ICare-ACS (Improving Care Processes for Patients With Suspected Acute Coronary Syndrome)

A Study of Cross-System Implementation of a National Clinical Pathway

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BACKGROUND: Efforts to safely reduce length of stay for emergency department patients with symptoms suggestive of acute coronary syndrome (ACS) have had mixed success. Few system-wide efforts affecting multiple hospital emergency departments have ever been evaluated. We evaluated the effectiveness of a nationwide implementation of clinical pathways for potential ACS in disparate hospitals.

METHODS: This was a multicenter pragmatic stepped-wedge before-and-after trial in 7 New Zealand acute care hospitals with 31 332 patients investigated for suspected ACS with serial troponin measurements. The implementation was a clinical pathway for the assessment of patients with suspected ACS that included a clinical pathway document in paper or electronic format, structured risk stratification, specified time points for electrocardiographic and serial troponin testing within 3 hours of arrival, and directions for combining risk stratification and electrocardiographic and troponin testing in an accelerated diagnostic protocol. Implementation was monitored for >4 months and compared with usual care over the preceding 6 months. The main outcome measure was the odds of discharge within 6 hours of presentation

RESULTS: There were 11 529 participants in the preimplementation phase (range, 284–3465) and 19 803 in the postimplementation phase (range, 395–5039). Overall, the mean 6-hour discharge rate increased from 8.3% (range, 2.7%–37.7%) to 18.4% (6.8%–43.8%). The odds of being discharged within 6 hours increased after clinical pathway implementation. The odds ratio was 2.4 (95% confidence interval, 2.3–2.6). In patients without ACS, the median length of hospital stays decreased by 2.9 hours (95% confidence interval, 2.4–3.4). For patients discharged within 6 hours, there was no change in 30-day major adverse cardiac event rates (0.52% versus 0.44%; *P*=0.96). In these patients, no adverse event occurred when clinical pathways were correctly followed.

CONCLUSIONS: Implementation of clinical pathways for suspected ACS reduced the length of stay and increased the proportions of patients safely discharged within 6 hours.

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Sources of Funding, see page 361

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Clinical Perspective

What Is New?

- This is the first study assessing the impact of clinical pathways for emergency department evaluation of possible acute coronary syndrome that is part of a nationwide implementation.
- Participating hospitals used either contemporary or high-sensitivity troponin assays and accelerated diagnostic protocols using either the TIMI (Thrombolysis in Myocardial Infarction) score or the Emergency Department Assessment of Chest pain Score. Increased rates of safe early discharge occurred regardless of the clinical troponin or risk assessment tool used.
- Implementation of clinical pathways more than doubled the odds of 6-hour discharge without changing the 30-day major adverse cardiac event rate.

What Are the Clinical Implications?

- The emergency department evaluation of patients with acute coronary syndrome is common and uses a lot of health resources. Clinical pathways safely decrease length of stay, allowing health resource to be used for other patients.
- Pathways can be successfully implemented across a variety of hospital settings regardless of the troponin assay in use.

Emergency department (ED) clinicians are cautious of discharging patients with possible acute coronary syndrome (ACS). The observation and investigation of such patients are major health-system burdens.[1–3] Clinical guidelines and clinical pathways are increasingly being used in these situations in which clinical uncertainty may lead to inappropriate or unnecessary investigation.

Clinical guidelines "are statements that include recommendations intended to optimize patient care"; they are based on "evidence and an assessment of the benefits and harms of alternative care options."[4] Clinical pathways are the translation of clinical practice guidelines to provide a plan of care suitable for a local health system and its structure. They take into account factors such as resource availability and consensus of local subject matter experts. Clinical pathways are structured, multidisciplinary inventory of actions that meet any 3 of the following criteria: (1) are used to channel the translation of guidelines or evidence into local practices, (2) detail the steps in a course of treatment or care, (3) have a time frame or criteria-based progression (ie, steps are taken if or when designated criteria are met), or (4) aim to standardize care for a specific clinical problem or outcome.[5] Clinical pathways have been shown to reduce complications, decrease length of stay, and reduce hospital costs.[6]

In the context of possible ACS, clinical pathways can provide prompts for important alternative diagnoses (thromboembolism, aortic dissection, etc) and facilitate urgent treatment when indicated (eg, in ST-segment–elevation myocardial infarction). In addition, they can provide direction for combining risk stratification and early blood sampling for quick, safe hospital discharge for low-risk patients. This component of the clinical pathway has been referred to as an accelerated diagnostic protocol (ADP).[7,8]

An ADP combines troponin results, structured scoring of clinical variables, and the electrocardiographic interpretation to identify patients at low risk of acute myocardial infarction. It enables faster diagnostic decisions in these patients by using early blood-sampling time points[9] to "accelerate" progress to the next step in clinical management (eg, admission, additional testing, discharge) as would otherwise have occurred with a longer serial troponin testing protocol.

Prospective observational trials of ADPs have identified approximately one third of patients with ED-suspected ACS as at low risk (<1%) of major adverse cardiac events (MACEs).[8,10–13] Randomized implementation trials of clinical pathways incorporating ADPs at Christchurch Hospital (Christchurch, NZ) demonstrated that early safe discharge rates could be improved (from 11.0% to 32.3%).[14,15] Immediate and successful implementation of clinical pathways incorporating an ADP at Christchurch Hospital prompted the New Zealand Ministry of Health to mandate that all hospitals implement similar clinical pathways for possible ACS.

We evaluated the safety and effectiveness of adopting clinical pathways for possible ACS in 7 diverse New Zealand hospitals. We hypothesized that introducing clinical pathways would increase the proportion of patients safely discharged home within 6 hours of presentation to an ED.

METHODS

The data will not be made available to other researchers for purposes of reproducing the results or replicating the procedure because there is no ethics body approval to share the patient-level data. Analytical methods and materials are already shared in this article.

Participants

We used a multicenter, pragmatic, stepped-wedge before-and-after implementation study of all adults presenting to 7 EDs with symptoms of suspected ACS, where the attending clinicians ordered serial cardiac troponin measurements to investigate for possible acute myocardial infarction. Adult patients (age ≥18 years) were included if they had at least 2 troponin measurements in hospital within 24 hours of

presentation (the first in the ED). Only the first presentation for each patient was included in the analysis.

Setting

The study was conducted in a convenience sample of 7 acute care hospitals selected because of varied size and population demographics (Table I in the online-only Data Supplement). Physicians ranged from interns to specialists in emergency, cardiology, and internal medicine. Hospitals were included if they intended to implement a clinical pathway by September 1, 2015, and were excluded if they had a preexisting clinical pathway for possible ACS. There were no restrictions on which troponin assays could be used. All sites used the >99th percentile as the threshold to report a troponin result as positive. Four hospitals used Roche Diagnostics high-sensitivity troponin T assay (also known as the fifth-generation troponin T assay; 99th percentile, 14 ng/L); 1 hospital used the Abbott ARCHITECT high-sensitivity troponin I assay (99th percentile, 26 ng/L); and 2 hospitals used a Siemens Ultra troponin I assay (99th percentile, 40 ng/L).

Design

The intervention at each hospital was a clinical pathway incorporating an ADP for the assessment of patients with suspected ACS in the ED. The study design was a pragmatic stepped-wedge before-and-after implementation trial (Figure 1) of clinical pathways. It was pragmatic because it did not specify the components of the clinical pathway but rather required stakeholder participation to define the intervention at each site. This allowed autonomy and adaptation of the clinical pathway to integrate into local real-life care. A stepped-wedge design was implemented with each site beginning the intervention one after another until all sites had adopted the intervention. A stepped-wedge design was chosen because a sequential rollout allowed later hospitals to benefit from the earlier experiences in how to manage practice changes and because this allowed rollout over a broader calendar period to help mitigate any potential seasonal enrollment or outcome effects. After the intervention implementation, all sites continued to use the implemented clinical pathways until the last hospital had at least 4 months of intervention exposure. One-month intervals between individual hospital start dates were planned, but sites could adjust start dates if necessitated by local service delivery issues. We used a recognized model for improvement called Plan-Do-Study-Act designed by the Institute of Health Improvement.[16] This was used to apply lessons learned from the implementation process at 1 hospital to other hospitals.

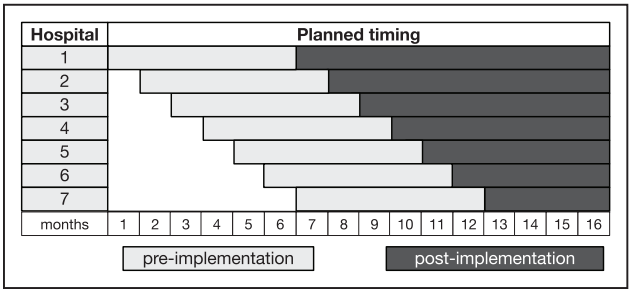

Figure 1. Proposed step wedge timing.

Control Phase (Usual Care Before Implementation)

The control period covered 6 months of usual care before the clinical pathway implementation date (Figure 1). The control arm involved the preexisting local standard practice for the assessment of patients with possible ACS. This included recording an ECG, vital signs, patient history, examination, and serial troponin measurement.

Intervention Phase

In early 2014, the New Zealand Ministry of Health instructed all hospitals to implement a clinical pathway, incorporating an ADP, for the assessment of patients with possible ACS. Pathways were required to have 4 core components (Table 1) based on the Society of Cardiovascular Patient Care Chest Pain Accreditation tool (cycle IV) (http://www.scpc.org/services/cpc.aspx) and adopted by the American College of Cardiology and the American Heart Association Mission: Lifeline program. The tool is not prescriptive beyond requiring implementation of each core component but focuses on engaging hospitals in a cross-system, multidisciplinary, all-inclusive improvement process. The intervention involved integrating core components and adapting existing practice into a clinical pathway. The exact format of each pathway component and the ADP used were decided at each hospital (Table 2). Participating sites were presented with evidence on published ADPs and chose which ADP they would use. ADPs required troponin measurement on arrival and then at 1, 2, or 3 hours to determine eligibility for early discharge. ADPs that were considered were the 2-Hour Accelerated Diagnostic Protocol to Assess Patients With Chest Pain Symptoms Using Contemporary Troponins as the Only Biomarker (ADAPT)[10,14]; Emergency Department Assessment of Chest Pain Score (EDACS)[15,17,18]; History, ECG, Age, Risk Factors, and Troponin (HEART)[11,19]; the High Sensitivity Cardiac Troponin T Assay for Rapid Rule-Out of AMI (TRAPID-AMI)[20,21]; and the new Vancouver Chest Pain Rule.[13]

Before implementation, there were meetings involving the first author and representatives from each stakeholder group (including but not limited to the ED, cardiology, general medicine physicians and nurses, hospital management, diagnostic laboratory directors, cardiac technicians, and hospital data analysts). The Kotter 8-step model for change management was used by stakeholders to plan and facilitate implementation at each site.[22] Clinical and management leaders were identified throughout local health systems and remained in

Table 1. Mandatory Components of Clinical Pathways

• A written clinical pathway document in paper or electronic format for the assessment of possible acute coronary syndrome in the emergency department.
• A structured and reproducible process of acute coronary syndrome risk stratification (eg, a clinical score/algorithm).
• Recommended sampling time points for performing cardiac troponin and electrocardiographic testing (eg, on arrival and at other specified time points).
• Guidance about how to combine clinical risk stratification and electrocardiographic and troponin testing with structured patient management (including incorporation of an accelerated diagnostic protocol)

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Table 2. Characteristics of Hospitals and Accelerated Diagnostic Protocol Used

Hospital	Hospital Type	Annual Emergency Department Attendance, n*	Troponin Assay	Timing for Low Risk, h	Thresholds, ng/L	Accelerated Diagnostic Protocol	Low-Risk Score
1	Local secondary and regional tertiary care	68 383	hs-cTnT	0 and 2	≥14	EDACS	<16
2	Local secondary	44 470	hs-cTnT	0 and 2	≥14	EDACS	<16
3	Regional secondary	49 600	TnI	0 and 2†	≥40	ADAPT‡	0
4	Local secondary and regional tertiary care	52 146	hs-cTnT	0 and 2	≥14	EDACS	<16
5	Regional secondary	15 841	hs-cTnT	0 and 2	≥14	EDACS	<16
6	Local secondary	41 482	TnI	0 and 2†	≥40	ADAPT‡	0
7	Local secondary and regional tertiary care	96 764	hs-cTnI	0 and 3	≥26	EDACS§	<16

ADAPT indicates 2-Hour Accelerated Diagnostic Protocol to Assess Patients With Chest Pain Symptoms Using Contemporary Troponins as the Only Biomarker; EDACS, Emergency Department Assessment of Chest Pain Score; hs-cTnI, high-sensitivity cardiac troponin I (Abbott assay); hs-cTnT, high-sensitivity cardiac troponin T (Roche assay); and TnI, cardiac troponin I (Siemens assay).

All hospitals also used ischemic electrocardiographic changes as a trigger to exit the pathway.

Tertiary referral at all designated centers included referral for cardiology.

*For the year July 2013 to June 2014.

†Only those after initial assessment who are at low risk have a 2-hour troponin.

‡ADAPT protocol incorporates the modified Thrombolysis in Myocardial Infarction score.

§This hospital included the possibility that a single troponin below the 99th percentile is sufficient to rule out acute myocardial infarction if the last symptoms were >6 hours earlier both in the preimplementation and postimplementation stages.

communication throughout the study. This model was used in all participating sites except for 1 hospital (hospital 7) where there was a locally organized change management process.

Outcomes

Primary Outcome

The primary outcome was the proportion of patients discharged home within 6 hours of ED arrival.

Secondary Outcomes

Discharge safety was assessed by determining the presence of any MACEs during 30 days. MACEs were identified through coding and were defined as death, cardiac arrest, (*International Classification of Diseases, 10th Revision* [*ICD-10*] codes I46.0, 46.1, 46.9), emergency revascularization procedure, cardiogenic shock (R57.0), ventricular arrhythmia (I47.2), ventricular fibrillation (I49.0), high-degree atrioventricular block needing intervention (I44.2), or acute myocardial infarction (I21.0, 21.1, 21.2, 21.3, 21.4, 21.9, 22.0, 22.1, 22.8, 22.9). Additional secondary outcomes included the proportion of patients discharged within 6 hours who had a MACE within 30 days and length of stay in hospital of patients without ACS. To assess the accuracy of this methodology to identify MACEs, we conducted an internal audit of 1192 patients from a separate local research cohort in whom there was robust blinded adjudication of MACE outcomes. We measured the proportion of agreement between adjudicated and *ICD-10*–coded outcomes and further assessed for bias (McNemar test) and interobserver agreement (κ statistic).

Data Collection

The data collection process was preplanned and developed before the study began. All study data were recorded electronically as per routine care. Clinicians responsible for patient care were not familiarized with the data collection or analysis methods. Participants were identified from the electronic laboratory database at each site, and their National Health Index identifier was used to identify relevant health records for each participant. The National Health Index identifier is a unique identifier of every individual who used any health service in New Zealand. It links the admissions, hospital blood measurements, and hospital or community mortality events of every person presenting to a New Zealand hospital. Participant length of ED stay, readmissions, MACEs, and deaths within 30 days of the index presentation were extracted from hospital data warehouses and from the New Zealand national death registry. We conducted case reviews that included pathway compliance for patients who were discharged within 6 hours if they were coded as having a MACE or death within 30 days of the index admission. This was done by the lead clinician at each site and the lead investigator (M.T.) by contacting the local hospital clinicians and, if possible, the patient's primary care doctor or the patient to determine the exact MACE.

Statistical Analysis

The primary outcome between the control and intervention arms was compared with a Cochran-Mantel-Haenszel test for stratified data and expressed as an odds ratio. This test treated each site independently. We quantified heterogeneity with the I^2 statistic, which reflects the proportion of variation in point estimates among studies beyond that expected by chance. Comparisons of length of hospital stay were by the Mann-Whitney test. All statistical calculations were performed in R 3.2.4.[23] Analysis was by intention to treat. The study received ethics approval from the Southern Health and Disabilities Ethics Committee (14/STH/102, regional institutional review board). Individual informed consent was not required for this planned change of standard care.

RESULTS

Nine sites planned to participate; 2 withdrew before data collection because of an inability to implement a

clinical pathway within the required time frame, leaving a total of 7 enrolling sites. The first site implemented its clinical pathway on October 7, 2014, and the last on August 1, 2015. There were small deviations from the planned 1-month interval startup process resulting from local clinical, safety, and logistical issues (Figure I in the online-only Data Supplement).

Each ADP classified patients as not low risk and not eligible for early discharge if there was a positive troponin result or an ischemic ECG or if the risk assessment score exceeded a prespecified threshold. Two sites chose a modified Thrombolysis in Myocardial Infarction score (2-Hour Accelerated Diagnostic Protocol to Assess Patients With Chest Pain Symptoms Using Contemporary Troponins as the Only Biomarker) and 5 chose the Emergency Department Assessment of Chest Pain Score (Table 2; the online-only Data Supplement gives the completed pathways).

Across all hospitals, in the 6 months before implementation of the clinical pathway, 11529 patients had 2 troponins measured within 24 hours (1922 per month). Of these, 46.5% were female (range, 42.3%–49.2%), and the mean age was 65.1 years (SD, 16.4 years; Table 3). After implementation (mean study duration, 10.6 months; range, 5–15.8 months), 19803 patients had 2 troponins measurements within 24 hours (1886 per month). Of these, 45.6% were female (range, 41.8%–47.9%), and the mean age was 65.8 years (SD, 16.1 years; Table 3). No change in 30-day MACE rates between before and after implementation was observed (13.6% versus 12.9% respectively; P=0.29).

Primary Outcome

The proportion of study patients discharged within 6 hours increased in every hospital (Table 4), with an overall change from 8.3% to 18.4%. The absolute increase at individual hospitals ranged from 1.7% to 28.4%. The odds of being discharged within 6 hours more than doubled after the introduction of the framework (odds ratio, 2.4; 95% confidence interval, 2.3–2.6; P<0.001; Figure 2). There was high heterogeneity between the odds ratios of sites (I^2=97%).

Secondary Outcomes

Hospital Length of Stay

The hospital length of stay for patients without ACS was shorter after intervention (P<0.001; Figure 3), with a median reduction in hospital length of stay of 2.9 hours (95% confidence interval, 2.4–3.4). There was a small decrease in length of hospital stay for all patients at each hospital (Table 5).

Safety

Intention-to-treat analysis found no differences in 30-day MACE rates before and after intervention between the cohorts of patients discharged within 6 hours (P=0.96). In the control cohort, 5 of 962 (0.52%) discharged within 6 hours had a 30-day MACE (1 non–ST-segment–elevation myocardial infarction and 4 all-cause deaths unrelated to ACS) compared with 16 of 3632 patients (0.44%) in the intervention cohort (8 non–ST-segment–elevation myocardial infarctions, 1 ST-segment–elevation myocardial infarction, 1 stable ventricular tachycardia, 1 asystolic pause requiring permanent pacemaker insertion, and 5 all-cause deaths). Case review revealed that 14 of the 16 postintervention discharges involved a deviation from the local clinical pathway (12 had a positive troponin and 2 had risk scores identifying them as not low risk). The remaining 2 cases were incorrectly coded as readmission non–ST-segment–elevation myocardial infarction (both had returned the next day as planned after clinical pathway guidance for stress testing, one of which was positive; Table II in the online-only Data Supplement).

Outcome Assessment Methodology Audit

In a cohort of 1192 patients investigated for possible ACS, there was 98% agreement between adjudicated MACEs and *ICD-10*–coded MACEs. The interrater agreement was very high (κ=0.91; 95% confidence interval, 0.85–0.97), and there was no evidence of any systematic bias (P=0.19).

Table 3. Demographics and 30-Day MACE Prevalence

	Before Implementation					After Implementation				
Hospital	n	Female, n (%)	Māori, n (%)	Age (SD), y	Prevalence, n (%)	n	Female, n (%)	Māori, n (%)	Age (SD), y	Prevalence, n (%)
1	1495	677 (45.3)	225 (15.1)	66.8 (15.9)	177 (11.8)	5036	2242 (44.5)	799 (15.9)	66.8 (16.0)	764 (15.2)
2	844	378 (44.8)	103 (12.2)	67.2 (15.4)	96 (11.4)	1738	776 (44.6)	209 (12.0)	65.4 (15.9)	190 (10.9)
3	2820	1366 (48.4)	139 (4.9)	66.8 (16.8)	417 (14.8)	5393	2564 (47.5)	264 (4.9)	65.2 (16.9)	653 (12.1)
4	1266	555 (43.8)	94 (7.4)	67.6 (15.2)	179 (14.1)	2320	1050 (45.3)	175 (7.5)	66.2 (15.6)	290 (12.5)
5	284	120 (42.3)	9 (3.2)	70.2 (16.0)	39 (13.7)	395	165 (41.8)	6 (1.5)	69.6 (15.2)	54 (13.7)
6	1355	667 (49.2)	134 (9.9)	63.4 (17.4)	144 (10.6)	1790	867 (48.4)	203 (11.3)	68.4 (14.0)	164 (9.2)
7	3465	1597 (46.1)	492 (14.2)	61.9 (16.1)	511 (14.7)	3135	1368 (43.6)	420 (13.4)	63.1 (16.0)	447 (14.3)

MACE indicates major adverse cardiac event.

Table 4. Discharge Within 6 Hours and 30-Day MACE Rates Before and After Clinical Pathway Implementation

Hospital	Length of Stay, h	Before Implementation			After Implementation			Absolute Difference (95% CI), %
		MACE in 30 d, n	No MACE in 30 d, n	Proportion <6 h, %	MACE in 30 d, n	No MACE in 30 d, n	Proportion <6 h, %	
1	>6	176	1230		759	3518		
	≤6	1	88	6.0	5	754	15.1	9.1 (7.5 to 10.7)
2	>6	92	434		186	791		
	≤6	4	314	37.7	4	757	43.8	6.1 (2.0 to 10.2)
3	>6	417	2325		649	4103		
	≤6	0	78	2.7	4	637	11.8	9.1 (8.0 to 10.1)
4	>6	179	962		288	1143		
	≤6	0	125	9.9	2	887	38.3	28.4 (25.8 to 31.1)
5	>6	39	142		53	188		
	≤6	0	103	36.3	1	153	39.0	2.7 (–5.0 to 10.4)
6	>6	144	1138		164	1399		
	≤6	0	73	5.4	0	227	12.7	7.3 (5.3 to 9.3)
7	>6	511	2778		447	2481		
	≤6	0	176	5.1	0	207	6.8	1.7 (0.4 to 2.7)
Total	>6	1558	9009		2546	13623		
	≤6	5	957	8.3	16	3622	18.4	10.1 (9.3 to 10.8)

CI indicates confidence interval; and MACE, major adverse cardiac event.

DISCUSSION

Principal Findings

This study demonstrates that a clinical pathway incorporating an ADP for possible ACS can be safely implemented in diverse EDs over a brief time interval. This suggests that the adoption of similar clinical pathways may be possible in other countries. After implementation at each hospital, a greater proportion of patients were discharged within 6 hours without compromising safety. Furthermore, the reduction in length of stay of the intervention cohort could equate to thousands of hours of clinician time and improved bed availability and could potentially make resources available for other patients.

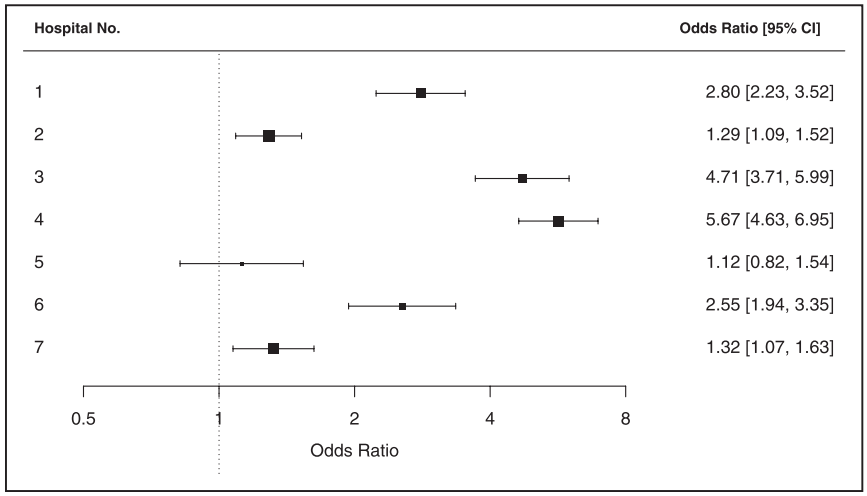

Figure 2. Forest plot of the odds ratio (OR) for early discharge for each hospital.
An OR >1 indicates increased odds of being discharged within 6 hours. CI indicates confidence interval

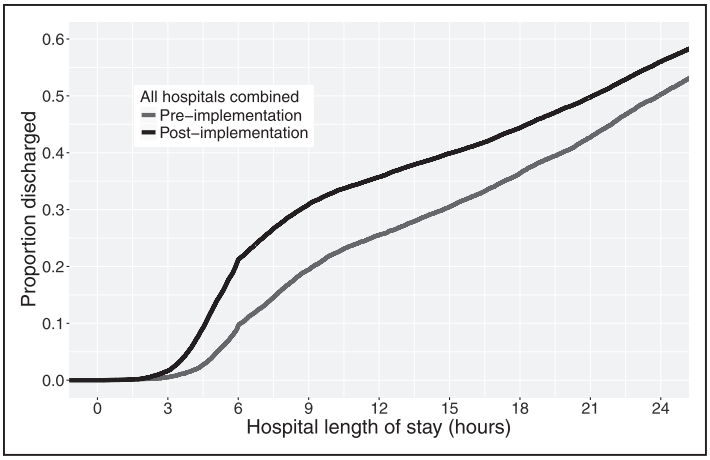

Figure 3. The cumulative proportion of patients without acute coronary syndrome discharged as a function of time in hospital.
The graph has been truncated at 24 hours.

The strengths of this study include its reach across a country with hospitals of varying sizes and service provisions, which collectively have a total annual ED attendance of 369 000, representing approximately a third of all New Zealand ED attendances.[24] In addition, despite large variations in rates of early discharge between hospitals before implementation, each hospital showed increased rates of early discharge after implementation. The prospective stepped-wedge design reduced potential bias from seasonal variations.

Another strength was that a specific troponin assay or risk assessment process was not specified. This increases the probability of duplicating these results in different geographic locations. Three different cardiac troponin assays were used, and it does not appear that the assay affected the outcome. Of the 4 hospitals that used the high-sensitivity troponin T assay (hospitals 1, 2, 4, and 5), the absolute increase in percentage discharged early ranged from the low end (2.7%) to the highest percentage (28.4%). This suggests that other factors such as the ADP and clinical pathway implementation process may also influence the final effectiveness.

The principal study weaknesses are that hospitals did not record which patients were being investigated for ACS, so serial troponin measurements were used to capture the population of interest and *ICD-10* coding to quantify clinical outcomes. Reassuringly, an audit found that adjudicated diagnosis of MACEs corresponded to the *ICD-10* codes used to define MACEs in this trial in 98% of cases. Second, there were insufficient hospitals in the study to identify factors associated with greater or less improvement. The dates of implementation were purposely varied to mitigate for seasonal variations in ED presentations and disease prevalence. Nevertheless, some of the differences between hospitals may be the result of differences in when the implementation began. For example, 1 hospital (hospital 3) began implementation a week before Christmas, a time when many staff members take summer vacations in New Zealand. This could have hampered implementation; however, this hospital still had a good change results. All hospitals with 1 exception (hospital 7) designed and implemented their local pathway only after a formal planning meeting of all local stakeholders led by the first author that used the Kotter change management tool. That hospital demonstrated the smallest increase in early discharge rate. Although we acknowledge that this is anecdotal, we believe that the efficacy and uptake of the pathway depend crucially on early and broad engagement of all stakeholders, clinician engagement with prior evidence, and the appointment of local leaders to monitor and foster implementation. Third, we were unable to ascertain whether there were any deaths or follow-up admissions to hospitals outside of New Zealand. This is likely to be a very small number and is unlikely to affect the overall study conclusions. Finally, a formal economic analysis was not done. It is hard to estimate a precise financial impact of implementation; however, a median reduction of 2.9 hours in length of stay for patients without ACS should be beneficial to reducing the common and important issue of ED overcrowding. We note that after implementation in 4 hospitals there was an apparent decrease in the number of patients tested, and in 3 hospitals there was an increase in the

Table 5. Length of Hospital Stay for Patients Without Acute Coronary Syndrome Before and After Clinical Pathway Implementation by Hospital

Hospital	Hospital Length of Stay, h*		*P* Value
	Before Implementation	After Implementation	
1	26.7 (12.2–68.5)	21.8 (7.2–73.6)	<0.001
2	7.6 (5.5–45.2)	6.4 (4.7–33.4)	<0.001
3	25.2 (14.8–71.2)	22.3 (9.8–57.9)	<0.001
4	17.5 (8–44.9)	8.9 (4.3–34.9)	<0.001
5	14.5 (4.5–54.2)	6.5 (4.5–49)	0.37
6	25.3 (15.1–50.9)	23.6 (9.7–52.8)	0.004
7	24.4 (15.8–59)	24.0 (14.3–64.8)	0.26

*Median (lower quartile–upper quartile).

number of patients tested (Table III in the online-only Data Supplement).

New Zealand is the first country to implement clinical pathways for hospital assessment of possible ACS as a function of national policy. There is limited existing national health system–level research in this field. One large randomized stepped-wedge intervention study of the History, ECG, Age, Risk Factors, and Troponin score in 9 hospitals in the Netherlands involving 3666 patients demonstrated that the pathway was noninferior to usual care for safety and was cost-effective, but it demonstrated no improvement in early discharge because of a 41% nonadherence to the score recommendation.[25] In Australia, an ADP similar to that in hospitals 3 and 6 has been implemented and assessed in the state of Queensland.[26] In that study, there was a reduction in mean hospital and mean ED lengths of stay and an absolute reduction in hospital admission rate of 13.3%.

Meaning of the Study

Regardless of hospital setting and circumstances, introducing clinical pathways for patients with possible ACS led to a safe increase in early discharge rates and reduced length of stay in hospital for patients without ACS. This has the potential to reduce the use of hospital resources and provides rapid reassurance to many patients who presented to EDs with symptoms consistent with ACS. Currently, most ED patients in developed countries with symptoms of suspected ACS are discharged without an ACS-related diagnosis.[1] Investigating these individuals places a significant burden on acute care hospital services. Our findings suggest that ≈6600 more patients in New Zealand could be discharged home within 6 hours after national implementation of these pathways, a 10.1% absolute increase. This finding suggests that globally many millions of patients with chest pain could be discharged early, thus releasing health resources for the care of other patients.

The 6-hour time frame was used as our primary outcome because in New Zealand there is a national health target that requires 95% of patients to be admitted or discharged from the ED within 6 hours. This target was put in place to address overcrowding and to improve patient flow in hospitals, in keeping with similar initiatives in Australia and the United Kingdom. We estimate that, after implementation of clinical pathways across all the acute care hospitals in New Zealand, patients would spend a total of ≈165 000 hours less in hospital per annum. Lastly, there are unmeasured emotional, social, and economic benefits because patients receive quick reassurance that they are not having a heart attack and can return earlier to their families and normal life activities, including work.

Conclusions

The implementation of hospital clinical pathways to assess patients with suspected ACS safely reduced length of hospital stay while increasing the rate of safe discharge within 6 hours.

AUTHORS

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FOOTNOTES

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