The Effect of Pay for Performance in the Emergency Department on Patient Waiting Times and Quality of Care in Ontario, Canada: A Difference-in-Differences Analysis

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Study objective: In 2008, a pay-for-performance program was implemented in sequential waves in Ontario emergency departments (EDs), with the aim of reducing length of stay. We seek to evaluate its effects on ED length of stay and quality of care.

Methods: This was a retrospective observational study of ED visits in Ontario from April 1, 2007, to March 31, 2011, using multivariable difference-in-differences analysis. Pay-for-performance hospitals and matched control sites were selected for each of 3 waves of the program. The primary outcome was 90th percentile ED length of stay; we also examined quality-of-care indicators.

Results: Pay-for-performance hospitals had a modest reduction in overall adjusted 90th percentile ED length of stay in wave 1 (−36 minutes; 95% confidence interval [CI] −50 to −21 minutes), but not in wave 2 (−14 minutes; 95% CI −30 to 2 minutes) or wave 3 (−7 minutes; 95% CI −23 to 8 minutes). ED admitted patients had a pronounced reduction in adjusted 90th percentile length of stay in wave 1 (−225 minutes; 95% CI −263 to −188 minutes) and wave 2 (−133 minutes; 95% CI −175 to −91 minutes). Nonadmitted low-acuity patients had reductions in adjusted 90th percentile ED length of stay in wave 1 (−24 minutes; 95% CI −29 to −18 minutes) and wave 3 (−19 minutes; 95% CI −24 to −14 minutes). The program did not negatively affect ED quality-of-care measures, such as 30-day mortality or readmission rates.

Conclusion: Pay-for-performance was associated with modest overall benefits for ED length of stay without adversely affecting quality of care. [Ann Emerg Med. 2016;67:496-505.]

Please see page 497 for the Editor's Capsule Summary of this article.

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0196-0644/$-see front matter

http://dx.doi.org/10.1016/j.annemergmed.2015.06.028

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INTRODUCTION

Pay-for-performance incentives to drive improvements in quality and efficiency have been increasingly used in health care environments during the past decade.[1,2] Initially, the majority of pay-for-performance initiatives were targeted at primary care.[2] More recently, incentive programs have been directed toward hospitals and specialist services.[3] However, the evidence for pay-for-performance programs to improve quality of care and patient outcomes is mixed.[4,5]

The emergency department (ED) is one important area in which pay for performance has not yet been widely implemented or rigorously evaluated. Prolonged ED waiting times and crowding are a concern in many jurisdictions[6-8] and are associated with important adverse consequences for patients.[7,9-11] However, concerns have been raised about the potential risks to quality of care when the focus is on meeting time-based performance targets.[12,13]

In 2008, the Ontario Ministry of Health and Long-Term Care launched the Emergency Department Wait Times strategy to address ED crowding and reduce length of stay (Figure 1).[14] Several initiatives were implemented as part of this strategy, including public reporting of ED performance in 2008,[15] setting province-wide benchmarks and targets for ED length of stay in early 2009,[15] a targeted ED process improvement (lean) program to improve patient flow within hospitals in 2009,[14] and the Pay for Results Program, a pay-for-performance program that provided annual financial incentives to hospitals for improved performance on ED

Editor's Capsule Summary

What is already known on this topic

The effects of pay-for-performance initiatives on quality improvement and patient outcomes are mixed.

What question this study addressed

The authors evaluated the effect of a pay-for-performance program implemented in Ontario, Canada, on emergency department (ED) length of stay and quality of care by comparing the change in these outcomes 1 year after implementation between program and control hospitals.

What this study adds to our knowledge

Short-term, modest improvements were observed as a result of greater reductions or smaller increases in ED length of stay in program versus control hospitals.

How this is relevant to clinical practice

The effects of pay-for-performance programs on ED processes and outcomes deserve further study, particularly the effect of design features and contextual factors.

length-of-stay targets, in April 2008.[14] We sought to evaluate the effect of the pay-for-performance program on ED length of stay and determine whether it was associated with any unintended consequences with respect to quality of care. We hypothesized that the program would be associated with an improvement in ED length of stay but not associated with unintended consequences.

MATERIALS AND METHODS

The pay-for-performance program was the first performance-based funding strategy directed at EDs in Ontario. Hospitals were rewarded for improvements in achieving specific benchmarks for ED length of stay, as specified by the Ministry: a maximum of 8 hours for patients admitted to the hospital or triaged as high acuity (defined as Canadian Triage and Acuity Scale[16] level I [resuscitation], II [emergent], or III [urgent]) and 4 hours for nonadmitted low-acuity patients (Canadian Triage and Acuity Scale level VI [less urgent] or V [nonurgent]).[15] The Ministry set targets for compliance with benchmarks of 90% or greater. To be eligible for funding, designated hospitals had to meet certain conditions, including being an acute care facility with 20,000 or more annual ED visits that accepts urgent or emergency ambulance patients 24 hours a day, 7 days a week. Sites were required to submit data on ambulance offloads, ED length of stay, and other measures of ED quality of care for regular review by the Ministry.

The Ministry determined eligibility for the pay-for-performance program and selected sites for participation annually. In wave 1 of the program (fiscal year 2008/2009), Ontario hospitals with the largest number of patients exceeding ED length-of-stay benchmarks were targeted,[14] with subsequent expansion to additional eligible hospitals annually. All participating hospitals were notified which wave they were allocated to before the introduction of the program; thus, lead time varied from a few months for wave 1 sites to at least 1 year for wave 2 sites and more than 2 years for wave 3 sites. Notice of annual performance targets for the program was typically given between January and March for the upcoming fiscal year. There were 23 hospitals enrolled in wave 1 (fiscal year 2008/2009), with paid incentives totaling $30 million spread across all hospitals.[14] An additional 23 and 25 hospitals joined in wave 2 (2009/2010) and wave 3 (2010/2011), with incentives of $55 million and $100 million, respectively.[17,18] Hospitals in waves 1 and 2 remained in the pay-for-performance program through fiscal year 2010 to 2011. The first wave targeted extreme ED lengths of stay (>24 hours) and set a performance goal of a 5% improvement in provincial ED length-of-stay targets (Table 1). In the second wave, the performance goal was 10%. The third wave set a performance goal of 15% and also mandated a decrease in time to initial physician assessment. Incentives were allocated internally within each hospital, but there were stipulations not to use payments to supplement physician income. Funds were not restricted to the ED and could be used to improve flow in inpatient areas as well. Failure to attain specified targets could render payments subject to recovery. There was no "tournament" or competitive component to the payment scheme, which allowed certain high-performing hospitals to lead shared-learning events and activities facilitating the dissemination of best practices. Table 1 describes the framework and variation in performance expectations associated with the pay-for-performance program in each of the 3 waves.

Setting and Selection of Participants

We conducted a retrospective observational study of ED visits among hospitals that were eligible for the pay-for-performance program in Ontario from April 1, 2007, to March 31, 2011. Frequency-matched control hospitals were selected separately for each wave. A hospital could be a control for multiple waves of the program; hospitals were excluded as controls if they had participated in the pay-for-performance program in a previous wave. Controls were matched if the median ED length of stay in the year before

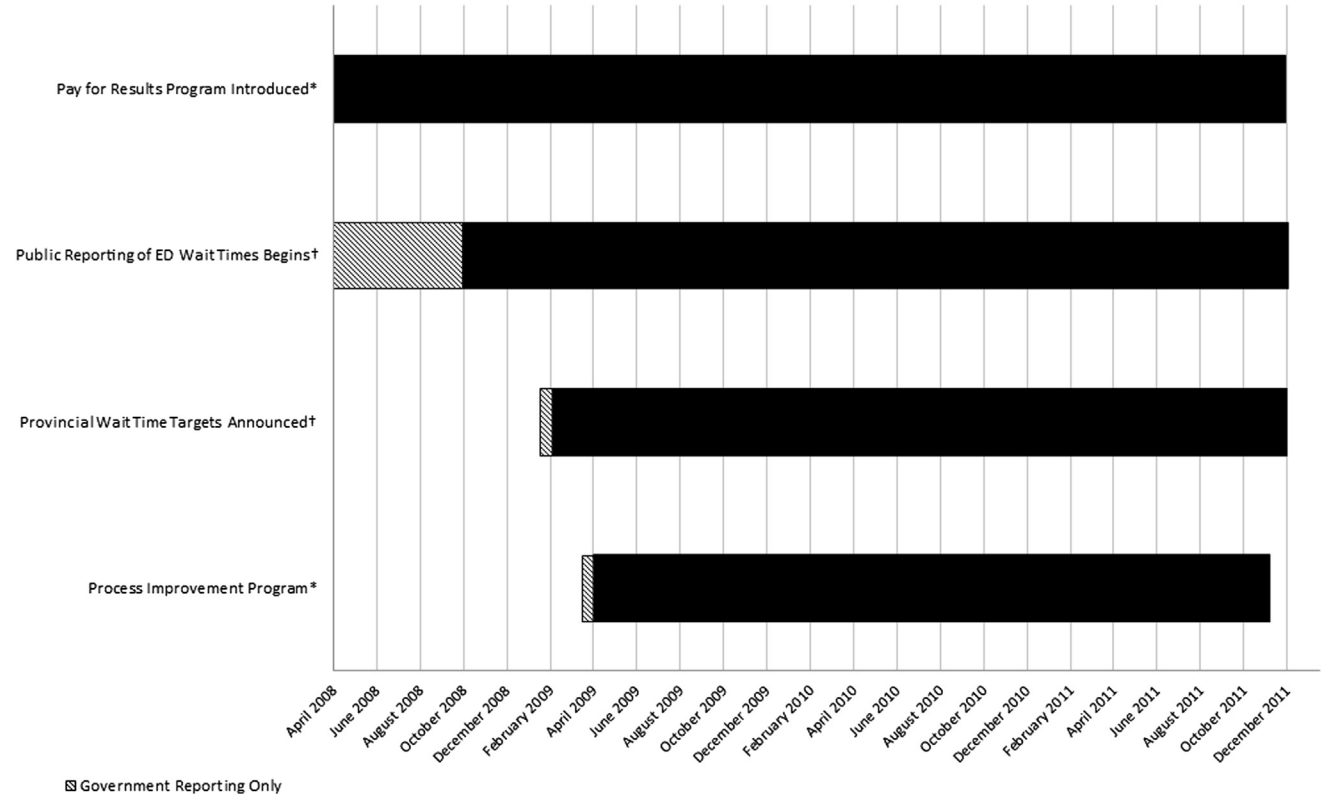

Figure 1. Ontario Ministry of Health and Long-Term Care ED wait time strategy.

a given program wave was within 0.5 hours of the range of median ED length of stay at program sites.

We excluded low-volume (<25,000 annual ED visits) hospitals (because ED length of stay tends not to be prolonged at these sites), pediatric hospitals (because of the difficulty of finding suitable controls for a small number of hospitals), and hospitals that had participated in pilot programs to reduce ED length of stay before the introduction of the pay-for-performance program (because we did not have data on the duration of their participation in these and other programs to reduce ED waiting times).

ED visits were identified through the National Ambulatory Care Reporting System[19-21] and hospital admissions through the Discharge Abstract Database,[22] both of which are collected through the Canadian Institute for Health Information. The Ontario Ministry of Health and Long-Term Care requires all hospitals to submit all ED visit and hospital separation data to the Canadian Institute for Health Information. Deaths were identified from the Registered Persons Database, a population-based registry of all legal residents in Ontario.[23] Neighborhood income quintile and community type were derived from Statistics Canada 2006 census estimates. These data sets were linked with unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences.

Outcome Measures

The primary outcome was 90th percentile ED length of stay, consistent with the targets set by the Ministry. This was defined as the time from triage or registration (whichever was earlier) to the time the patient left the ED. Other outcomes included median ED length of stay, as well as 90th percentile and median time to initial physician assessment (defined as the time from triage or registration to the time the patient was first assessed by a physician). We examined ED length of stay according to whether the patient was admitted because performance targets differed according to admission and others have found that benchmarks were associated with an increase in ED length of stay among admitted patients.[12]

We also examined a number of ED quality-of-care measures identified in the literature and through a Delphi panel process.[24] These included rates of patients who left without being seen by a physician,[24] overall and short-term (<48-hour) hospital admission, 7- and 30-day mortality, 30-day readmission among admitted

Table 1. Pay-for-performance program features.

Program Features	Wave 1 (2008/09)	Wave 2 (2009/10)	Wave 3 (2010/11)
Total number of hospitals participating in the program during each wave	23	46	71
Number of new hospitals added in the wave	N/A	23	25
Number of sites included in study	19	19	22
Total funding for all hospitals, CAD $, millions	30[14]	55[17]	100[18]
Fixed funding, CAD $, millions	30[14]	55[17]	60 (infrastructure funding, eg, staffing, space redesign)[18]
Variable funding, CAD $, millions	None	None	40[18]
Performance target: fixed funding[49]	Extreme ED LOS* (>24 h) must be reduced to a maximum of 2% of total patients	The % of patients treated within the provincial ED LOS targets must increase by 10% above the 2008/09 baseline:	The % of patients treated within the provincial ED LOS targets must increase by 15% above the 2009/10 baseline:
	% of CTAS I/II patients with ED LOS within 8 h and CTAS III patients with ED LOS within 6 h must improve by a 5% absolute increase compared with 2006/07	Target for admitted and CTAS I/II/III patients: 8 h Target for nonadmitted CTAS IV/V patients: 4 h	Target for admitted and CTAS I/II/III patients: 8 h Target for nonadmitted CTAS IV/V: 4 h
	% of CTAS IV/V patients with ED LOS within 4 h must improve compared with 2006/07	Local Health Integration Networks (regional funding body) permitted to add other performance expectations for specific sites	The 90th percentile time patients waited for an initial physician assessment must decrease
Performance target: variable funding[49]	N/A	N/A	CAD $100 per CTAS IV/V patient discharged within 4 h above baseline CAD $500 per admitted patient meeting 8-h target above baseline Capped in accordance with available total budget

CTAS, Canadian Triage and Acuity Scale (I=resuscitation; II=emergency; III=urgent; IV=less urgent; V=nonurgent).
*ED length of stay, defined as time from patient registration or triage to the time the patient left the ED.

patients, and 72-hour unscheduled ED revisits among discharged patients.[24] We examined hospital admission rates because the introduction of ED length-of-stay benchmarks might lead to a change in admission practices, and short-term admissions may be a proxy for avoidable hospitalizations.

Study Design

Because selection criteria for pay-for-performance hospitals changed from wave to wave, we conducted separate analyses for each wave according to the fiscal year they were introduced to the program. We compared baseline characteristics of pay-for-performance hospitals and controls in the fiscal year before each wave with respect to age, sex, ED length of stay, physician initial assessment, ED volume, teaching hospital status,[25] admission rates, percentage of resuscitation and emergency patients (Canadian Triage and Acuity Scale level I or II), participation in an Alternative Funding Arrangement plan (a model of physician payment typically based on an hourly rate instead of fee for service), and participation in a Ministry lean program to improve patient flow or other lean-type interventions during each month.

We conducted difference-in-differences analyses to compare the change in each outcome in the first fiscal year after the introduction of pay for performance between program and control hospitals.[26-29] Regression model details are shown in Appendix E1 (available online at http://www.annemergmed.com).

This study received approval from the research ethics board of Sunnybrook Health Sciences Centre. Descriptive analyses were generated with SAS (version 9.3; SAS Institute, Inc., Cary, NC).[30] Stata MP (version 12.1; StataCorp, College Station, TX) for Unix was used for all multivariable models.[31]

RESULTS

There were 87 eligible hospitals during the first 3 waves of the pay-for-performance program. Of these, 8 were

Table 2. Baseline characteristics of ED visits at pay-for-performance and control hospitals in the year before the introduction of the program.

Characteristic	Wave 1 (Baseline 2007/08)		Wave 2 (Baseline 2008/09)		Wave 3 (Baseline 2009/10)	
	Pay for Performance (n=894,084)	Control (n=908,450)	Pay for Performance (n=937,266)	Control (n=1,008,147)	Pay for Performance (n=881,195)	Control (n=269,021)
Number of hospitals	19	20	19	27	22	10
Number of teaching hospitals	8	2	3	0	0	0
Number of Alternative Funding Arrangement* hospitals	13	16	13	25	19	10
Number of hospitals engaged in a lean-type intervention	11	12	14	12	13	1
ED length of stay, median (IQR), h	4.2 (2.4–7.1)	3.3 (1.9–5.6)	2.9 (1.6–5.1)	2.9 (1.7–4.7)	2.8 (1.6–4.8)	2.2 (1.2–3.8)
Admitted patients	10.7 (6.2–19.8)	8.9 (5.4–17.2)	11.9 (6.4–24.5)	7.6 (4.8–13.8)	7.9 (5.0–14.5)	6.5 (4.2–12.0)
Nonadmitted patients	3.8 (2.2–6.0)	3.0 (1.8–4.8)	2.6 (1.5–4.3)	2.6 (1.5–4.2)	2.6 (1.5–4.2)	2.1 (1.2–3.4)
ED volume, mean (SD)	48,886 (8,280)	50,277 (14,065)	55,058 (18,627)	41,423 (13,781)	46,199 (13,015)	26,650 (1,988)
High-acuity patients (CTAS 1–3), No. (%)	587,567 (65.7)	554,312 (61.0)	594,273 (63.4)	564,007 (55.9)	504,680 (57.3)	137,375 (51.1)
Patients admitted to hospital, No. (%)	127,304 (14.2)	109,429 (12.1)	100,069 (10.7)	98,199 (9.7)	85,617 (9.7)	20,802 (7.7)
Left without being seen, No. (%)	51,526 (5.8)	41,727 (4.6)	35,705 (3.8)	47,392 (4.7)	38,261 (4.3)	11,247 (4.2)
Age, mean (SD), y	44.0 (24.0)	41.7 (24.7)	41.1 (24.7)	40.9 (24.7)	41.0 (24.7)	40.5 (25.0)
Female patient, No. (%)	466,655 (52.2)	465,655 (51.3)	483,189 (51.6)	527,564 (52.3)	465,764 (52.9)	139,379 (51.8)

*A model of physician payment typically based on an hourly rate instead of fee for service.

low-volume hospitals, 3 were pediatric hospitals, and 6 had participated in pilot programs to reduce waiting times, leaving 70 unique hospitals for analysis. During the entire study period, there were a total of 1,857,009 ED visits at 19 wave 1 program sites and 1,825,209 visits at 20 control sites; 1,903,040 visits at 19 wave 2 program sites and 2,015,649 visits at 27 control sites; and 1,786,913 visits at 22 wave 3 program sites and 547,398 visits at 10 control sites. (Control sites in earlier waves may have gone on to become program sites or may have acted as controls in multiple waves; therefore, the total number of EDs summed across all waves was 117.) Of the 8,010,957 unique observations in the cohort, none were missing age, 68 (0.001%) were missing sex, 4,580 (0.06%) were missing Canadian Triage and Acuity Scale level, 115,594 (1.4%) were missing ED length of stay, and 1,478,826 (18.5%) were missing time to physician assessment. The frequency of missing values was similar among program and control sites.

Table 2 shows baseline characteristics of program and control sites in each respective wave before the start of the program. In some waves, program sites had higher volumes (waves 2 and 3), were more likely to have participated in other lean-type interventions (wave 3), were more (wave 3) or less (wave 2) likely to be Alternative Funding Arrangement hospitals, or were more likely to be teaching hospitals (waves 1 and 2) than control sites.

Figures 2 and 3 present the results of the difference-in-differences models comparing the change in outcomes at pay-for-performance hospitals with controls (full model details are available in Tables E1 through E3, available online at http://www.annemergmed.com). Figure 2 shows the effects of the program on ED length of stay in each of the 3 program waves. In these models, pay-for-performance hospitals had small but significantly greater reductions in overall 90th percentile ED length of stay in wave 1 (–36 minutes) but not wave 2 or 3. Significant reductions were also observed in waves 1 and 3 sites for ED length of stay among nonadmitted patients, and waves 1 and 2 sites experienced reductions in ED length of stay among admitted patients. Wave 3 sites had lower overall median ED length of stay, 90th percentile and median time to physician assessment, and length of stay for nonadmitted patients, particularly those classified as low acuity. Figure 3 shows the effects of the pay-for-performance program on ED length-of-stay targets and quality-of-care measures in each of the 3 program waves. Improvements in targets were observed for both admitted and nonadmitted patients across all waves. The program was not associated with any unintended consequences, and the rate of patients who left without being seen decreased in waves 1 and 3.

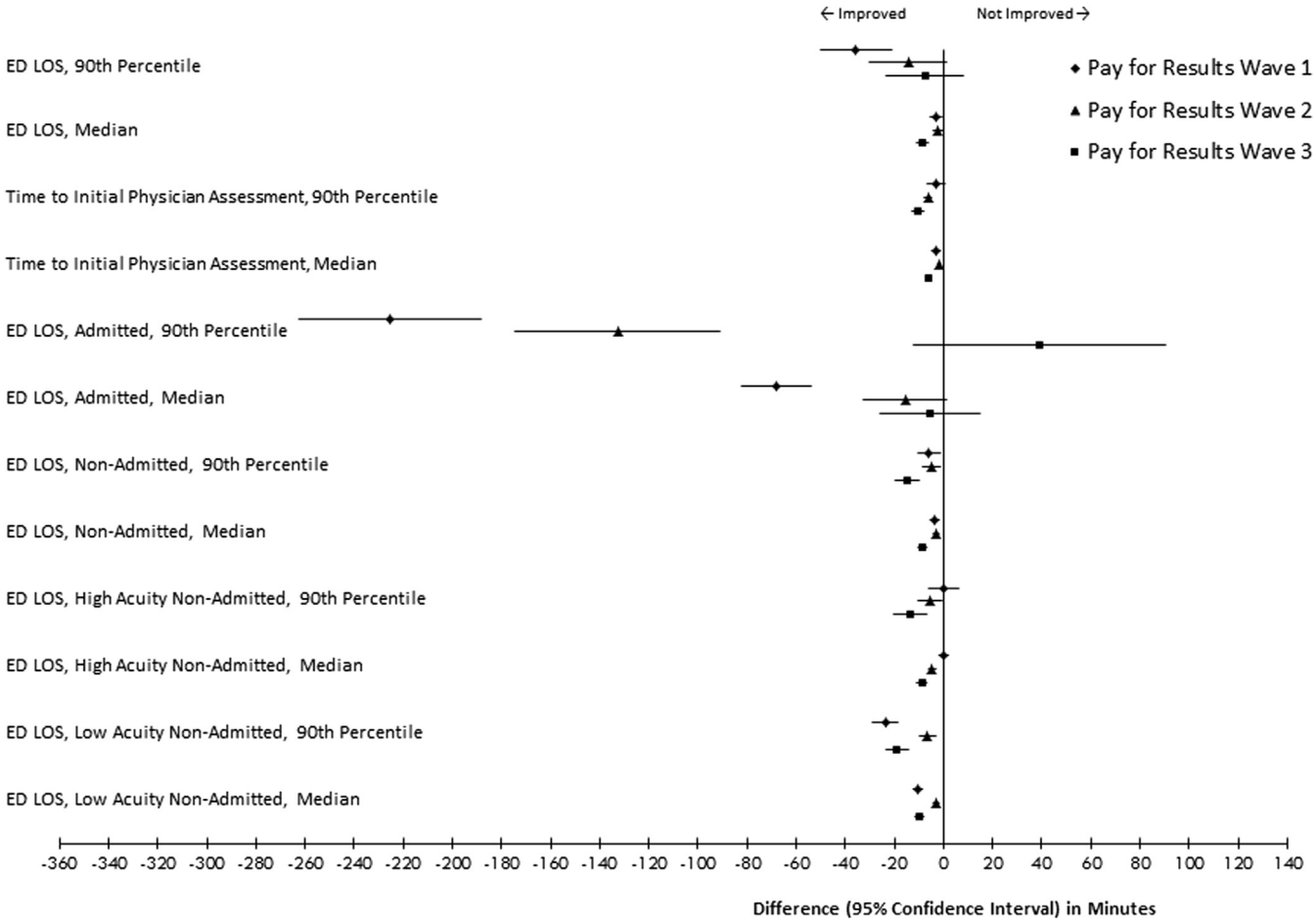

Figure 2. Change in ED length of stay before and after the Ontario Pay-for-Results program among program sites compared with control sites (difference-in-differences models). Adjusted for age/sex group, Canadian Triage and Acuity Scale group, participation in the government-funded Emergency Department Process Improvement Program (lean), participation in other lean-type interventions, participation in an Alternative Funding Arrangement plan, emergency department volume, teaching hospital, calendar month, individual emergency department.

LIMITATIONS

This study had several limitations. Administrative data are subject to inaccuracies, but we used some of the most reliable data elements.[19,20] Some data elements such as time of initial physician assessment had more missing data. Program assignment was not random and program sites may have been different from control sites, limiting generalizability. The number of suitable controls diminished with each wave, and although we frequency-matched controls with program sites, there remained some differences in hospital characteristics (these factors were controlled for in multivariable models); thus, there may have been residual confounding. All EDs were required to publicly report ED length of stay; this overlapped with the pay-for-performance program, and hence we could not distinguish the independent effect of each initiative.

Although public reporting is associated with improvements in quality-of-care measures and patient outcomes in some settings,[32] including Ontario,[33] others have also observed additional positive effects of pay for performance in the context of public reporting.[34] We did not have detailed information about how financial incentives were used at individual hospitals; a better understanding of program features could identify factors associated with success. It is possible that some control hospitals became increasingly engaged in efforts to reduce ED length of stay, which may have diminished the effect among pay-for-performance sites. Because a number of controls joined the program, we did not have a sufficient number of them to extend the follow-up period beyond 1 year. Pay for performance in health care varies, limiting generalizability to programs with different designs. However, this evaluation did benefit

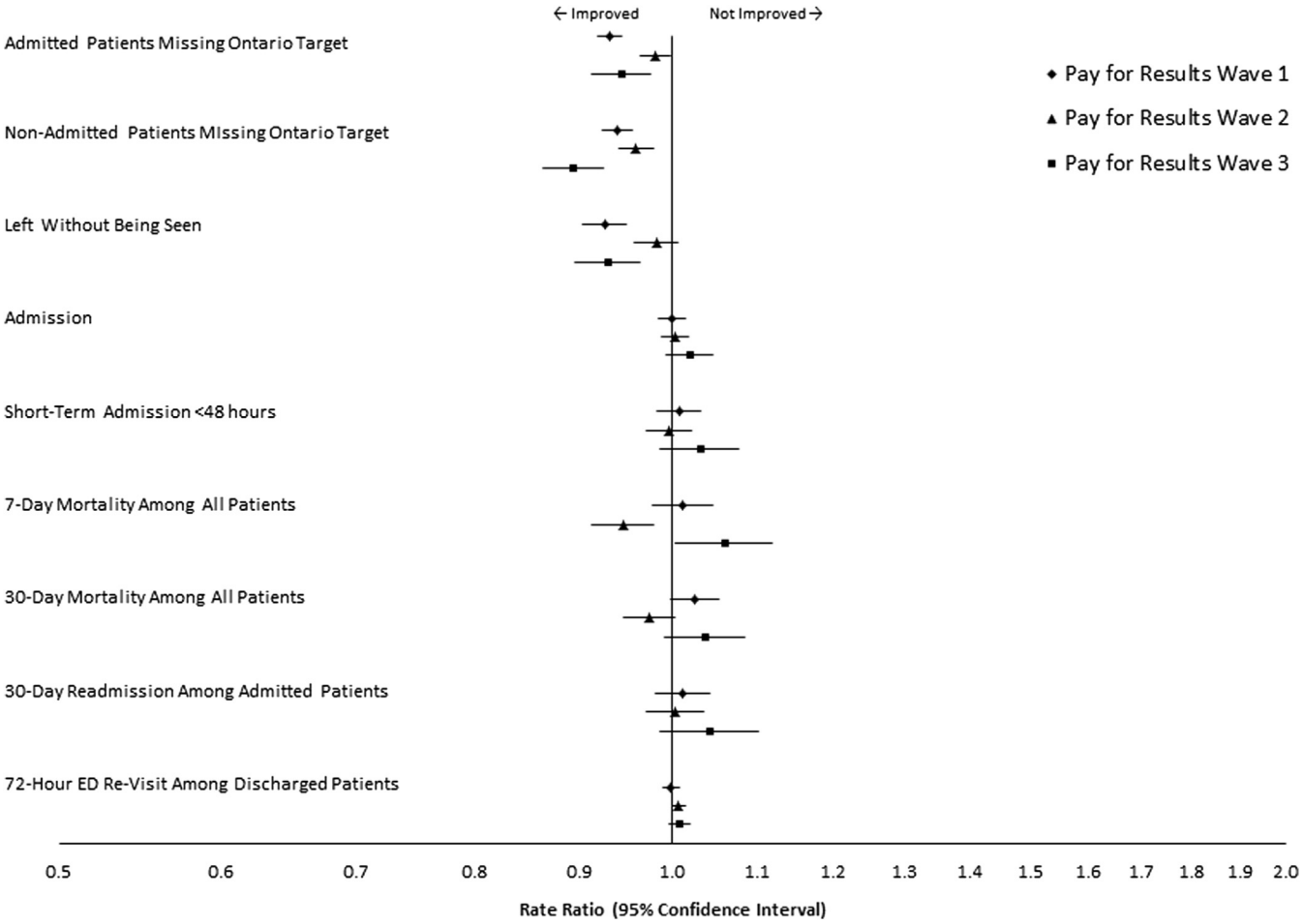

Figure 3. Change in ED length-of-stay targets and quality-of-care outcomes before and after the Ontario Pay-for-Results program among program sites compared with control sites (difference-in-differences models). Adjusted for age/sex group, Canadian Triage and Acuity Scale group, participation in the government-funded Emergency Department Process Improvement Program (lean), participation in other lean-type interventions, participation in an Alternative Funding Arrangement plan, emergency department volume, teaching hospital, calendar month, individual emergency department.

from having no competing incentives in a single-payer system.

DISCUSSION

Among Ontario hospitals participating in a voluntary pay-for-performance program, there were moderate improvements in overall ED length of stay compared with that of control sites. In the first 2 waves, reductions in ED length of stay were most pronounced among admitted patients. Overall performance with respect to benchmarks also improved. In some instances, improvements in ED length of stay represented greater reductions among program sites; in others, program sites experienced increases that were less pronounced than those at control sites. These findings were consistent with the structure of the incentives, particularly in the first wave, in which the focus was on reductions in extreme baseline lengths of stay. In addition, program sites experienced greater reductions in time to see a physician in wave 3 of the program, in which this measure was explicitly targeted for the first time. We did not observe significant adverse consequences; rather, we observed a decline in the left-without-being-seen rate among program sites in the first and third waves. On balance, these findings suggest modest improvements associated with the use of financial incentives to target ED length of stay and provide evidence that there are not unintended effects with respect to quality of care.

Recent studies of pay-for-performance initiatives show few positive results, whether the incentives targeted hospitals[29,35-38] or primary care providers.[5,39-41] Studies of pay-for-performance initiatives in the ED are rarer, but one before-after study found that payments for meeting

ED length-of-stay targets were effective,[39] whereas another in British Columbia observed mixed results across different health regions.[42] In our study, the most sizeable gains were found among hospitals with the poorest baseline performance, ie, those in wave 1. These findings are consistent with other research identifying greater effects of pay-for-performance for the poorest performers.[34,41,43]

The design of financial incentive programs in health care is important to success.[43] Programs targeting institutions with larger financial incentives and opportunities for shared learning may be more effective than those aimed at individual physicians or physician groups.[29,37,44,45] Several features of Ontario's pay-for-performance program may have been beneficial, including paying the incentive to the hospital up front and subjecting it to recovery if performance did not meet targets, which would appeal to loss aversion[46]; an absence of competition (ie, improvement was not based on ranking among EDs and all had an opportunity to achieve the gains required to earn incentives),[43,47] and shared learning opportunities among participating sites.[29] On the other hand, some features may have limited success; for example, incentives were not necessarily aligned with the dominant funding structure (global budgets) for Ontario hospitals, which for the most part is not linked to performance.[48] In addition, the program's financial incentives alone may have been incapable of significantly addressing access to inpatient beds, a major contributor to ED crowding, especially in Ontario,[49] and could not address community resources such as beds in chronic care facilities needed for the postacute care of hospital patients because they are not funded by hospitals.[50] Finally, the annual incentive allocations may have led to uncertainty about their sustainability and reduced willingness to make longer-term investments.

This study examined financial incentives directed at ED length of stay in a large sample of EDs using contemporaneous controls for comparison. Our results suggest that in a context of a comprehensive strategy to address ED crowding, the pay-for-performance program provided modest additional benefits (ie, attenuated deterioration or improvement in waiting times) without adversely affecting quality of care, which may mitigate concerns about the effect of pay for performance on quality-of-care measures that are not subject to incentives. A remaining question concerns the sustainability of performance improvement through financial incentives. This study examined only the first year after implementation, and a longer period of follow-up may have revealed greater effect, although several studies have found that initial gains in quality-of-care measures and patient outcomes attenuate over time.[35,44,50] It is also unclear whether more specific hospital characteristics or program design features played a role in the variable effects across different waves of the program. In future research, attention needs to be paid to sustainability, incentive design, and contextual factors in determining the effectiveness of pay-for-performance schemes.

The authors acknowledge Howard Ovens, MD, CCFP (EM), for his invaluable assistance in providing information on the pay-for-performance program characteristics.

Supervising editor: Melissa L. McCarthy, ScD

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Author contributions: MJV, TAS, AG, and MJS were responsible for study conception and design. MJV and TAS were responsible for data analysis. MJV, TAS, ASB, and MJS were responsible for interpretation of the data. MJV, ASB, and MJS were responsible for drafting the article. All authors were responsible for revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MJV takes responsibility for the paper as a whole.

Funding and support: By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have stated that no such relationships exist and provided the following details: This study was funded by the Ontario Ministry of Health and Long-Term Care (MOHLTC). Dr. Guttmann is supported by a Canadian Institutes of Health Research (CIHR) Applied Chair in Child Health Policy and Services Research. Dr. Schull is supported by a CIHR Applied Chair in Health Services and Policy Research. This study was supported by the Institute for Clinical Evaluative Sciences (ICES), which is funded by an annual grant from the Ontario MOHLTC.

Publication dates: Received for publication January 21, 2015. Revision received June 2, 2015. Accepted for publication June 26, 2015. Available online July 26, 2015.

Presented at the Canadian Association for Health Services and Policy Research meeting, May 2013, Vancouver, British Columbia, Canada; and the Canadian Association of Emergency Physicians, June 2013, Vancouver, British Columbia, Canada.

The opinions, results, and conclusions reported in this article are those of the authors and are independent from the funding sources. No endorsement by ICES or the Ontario MOHLTC is intended or should be inferred.

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APPENDIX E1

Details of statistical models

To calculate 90th percentile and median ED length of stay and time to physician assessment, data were collapsed into ED, week, age/sex group (male and female patients aged 0 to 19, 20 to 44, 45 to 64, 65 to 74, and >74 years) and Canadian Triage and Acuity Scale group (high [I to III] versus low acuity [IV to V]) strata, and dependent variables were calculated within each stratum; thus, patients with missing data on age, sex, or Canadian Triage and Acuity Scale level were excluded. Patients with missing data on ED length of stay or time to physician assessment were not included in the calculation of these outcomes but were included in the calculation of quality-of-care measures. The unit of analysis was the ED, week, age/sex group, and Canadian Triage and Acuity Scale group stratum, and there were 241,185 observations when data were collapsed for modeling purposes.

Separate regression models were used for each outcome. We modeled the change in ED length of stay and time to physician initial assessment after implementation of the pay-for-performance program, using generalized least squares for serially correlated continuous data,[1] applying an autoregressive AR1 correlation structure, weighting by stratum population. To model the change in the number of patients meeting ED length-of-stay targets and unintended consequences, we used generalized estimating equations[2] Poisson models for serially correlated count data, applying an AR1 correlation structure, with the logarithm of the stratum population as the offset parameter. Because patients visiting the same hospital have correlated outcomes, we clustered by hospital to adjust the standard errors.

The change in outcome was modeled with separate dummy variables for pay-for-performance and control sites to compare the single fiscal year after the program started to the previous fiscal year. For example, for wave 1 sites and controls, we compared 2008/2009 with 2007/2008. In all models, we then compared the change in each outcome among program sites to the change among control sites (difference in differences).[3,4]

Each model controlled for age/sex group, acuity (high versus low), hospital teaching status (teaching versus others), ED volume in fiscal wave 2007/2008 (volume ≥45,000 versus others), calendar month, Alternative Funding Arrangement participation, and participation in the Ministry lean program or other lean-type interventions during each month. Other local lean-type interventions carried out by hospitals from 2007 to 2010 were identified in a survey of all EDs, which achieved a response rate of 100%. ED fixed effects were also included in the models (dummy variables for each ED).

Table E1. Change in outcomes among pay-for-performance hospitals versus control hospitals, wave 1.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
ED waiting times, min				
ED LOS,† 90th percentile				
Pay-for-performance hospitals	703 (699 to 708)	731 (722 to 740)	28 (17 to 38)	−36 (−50 to −21)
Control hospitals	695 (690 to 699)	758 (749 to 767)	63 (53 to 74)	
ED LOS,† median				
Pay-for-performance hospitals	252 (251 to 252)	253 (251 to 254)	1 (−1 to 3)	−3 (−5 to −0.3)
Control hospitals	251 (250 to 252)	255 (253 to 256)	4 (2 to 6)	
Time to initial physician assessment, 90th percentile				
Pay-for-performance hospitals	252 (251 to 253)	253 (251 to 255)	1 (−2 to 3)	−3 (−7 to 0.5)
Control hospitals	251 (250 to 252)	255 (253 to 257)	4 (1 to 6)	
Time to initial physician assessment, median				
Pay-for-performance hospitals	102 (102 to 103)	102 (101 to 102)	−1 (−1 to 0)	−3 (−4 to −2)
Control hospitals	102 (101 to 102)	104 (103 to 105)	3 (2 to 3)	
ED LOS,† admitted patients, 90th percentile				
Pay-for-performance hospitals	1,808 (1,796 to 1,820)	1,978 (1,957 to 1,999)	170 (144 to 197)	−225 (−263 to −188)
Control hospitals	1,766 (1,755 to 1,777)	2,161 (2,138 to 2,185)	395 (367 to 424)	
ED LOS,† admitted patients, median				
Pay-for-performance hospitals	748 (743 to 753)	842 (834 to 845)	94 (84 to 104)	−68 (−83 to −54)
Control hospitals	738 (733 to 742)	900 (891 to 909)	162 (151 to 173)	
ED LOS,† nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	479 (477 to 481)	469 (466 to 471)	−10 (−14 to −7)	−6 (−11 to −1)
Control hospitals	477 (476 to 479)	473 (470 to 476)	−4 (−8 to −1)	
ED LOS,† nonadmitted patients, median				
Pay-for-performance hospitals	216 (215 to 216)	213 (212 to 214)	−3 (−4 to −1)	−3 (−5 to −2)
Control hospitals	215 (214 to 215)	216 (215 to 217)	1 (0 to 2)	
ED LOS,† high-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	555 (553 to 557)	547 (543 to 551)	−8 (−12 to −3)	0 (−6 to 7)
Control hospitals	554 (552 to 556)	546 (543 to 550)	−8 (−13 to −3)	
ED LOS,† high-acuity nonadmitted patients, median				
Pay-for-performance hospitals	250 (249 to 251)	248 (247 to 249)	−2 (−3 to 0)	0 (−2 to 2)
Control hospitals	250 (249 to 250)	248 (247 to 250)	−1 (−3 to 0)	
ED LOS,† low-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	362 (360 to 363)	339 (335 to 342)	−23 (−27 to −19)	−24 (−29 to −18)
Control hospitals	356 (354 to 358)	357 (354 to 360)	1 (−3 to 5)	
ED LOS,† low-acuity nonadmitted patients, median				
Pay-for-performance hospitals	162 (162 to 163)	156 (155 to 157)	−6 (−7 to −5)	−11 (−12 to −9)
Control hospitals	160 (159 to 160)	164 (163 to 165)	5 (3 to 6)	
Targets/quality of care, RR				
Admitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	57.26 (56.93 to 57.59)	62.33 (61.78 to 62.89)	1.09 (1.09 to 1.10)	0.93 (0.91 to 0.94)
Control hospitals	56.41 (56.08 to 56.74)	65.93 (65.29 to 66.56)	1.17 (1.16 to 1.18)	
Nonadmitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	22.66 (22.51 to 22.81)	21.96 (21.73 to 22.18)	0.97 (0.96 to 0.98)	0.94 (0.92 to 0.96)
Control hospitals	21.96 (21.73 to 22.18)	23.00 (22.71 to 23.29)	1.03 (1.02 to 1.05)	
Admitted				
Pay-for-performance hospitals	13.03 (12.97 to 13.11)	12.40 (12.29 to 12.52)	0.95 (0.94 to 0.96)	1.00 (0.98 to 1.01)
Control hospitals	13.03 (12.96 to 13.10)	12.40 (12.28 to 12.53)	0.95 (0.94 to 0.96)	
Short-term admission (<48 h)				
Pay-for-performance hospitals	2.29 (2.27 to 2.31)	2.15 (2.12 to 2.19)	0.94 (0.92 to 0.96)	1.01 (0.98 to 1.03)
Control hospitals	2.30 (2.27 to 2.32)	2.14 (2.11 to 2.18)	0.93 (0.92 to 0.95)	
Died within 7 days				
Pay-for-performance hospitals	0.86 (0.85 to 0.87)	0.85 (0.83 to 0.86)	0.98 (0.96 to 1.01)	1.01 (0.98 to 1.05)
Control hospitals	0.87 (0.86 to 0.88)	0.84 (0.82 to 0.86)	0.97 (0.94 to 0.99)	
Died within 30 days				
Pay-for-performance hospitals	1.93 (1.91 to 1.95)	1.91 (1.88 to 1.94)	0.99 (0.97 to 1.01)	1.03 (1.00 to 1.06)
Control hospitals	1.94 (1.92 to 1.96)	1.87 (1.84 to 1.91)	0.96 (0.94 to 0.99)	
Admitted patients readmitted to hospital within 30 days				
Pay-for-performance hospitals	10.06 (9.94 to 10.19)	10.12 (9.91 to 10.33)	1.01 (0.98 to 1.03)	1.01 (0.98 to 1.04)
Control hospitals	10.09 (9.96 to 10.23)	10.03 (9.81 to 10.24)	0.99 (0.97 to 1.02)	

Table E1. Continued.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
Discharged patients revisiting the ED within 72 h				
Pay-for-performance hospitals	28.44 (28.34 to 28.54)	29.62 (29.44 to 29.80)	1.04 (1.03 to 1.05)	1.00 (0.99 to 1.01)
Control hospitals	28.38 (28.28 to 28.48)	29.60 (29.43 to 29.77)	1.04 (1.04 to 1.05)	

*For ED waiting times, differences represent absolute differences in minutes. For targets/quality-of-care outcomes, differences represent rate ratios; all estimates adjusted for age/sex group, Canadian Triage and Acuity Scale group, participation in the government-funded Emergency Department Process Improvement Program (lean), participation in other lean-type interventions, participation in an Alternative Funding Arrangement plan, ED volume, teaching hospital, calendar month, and individual ED.
†ED length of stay.

Table E2. Change in outcomes among pay-for-performance hospitals versus control hospitals, wave 2.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
ED waiting times, min				
ED LOS,† 90th percentile				
Pay-for-performance hospitals	571 (566 to 576)	559 (549 to 569)	−12 (−24 to −1)	−14 (−30 to 2)
Control hospitals	568 (563 to 573)	569 (560 to 579)	2 (−9 to 13)	
ED LOS,† median				
Pay-for-performance hospitals	196 (195 to 196)	195 (194 to 197)	0 (−2 to 1)	−2 (−4 to −0.2)
Control hospitals	195 (194 to 196)	197 (196 to 198)	2 (1 to 4)	
Time to initial physician assessment, 90th percentile				
Pay-for-performance hospitals	201 (200 to 201)	203 (202 to 205)	3 (2 to 4)	−6 (−8 to −5)
Control hospitals	199 (198 to 199)	208 (207 to 209)	9 (8 to 10)	
Time to initial physician assessment, median				
Pay-for-performance hospitals	80 (79 to 80)	82 (81 to 82)	2 (2 to 3)	−2 (−3 to −1)
Control hospitals	79 (79 to 79)	83 (83 to 83)	4 (3 to 4)	
ED LOS,† admitted patients, 90th percentile				
Pay-for-performance hospitals	1,877 (1,864 to 1,890)	1,794 (1,769 to 1,819)	−83 (−114 to −53)	−133 (−175 to −91)
Control hospitals	1,843 (1,831 to 1,856)	1,893 (1,868 to 1,918)	49 (19 to 80)	
ED LOS,† admitted patients, median				
Pay-for-performance hospitals	755 (750 to 760)	778 (768 to 789)	24 (11 to 36)	−15 (−33 to 2)
Control hospitals	751 (746 to 756)	790 (780 to 800)	39 (27 to 51)	
ED LOS,† nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	375 (374 to 376)	373 (370 to 375)	−2 (−5 to 1)	−5 (−8 to −1)
Control hospitals	373 (372 to 375)	376 (374 to 378)	3 (0 to 5)	
ED LOS,† nonadmitted patients, median				
Pay-for-performance hospitals	168 (168 to 169)	168 (167 to 169)	0 (−1 to 1)	−3 (−4 to 2)
Control hospitals	168 (167 to 168)	170 (170 to 171)	3 (2 to 4)	
ED LOS,† high-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	555 (553 to 557)	547 (543 to 551)	−8 (−12 to −3)	0 (−6 to 7)
Control hospitals	554 (552 to 556)	546 (543 to 550)	−8 (−13 to −3)	
ED LOS,† high-acuity nonadmitted patients, median				
Pay-for-performance hospitals	197 (196 to 197)	197 (196 to 198)	0 (−1 to 1)	−5 (−6 to −3)
Control hospitals	195 (195 to 196)	201 (200 to 201)	5 (4 to 6)	
ED LOS,† low-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	286 (285 to 287)	278 (276 to 281)	−8 (−10 to −5)	−7 (−10 to −3)
Control hospitals	286 (283 to 286)	283 (281 to 285)	−1 (−4 to 1)	
ED LOS,† low-acuity nonadmitted patients, median				
Pay-for-performance hospitals	131 (130 to 131)	129 (128 to 129)	−2 (−3 to 1)	−3 (−4 to −2)
Control hospitals	130 (130 to 131)	131 (130 to 131)	1 (0 to 1)	
Targets/quality of care, RR				
Admitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	49.99 (49.66 to 50.32)	52.45 (51.91 to 53.00)	1.05 (1.04 to 1.06)	0.98 (0.96 to 1.00)
Control hospitals	49.80 (49.47 to 50.13)	53.25 (52.63 to 53.87)	1.07 (1.06 to 1.08)	
Nonadmitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	14.26 (14.16 to 14.36)	14.39 (14.19 to 14.59)	1.01 (0.99 to 1.03)	0.96 (0.94 to 0.98)
Control hospitals	14.08 (13.97 to 14.19)	14.80 (14.62 to 14.97)	1.05 (1.04 to 1.07)	
Left without being seen				
Pay-for-performance hospitals	3.94 (3.91 to 3.97)	4.07 (4.00 to 4.14)	1.03 (1.01 to 1.05)	0.98 (0.96 to 1.01)
Control hospitals	3.91 (3.87 to 3.94)	4.10 (4.05 to 4.16)	1.05 (1.03 to 1.07)	
Admitted				
Pay-for-performance hospitals	11.07 (11.01 to 11.13)	10.67 (10.56 to 10.78)	0.96 (0.95 to 0.97)	1.00 (0.99 to 1.02)
Control hospitals	11.12 (11.06 to 11.19)	10.67 (10.58 to 10.77)	0.96 (0.95 to 0.97)	
Short-term admission (<48 h)				
Pay-for-performance hospitals	2.24 (2.22 to 2.28)	2.16 (2.12 to 2.19)	0.96 (0.94 to 0.98)	1.00 (0.97 to 1.02)
Control hospitals	2.24 (2.22 to 2.27)	2.17 (2.14 to 2.20)	0.97 (0.95 to 0.99)	
Died within 7 days				
Pay-for-performance hospitals	0.80 (0.79 to 0.81)	0.74 (0.73 to 0.76)	0.93 (0.90 to 0.95)	0.95 (0.91 to 0.98)
Control hospitals	0.80 (0.79 to 0.81)	0.78 (0.76 to 0.80)	0.98 (0.95 to 1.00)	
Died within 30 days				
Pay-for-performance hospitals	1.75 (1.73 to 1.77)	1.65 (1.62 to 1.68)	0.94 (0.92 to 0.96)	0.97 (0.95 to 1.00)
Control hospitals	1.75 (1.73 to 1.76)	1.69 (1.66 to 1.72)	0.97 (0.95 to 0.99)	

Table E2. Continued.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
Admitted patients readmitted to hospital within 30 days				
Pay-for-performance hospitals	11.40 (11.26 to 11.54)	11.45 (11.19 to 11.72)	1.01 (0.98 to 1.03)	1.00 (0.97 to 1.04)
Control hospitals	11.40 (11.25 to 11.56)	11.42 (11.19 to 11.65)	1.00 (0.98 to 1.03)	
Discharged patients revisiting the ED within 72 h				
Pay-for-performance hospitals	33.35 (33.26 to 33.45)	33.80 (33.59 to 33.97)	1.01 (1.01 to 1.02)	1.01 (1.00 to 1.02)
Control hospitals	33.38 (33.28 to 33.48)	33.57 (33.41 to 33.73)	1.01 (1.00 to 1.01)	

*For ED waiting times, differences represent absolute differences in minutes. For targets/quality-of-care outcomes, differences represent rate ratios; all estimates adjusted for age/sex group, Canadian Triage and Acuity Scale group, participation in the government-funded Emergency Department Process Improvement Program (lean), participation in other lean-type interventions, participation in an Alternative Funding Arrangement plan, ED volume, teaching hospital, calendar month, and individual ED.
†ED length of stay.

Table E3. Change in outcomes among pay-for-performance hospitals versus control hospitals, wave 3.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
ED waiting times, min				
ED LOS,† 90th percentile				
Pay-for-performance hospitals	484 (478 to 489)	471 (464 to 477)	−13 (−23 to −3)	−7 (−23 to 8)
Control hospitals	479 (475 to 483)	474 (461 to 486)	−6 (−19 to 8)	
ED LOS,† median				
Pay-for-performance hospitals	182 (181 to 183)	174 (173 to 176)	−8 (−9 to −6)	−9 (−11 to −6)
Control hospitals	179 (178 to 180)	180 (178 to 182)	1 (−2 to 3)	
Time to initial physician assessment, 90th percentile				
Pay-for-performance hospitals	193 (193 to 194)	185 (184 to 186)	−8 (−10 to −7)	−10 (−13 to −8)
Control hospitals	190 (189 to 190)	192 (190 to 194)	2 (0 to 4)	
Time to initial physician assessment, median				
Pay-for-performance hospitals	77 (76 to 77)	74 (74 to 75)	−2 (−3 to −2)	−6 (−7 to −5)
Control hospitals	75 (75 to 76)	79 (78 to 80)	3 (2 to 4)	
ED LOS,† admitted patients, 90th percentile				
Pay-for-performance hospitals	1,418 (1,402 to 1,434)	1,491 (1,470 to 1,512)	72 (41 to 104)	39 (−12 to 91)
Control hospitals	1,445 (1,434 to 1,455)	1,478 (1,436 to 1,520)	33 (−12 to 78)	
ED LOS,† admitted patients, median				
Pay-for-performance hospitals	606 (599 to 612)	635 (627 to 644)	30 (17 to 42)	−6 (−26 to 15)
Control hospitals	614 (610 to 619)	650 (633 to 666)	35 (18 to 53)	
ED LOS,† nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	356 (354 to 358)	339 (337 to 341)	−17 (−20 to −14)	−15 (−20 to −10)
Control hospitals	350 (349 to 351)	348 (344 to 352)	−2 (−6 to 2)	
ED LOS,† nonadmitted patients, median				
Pay-for-performance hospitals	160 (159 to 160)	153 (152 to 154)	−7 (−8 to −6)	−9 (−10 to −7)
Control hospitals	157 (156 to 157)	159 (157 to 160)	2 (0 to 3)	
ED LOS,† high-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	433 (431 to 435)	414 (411 to 417)	−18 (−23 to −14)	−13 (−20 to −6)
Control hospitals	426 (425 to 428)	421 (415 to 427)	−5 (−11 to 1)	
ED LOS,† high-acuity nonadmitted patients, median				
Pay-for-performance hospitals	192 (191 to 193)	185 (184 to 186)	−7 (−9 to −6)	−9 (−11 to −7)
Control hospitals	189 (188 to 189)	191 (189 to 192)	2 (0 to 4)	
ED LOS,† low-acuity nonadmitted patients, 90th percentile				
Pay-for-performance hospitals	271 (269 to 272)	254 (252 to 256)	−17 (−20 to −13)	−19 (−24 to −14)
Control hospitals	264 (263 to 265)	267 (263 to 270)	2 (−2 to 6)	
ED LOS,† low-acuity nonadmitted patients, median				
Pay-for-performance hospitals	124 (123 to 124)	117 (116 to 118)	−7 (−8 to −6)	−10 (−12 to −8)
Control hospitals	121 (120 to 121)	124 (122 to 125)	3 (1 to 4)	
Quality of care, %				
Admitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	42.00 (41.53 to 42.46)	43.17 (42.54 to 43.80)	1.03 (1.01 to 1.05)	0.94 (0.91 to 0.98)
Control hospitals	42.01 (41.63 to 42.39)	45.73 (44.47 to 47.00)	1.09 (1.06 to 1.12)	
Nonadmitted patients missing ED LOS† performance target				
Pay-for-performance hospitals	13.06 (12.92 to 13.21)	11.27 (11.10 to 11.44)	0.86 (0.85 to 0.88)	0.89 (0.86 to 0.93)
Control hospitals	12.44 (12.32 to 12.55)	12.00 (11.66 to 12.33)	0.96 (0.94 to 0.99)	
Left without being seen				
Pay-for-performance hospitals	3.83 (3.79 to 3.88)	3.35 (3.29 to 3.42)	0.89 (0.85 to 0.90)	0.93 (0.90 to 0.97)
Control hospitals	3.70 (3.66 to 3.74)	3.48 (3.38 to 3.58)	0.94 (0.91 to 0.97)	
Admitted				
Pay-for-performance hospitals	10.57 (10.48 to 10.66)	10.08 (9.96 to 10.20)	0.95 (0.94 to 0.97)	1.02 (0.99 to 1.05)
Control hospitals	10.49 (10.42 to 10.56)	9.81 (9.60 to 10.01)	0.94 (0.91 to 0.96)	
Short-term admission (<48 h)				
Pay-for-performance hospitals	2.19 (2.16 to 2.22)	2.11 (2.07 to 2.15)	0.96 (0.94 to 0.99)	1.03 (0.99 to 1.08)
Control hospitals	2.18 (2.16 to 2.21)	2.04 (1.96 to 2.11)	0.93 (0.90 to 0.97)	
Died within 7 days				
Pay-for-performance hospitals	0.78 (0.76 to 0.79)	0.78 (0.76 to 0.80)	1.01 (0.97 to 1.05)	1.06 (1.00 to 1.12)
Control hospitals	0.78 (0.77 to 0.80)	0.74 (0.71 to 0.78)	0.95 (0.90 to 1.00)	
Died within 30 days				
Pay-for-performance hospitals	1.66 (1.64 to 1.69)	1.66 (1.62 to 1.69)	1.00 (9.97 to 1.03)	1.04 (0.99 to 1.09)
Control hospitals	1.67 (1.65 to 1.69)	1.61 (1.55 to 1.66)	0.96 (0.92 to 1.00)	

Table E3. Continued.

Outcome	Adjusted Mean or %		Pre-/Postprogram Period Difference*	Difference in Differences*
	Preprogram Period	Postprogram Period		
Admitted patients readmitted to hospital within 30 days				
Pay-for-performance hospitals	11.82 (11.59 to 12.04)	11.84 (11.53 to 12.16)	1.00 (0.97 to 1.04)	1.04 (0.99 to 1.10)
Control hospitals	11.90 (11.70 to 12.09)	11.42 (10.90 to 11.94)	0.96 (0.91 to 1.01)	
Discharged patients revisiting the ED within 72 h				
Pay-for-performance hospitals	34.68 (34.54 to 34.82)	34.88 (34.68 to 35.09)	1.01 (1.00 to 1.01)	1.01 (1.00 to 1.02)
Control hospitals	34.77 (34.65 to 34.89)	34.66 (34.33 to 34.99)	1.00 (0.99 to 1.01)	

*For ED waiting times, differences represent absolute differences in minutes. For quality-of-care outcomes, differences represent rate ratios; all estimates adjusted for age/sex group, Canadian Triage and Acuity Scale group, participation in the government-funded Emergency Department Process Improvement Program (lean), participation in other lean-type interventions, participation in an Alternative Funding Arrangement plan, ED volume, teaching hospital, calendar month, and individual ED.
†ED length of stay.