment at discharge.

ICONS was a five-year disease management study (1997 to 2002) undertaken to measure and improve the quality of care provided to Nova Scotians with cardiovascular disease. All Nova Scotia residents hospitalized with a clinical diagnosis of AMI (equivalent to the *International Classification of Diseases, 9th revision, Clinical Modification* [22] code 410) were included in the study, and trained ICONS staff retrospectively abstracted detailed demographic, clinical, treatment and outcome data (23). There were 1557 patients with STEMI available for analysis of reperfusion strategies and 3437 total AMI patients available for analysis of treatment at discharge.

Each database had its own method of defining and confirming the diagnosis of AMI according to the data provided on the case report forms (Table 1). All patients from each source who had a confirmed diagnosis of STEMI according to the registry were analyzed for reperfusion strategies, and all AMI patients (STEMI or non-STEMI) were analyzed for use of treatments at discharge. All databases had data available on age and sex to assess use according to these characteristics.

Statistical analysis

The data were summarized using simple descriptive statistics, such as means and proportions. All four data sources were used to provide analysis of the use of reperfusion therapy at admission to hospital. The proportion of patients receiving reperfusion therapy (primary PCI, fibrinolytics) was calculated, as were symptom onset-to-arrival, door-to-balloon and door-to-needle times, where available. The type of fibrinolytic used was also calculated. Sex- and age-related analyses were conducted. For the CACS, ICONS and EFFECT registries, the proportion of patients receiving ASA, beta-blockers, ACEIs, statins and calcium antagonists at hospital discharge was summarized. The proportion of patients receiving a beta-blocker within 12 h of presentation was also available from the EFFECT database.

RESULTS

Overall, age- and sex-specific use rates of reperfusion therapies for STEMI, including both fibrinolysis and primary angioplasty, are given in Table 3 for all data sources. Reperfusion rates were approximately 5% to 10% higher in both prospectively collected registries (CACS and FASTRAK II) than in the retrospectively collected registries (EFFECT and ICONS). Rates of reperfusion therapy were higher in men than in women, and decreased with increasing age in both men and women, especially in those patients 75 years of age and older. Overall rates were 12% to 14% higher for men than women in the retrospective registries and 7% to 8% higher in the prospective registries.

Over 80% of patients presented within 12 h of symptom onset in all data sources. However, women were more likely than men to delay presenting to hospital after the start of their symptoms, especially those older than 75 years of age (Table 4). On arrival to hospital, men were more likely to receive prompt treatment with fibrinolytics, with a median door-to-needle time of 5 min to 9 min less than for women (Table 5). Only 35% to 44% of patients had a door-to-needle time of less than 30 min, the current standard of practice (1). Notably, the two retrospective registries that are more inclusive and generalizable had fewer patients meeting this goal.

The most common fibrinolytic agent used was alteplase (62% in CACS, and 63% in EFFECT and ICONS), followed by streptokinase (15% in CACS, 28% in EFFECT and 33% in ICONS) and reteplase (3% in ICONS, 8% in EFFECT and 17% in CACS). Other fibrinolytic agents were used less frequently (1% in EFFECT, 2% in ICONS and 6% in CACS). Because tenecteplase was not marketed in Canada until October 2001, it was not available for use during the study period. (Data were unavailable for fibrinolytic use from FASTRAK II.)

In the FASTRAK II registry, the most common reason not to use a fibrinolytic agent was late patient presentation to hospital after symptom onset (28% of patients). Concern about intracranial bleeding was greater for women than for men (9.4% versus 5.4%) and was a particular concern with increasing patient age

TABLE 3
Overall and age- and sex-specific reperfusion therapy rates for ST elevation acute myocardial infarction

Type of reperfusion	Overall rate (%)	Men (age [years])				Women (age [years])			
		20–64	65–74	75+	Total	20–64	65–74	75+	Total
EFFECT (n=5506)									
Any reperfusion therapy	60	72	61	44	64	67	57	39	51
Fibrinolysis	58	70	60	43	62	66	56	38	50
Primary angioplasty	1	1	1	1	2	2	1	0	1
ICONS (n=1557)									
Any reperfusion therapy	63	73	65	53	67	76	57	37	53
Fibrinolysis	62	73	65	53	67	72	56	37	53
Primary angioplasty	3	3	4	2	3	4	2	4	4
FASTRAK II (n=9228)									
Any reperfusion therapy	70	78	71	57	72	70	71	55	64
Fibrinolysis	64	71	64	52	66	65	66	51	59
Primary angioplasty	6	7	7	6	7	6	5	4	5
CACS (n=1173)									
Any reperfusion therapy	67	71	69	59	69	76	56	50	62
Fibrinolysis	66	70	68	57	68	74	55	50	61
Primary angioplasty	1	1	0	2	1	2	2	0	1

Data from the FASTRAK II, Improving Cardiovascular Outcomes in Nova Scotia (ICONS), Enhanced Feedback for Effective Cardiac Treatment (EFFECT) and Canadian Acute Coronary Syndromes (CACS) registries

TABLE 4
Overall and age- and sex-specific symptom onset to arrival times for ST elevation acute myocardial infarction

Symptom onset by database	Overall rate (%)	Men (age [years])				Women (age [years])			
		20–64	65–74	75+	Total	20–64	65–74	75+	Total
EFFECT (n=5506)									
Symptom onset to arrival (h)									
0–6	75	78	77	74	77	75	72	70	72
6–12	10	9	9	11	10	10	11	10	11
>12	15	13	14	15	13	15	15	20	17
Missing	15	8	15	23	13	11	16	26	19
ICONS (n=1557)									
Symptom onset to arrival (h)									
0–2	48	54	53	36	51	50	39	37	43
2–4	20	19	19	27	21	19	21	19	19
4–6	6	7	6	5	7	5	0	10	6
6–12	7	4	10	11	7	7	13	6	8
>12	18	15	12	21	15	19	27	27	24
Missing	13	6	9	19	9	9	23	25	19
FASTRAK II (n=9228)									
Symptom onset to arrival (h)									
0–2	51	56	53	49	54	49	48	40	45
2–4	17	16	16	18	16	17	19	20	19
4–6	7	7	8	7	7	6	9	9	8
6–12	8	8	8	8	8	9	9	9	9
>12	16	13	15	18	15	18	15	23	19
Missing	12	10	12	15	11	12	10	17	14
CACS (n=1173)									
Symptom onset to arrival (h)									
0–12	86	88	85	88	87	88	86	75	83
>12	14	12	15	12	13	12	14	25	17
Missing	2	2	5	2	2	3	1	3	2

Note: The symptom onset-to-arrival time hourly breakdown varied across the four registries. Data from the FASTRAK II, Improving Cardiovascular Outcomes in Nova Scotia (ICONS), Enhanced Feedback for Effective Cardiac Treatment (EFFECT) and Canadian Acute Coronary Syndromes (CACS) registries

(2.4% in women aged 20 to 49 years and up to 10.5% in women 75 years of age and older).

Only 1% to 6% of patients presenting with AMI received reperfusion therapy with primary PCI. The highest rates were in the FASTRAK II registry, which encompasses a period one year later than the other data sources. Door-to-balloon time was only reliably available from the FASTRAK II registry. Overall, the door-to-balloon time was greater than 120 min in 25% of cases, and was over 90 min in 50% of cases. Slightly more men than women had door-to-balloon times of less than the median of 90 min. As with fibrinolysis, the door-to-balloon times were substantially longer among patients older than 75 years of age, regardless of sex.

An analysis of discharge therapy was conducted in 4505 patients with AMI from the CACS registry, 11,510 patients from the EFFECT registry in Ontario and 3437 patients from the ICONS registry in Nova Scotia. Use rates of various drugs from 1999/2000 to 2000/2001, as reflected in these registries, are displayed in Table 6. Use of the medications was higher among ICONS patients in both periods than among the CACS and EFFECT populations. The ICONS registry documented an increased use of ASA, beta-blockers, ACEIs and statins at discharge, and a decrease in use of calcium antagonists at discharge over time. In the EFFECT study population, there was no change in ASA use at discharge. Beta-blocker use within 12 h of admission and at discharge increased, as did ACEI and statin use at discharge. Use of calcium antagonists at discharge increased by 6%. In the CACS registry population, there was a consistent increase in the use of ASA, beta-blockers, ACEIs and statins at discharge, with less calcium antagonist use at discharge.

TABLE 5
Overall and sex-specific door-to-needle and door-to-balloon times for ST elevation acute myocardial infarction

	Overall rate (%)	Men (%)	Women (%)
EFFECT			
Door-to-needle time (fibrinolysis) (min) (n=3217)			
<30	36	39	27
30–40	14	14	14
40–60	19	18	20
>60	25	23	31
Missing	6	6	8
Median time (min) (n=3017) (limit to times of <4 h)	39	36	45
Median door-to-balloon time for primary angioplasty (min)	N/A	N/A	N/A
ICONS			
Door-to-needle time (fibrinolysis) (min) (n=982)			
<30	35	38	28
30–40	16	15	17
40–60	22	21	25
>60	27	26	30
Missing	1	0	1
Median time (min)	39	35	43
Median door-to-balloon time for primary angioplasty (min)	N/A	N/A	N/A
FASTRAK II			
Door-to-needle time (fibrinolysis) (min) (n=5872)			
<30	44	46	38
30–40	16	16	17
40–60	19	18	20
>60	21	20	25
Missing	5	4	5
Median time (min)	34	33	38
Median door-to-balloon time for primary angioplasty (min) (n=554)	90	90	92

Data from the FASTRAK II, Improving Cardiovascular Outcomes in Nova Scotia (ICONS) and Enhanced Feedback for Effective Cardiac Treatment (EFFECT) registries. Data for door-to-needle and door-to-balloon times not available (N/A) for Canadian Acute Coronary Syndromes (CACS). Data for door-to-balloon times not available for ICONS. Door-to-balloon time not included for EFFECT due to small numbers potentially leading to inaccurate time estimates

DISCUSSION

In the present study, we report the findings of in-hospital treatment of AMI across Canada using four different registries, representing heterogeneous data sources. While we fully appreciate the problems associated with converging disparate data, this work represents the first national overview of acute treatment of AMI and the best data currently available. We support the need for an improved, single data source to supply insights into the acute management of MI in Canada.

The results of the present study suggest that the use of evidence-based therapies is improving but remains lower than optimal (1,2). Furthermore, age- and sex-related differences in prescribing persist and are consistent with previous reports (5-14,24,25). Reperfusion rates in our study ranged from 60% to 70%, notably lower in the retrospective, more generalizable data sources (EFFECT and ICONS registries). The differences in these rates may reflect the different characteristics, such as age and sex, of the data source populations we used for analysis, with the average age in the retrospective data sources being three years more than in the prospective data sources (Table 1). In a multinational study of 9251 patients (26), the GRACE Registry Investigators found that 30% of STEMI patients did not receive reperfusion, which is similar to our rate. Our analysis found that women were less likely to receive reperfusion with fibrinolytics than men, which is consistent with previous reports (10,12,13,24-28). This difference was especially pronounced in the two retrospective data sources (EFFECT and ICONS registries), where the difference was as high as 14%. Women, especially older women, were more likely to delay presenting to hospital than were men, which may account for some of this difference. The effect due to sex could not be completely explained by age as a confounding variable because rates of reperfusion therapy for women were lower than men in most age groups. Increasing age was inversely proportional to use of reperfusion strategies for men.

Less than one-half of the patients met the target door-to-needle time for fibrinolytic reperfusion therapy of less than 30 min, with fewer patients in the retrospective data sources meeting this goal (1). The reasons documented for initially not using fibrinolysis were primarily related to late patient arrival, but also encompassed issues with electrocardiogram diagnosis and risks of intracranial or other bleeding. Concern about intracranial or other bleeding did relate mostly to elderly patients and may have contributed to the delay when

TABLE 6
Comparison of overall in-hospital medication use rates per 100 acute myocardial infarction patients, 1999/2000 to 2000/2001

	EFFECT (Ontario)		ICONS (Nova Scotia)		CACS	
Type of medical use (%)	1999/2000 (n=5788)	2000/2001 (n=5722)	1999/2000 (n=1685)	2000/2001 (n=1752)	1999/2000 (n=1132)	2000/2001 (n=3373)
Beta-blocker use within 12 h of admission	25	27	N/A	N/A	N/A	N/A
Acetylsalicylic acid use at discharge	83	83	85	88	83	85
Beta-blocker use at discharge	74	76	86	89	69	74
ACE inhibitor use at discharge	54	65	56	67	50	54
Statin use at discharge*	33	41	48	53	48	52
Calcium antagonist use at discharge	26	32	24	21	29	29

**Any lipid-lowering agent for Canadian Acute Coronary Syndromes (CACS) registry. ACE Angiotensin-converting enzyme; N/A Data not available. Data from the Enhanced Feedback for Effective Cardiac Treatment (EFFECT), Improving Cardiovascular Outcomes in Nova Scotia (ICONS) and CACS registries*

reperfusion therapy was given (1). Women had longer door-to-needle times than men, ranging from 5 min to 9 min longer. Because each minute counts toward a positive outcome for reperfusion strategies, timely reperfusion remains an important goal for improvement in current practice (29-33). Comparing our findings with a recently published analysis of the FASTRAK II data from 1998 to 2000, we found that the median door-to-needle time was 4 min to 9 min shorter in the present study, representing a possible improvement in time to treatment over the years (21).

The preferred mode of reperfusion therapy for AMI is primary PCI because if performed in a timely manner, it has superior outcomes to fibrinolysis (1,3). While this is an evolving strategy that involves substantial systems change, a rate of less than 10% suggests an underuse of an effective therapy. Target goals for the proportion of patients with AMI to receive primary PCI versus fibrinolytic therapy have not been developed; however, target goals for door-to-balloon times have been set. The door-to-balloon time for primary angioplasty was only available from the FASTRAK II registry, where the median time was 90 min. Because the target goal for door-to-balloon time was less than 90 min, only one-half of the patients met this goal. Because timing of primary PCI is critical to improved outcomes, there is room for improvement in the door-to-balloon times for this mode of therapy (34).

There was a general improvement in the use of evidence-based medications in all three populations that were assessed for medication use at the time of hospital discharge. This was particularly noteworthy in the ICONS population, although the purpose of the ICONS study was to optimize medical care at hospital discharge (23). ICONS has been operating since 1997, providing feedback to sites actively, while a similar intervention in Ontario is only currently being launched with the EFFECT study. This may account for the higher use rates in the ICONS registry than in the EFFECT registry. Despite the improvements over time, the use of ASA in all data sources may still be considered somewhat low. Because we examined all patients, rather than only 'ideal' patients, some patients not receiving ASA in our study may truly not have been suitable candidates for therapy. Of note, beta-blocker use at discharge in our study including all patients was much better than that seen in the study of America's best hospitals, which had a rate of 63.8% in 'ideal' patients (18). The ICONS and EFFECT province-wide initiatives included a variety of hospital types and sizes, and would not necessarily be expected to match those rates at America's 'best' hospitals.

While the rates of ACEI use at discharge were similar to those seen in a Quebec study from 1997 (35), they were much lower in both of our study periods than in those observed in the more recent Guidelines Applied in Practice (GAP) Initiative, which had rates of approximately 80% (15,35). The GAP Initiative was a specific initiative in highly motivated hospitals in a small, local network assessing only 'ideal' patients, and their rates would be expected to be higher than the broad-based populations that we studied. While it is possible that more of our patients had contraindications to ACEIs than patients in the GAP study, a rate of 50% to 60% seen in our analysis likely represents an opportunity for improvement.

While statins were prescribed for approximately one-half of the patients in the ICONS and CACS registries at discharge, the rates of use were approximately 10% lower in Ontario and have not improved when compared with data from a recent analysis (36). The lowest rates of use of statins were in very elderly patients (75 years of age and older) and may reflect that, until recently, there was a paucity of efficacy data relating to this age group, as well as a possible age bias (36).

While the rate of calcium antagonist use declined or stayed stable in the ICONS and CACS populations, it increased by 6% in the EFFECT population. Given that calcium antagonists are accepted therapies for hypertension in elderly patients, it is possible that calcium antagonist therapy in the AMI setting is simply being continued for elderly patients with concomitant hypertension. Because the demographics of the EFFECT population were similar in the two study periods, this increased use of calcium antagonists in Ontario warrants further investigation.

Although the present study design did not allow us to determine the underuse of evidence-based medication use relative to contraindications nor the reasons for the differences in use according to age, sex and region, it did allow us to document these disparities. To our knowledge, this is the first comprehensive report that compared regional patterns of treatment of patients with AMI across Canada from four different data sources. Geographical variation has been previously reported in other countries, most notably through the Cooperative Cardiovascular Project in the United States (11). There are several possible reasons for differences in regional drug use, including communication strategies relating to medication use, divergent means for the dissemination of evidence to support new therapies, as well as dissimilar government policies with respect to medication reimbursement. Provincial differences in quality initiatives during this period may also contribute to

some of the regional differences seen. For example, the ICONS project in Nova Scotia, launched in 1997, has been positively impacting the use of evidence-based discharge medications over time (37). The EFFECT study was just started recently and practitioners in Ontario have not had a chance to respond to its findings as yet.

The differences in the registries we used may also impact the differences seen in the rates of medication use. FASTRAK II and CACS are prospective registries based on the participation of selective centres with patients identified through the CCU, while the EFFECT and ICONS registries are based on patients identified retrospectively, intended to represent a population-based picture and include patients admitted to the non-CCU setting. The difference in the populations in the registries may explain the finding of the same average patient age in the ICONS and EFFECT registries, while those in the FASTRAK II and CACS registries were similarly three years younger than the population-based registries. These age differences may impact the type of medical care received by patients.

A limitation of the present study was that four different registries from slightly different time frames were used as data sources for the analysis. Due to the voluntary nature of some of the registries, the rates of medication use may have been higher than in other practices due to volunteer bias. However, depending on how carefully and completely the data were collected, the reported rates of medication use may have been lower than reality. This must be taken into account when comparing rates of use. In addition, each registry had its own definition of AMI. We simply allowed the use of each registry's AMI definition to assist us with defining the appropriate patients, rather than attempting to determine consistent definitions between the sources. As far as the two prospective registries were concerned, most of the information was based on self-report from hospitals.

Our analyses were significantly limited by the lack of adjustment for confounding factors, severity of illness and contraindications. Confounders, such as age, sex and comorbidities, may influence the rates of use of therapy, and these were not accounted for in our study. We also did not look at 'ideal' patients because all the data sources did not consistently have data available on contraindications. What our analyses did was report overall rates of therapy use, which represent a broad-based look at entire populations of patients with AMI. Studies can never adequately assess matters of judgment of choice of therapy nor entirely ascertain that potential contraindications were recorded in medical records. Therefore, the concept of the 'ideal' patient will always be hindered by these limitations. While acknowledging the above noted limitations, our broad-based study represents the best available overview of the treatment of AMI within Canada.

While we sought out the best data sources available in Canada at the present time for assessment of medication therapy in the AMI setting, there are several limitations as noted above. The development of a national disease surveillance system for AMI would allow for more comprehensive and consistent assessment of the quality of AMI care across Canada. Furthermore, the development of a quality improvement system, such as that available in the Cardiovascular Cooperative Project or the GAP Initiative in the United States, would be a significant advance in the assessment and improvement of quality of AMI care in Canada for participating organizations. Standardized definitions, data collection and regional representation are several potential advantages of such systems (17,38).

CONCLUSIONS

Although Canadian and provincial rates of use of evidence-based medications for the treatment of AMI have been increasing over time, there remains room for improvement, particularly for time to treatment for reperfusion and use of newer therapies, such as primary PCI, ACEIs and statins. The development of a comprehensive disease surveillance program and a quality improvement initiative has the potential to advance the assessment and improve the quality of AMI care in Canada.

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