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Comparison of Emergency Department Time Performance between a Canadian and an Australian Academic Tertiary Hospital

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as doi: [10.1111/1742-6723.13247](https://doi.org/10.1111/1742-6723.13247)

M4N 3M5

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Acknowledgement:

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Introduction

Emergency department (ED) crowding is an international problem [1]. One approach to crowding has been pay-for-performance, which has been implemented in multiple countries [2] - including Ontario and Australia. By comparing a Canadian and Australian hospital's approach to time targets, what can be learned?

Ontario started 'Pay for Results' (P4R) in 2008. The program allocates 90 million dollars of funding per year to 73 designated Ontario hospitals (emergency department volumes >30 000). Hospitals are measured by relative target achievement. Funding is divided 70:30 by current performance and improvement from the initial P4R year with an additional adjustment for ED volume. The program was designed to be part of a toolkit and not a solution. It encouraged hospitals to perform a root cause analysis for its overcrowding and to use the funding for internal solutions. If a hospital couldn't improve despite internal changes, the program acknowledged a capacity problem and more funding support for external system issues would be required[3]. Currently, Ontario's healthcare policy is not to add more hospital beds, but to have existing beds used more effectively[4] [5] and this has shaped its approach to crowding.

In 2009, Australia established the National Emergency Access Target (NEAT)[6] which included facilitation and reward funding [7] to reach a four-hour target [8]. Facilitation funding included ED capital (observation units, pathology, diagnostic equipment, facilities for alternative services), new subacute beds (hospital or community

rehabilitation, palliative, mental health, psycho-geriatric beds) and recurrent projects (equipment, infrastructure, information technology, staffing). There was no evidence supporting the time target of four hours, but it had been introduced in the United Kingdom earlier [9].

Ontario has continued its program despite slow improvement [10] [11]. Australia stopped funding NEAT because of federal budget cuts[12] and modest gains in target achievement [13, 14]. Instead of funding for ten years, it only lasted for five. However, the Australasian College of Emergency Medicine continues to support time targets as a strategy to decrease crowding[15].

Australia's health care system is two-tiered with public and private (both profit and not-for-profit) hospitals[16]. Public hospitals receive state and federal funding and managed by the state. Canada has a universal health care system managed by provincial governments and funded through federal taxation[17].

The primary goal of this paper is to compare achievement of Ontario ED and Australian National Emergency Access Targets (NEAT) between Sunnybrook Health Sciences Center (Sunnybrook, Canada) and Austin Health (Austin, Australia) during two separate time periods. The secondary goals were to identify factors associated with failure to meet targets within the EDs and between 2012 and 2016.

Methods

This was a retrospective, observational study of Sunnybrook and Austin ED patients for the 2012 and 2016 calendar years. Since 2007, the principal investigator worked at both hospitals and observed similarities between the two systems, benchmarks and achievements. It was felt that Sunnybrook could adopt some of Austin's crowding interventions. Because the hospitals were not identical, they would likely implement different crowding interventions. The investigators chose 2012 because change strategies would have been established. Follow-up duration of four years allowed an adequate time period for effectiveness evaluation. The Austin Health Human Research Ethics Committee and Sunnybrook Research Ethics Board approved the study.

Sunnybrook is an adult academic tertiary level hospital in Toronto, Canada. It is a regional trauma, cancer, high-risk maternal, neonatal, neurosurgical, interventional cardiology and stroke center. It has a "direct" population where approximately 5-7% of patients bypass the emergency physician to be seen directly by the specialty service, such as trauma. The goal is to stream patients such that they see the specialties quickly. Although the non-ED physicians see the patients, they have priority for emergency resources, such as stretchers, hospital beds, nursing, diagnostic imaging and resuscitation services. This does impact regular emergency patients as they compete for the same resources. Sunnybrook does not have an observation unit or after-hours general practitioner clinic. Austin Hospital is an academic tertiary level hospital in Melbourne, Australia with a pediatric-adult population. It is an oncology, liver transplant, spinal cord,

mental health, and rehabilitation center. The Mercy Hospital, specializing in women's health is co-located with the Austin and draws gynecology patients. There is no "direct" population. Austin ED has an observation unit and an after-hours general practitioner clinic.

Sunnybrook data sources were the Electronic Patient Registry, Emergency Department Information Systems, Emergency Department Stretcher and Hospital Occupancy Tables. Emergency registration, physicians and nurses input patient encounter data. Sunnybrook's data management department provided hospital occupancy tables. Austin sources were Medtrak®, Cerner® and Hospital Occupancy Tables. Emergency registration, physicians and nurses enter data for each patient encounter. All patient visits were included, including multiple visits by the same patient at different times. For both institutions, hospital occupancy included only emergency department accessible beds.

Stata (Version 13.1, StatCorp, College Station, TX) identified missing time points, duplicated registrations and erroneous durations (e.g. negative). Duplicated registrations of the same patient visit were removed. For missing and discrepant data points, chart reviews were performed (IC). If the information was found, the data point was corrected manually. If the data was still missing post chart review, it was excluded. All other data entries were included. Descriptive statistics were determined for demographics, urgency, disposition and factors.

Ontario government time targets are grouped by the dispositions of admissions, high and low urgency discharges. The Canadian Triage Acuity Scale (CTAS) [18] and Australasian Triage Score (ATS)[19] define urgency and provide recommendations for physician initial time to assessment. Both scores are similar, define one as highest urgency (requiring immediate physician management) and five as the lowest. Patients were categorized as: 1) low urgency discharges 2) high urgency discharges 3) observation unit admission 4) hospital admission 5) left-without-being-seen 6) redirect to general practitioner clinic and 7) death.

Durations were: ED length of stay (EDLOS), time to physician initial assessment (TPIA), time to bed request (TBR), and time to ward bed (TWB). TPIA, TBR, EDLOS were the durations between triage time and physician initial assessment, bed request and discharge time, respectively. TWB was the duration between EDLOS-TBR. Consultation rate was the total number of patients requiring one (or more) consultation(s) by an inpatient unit during their ED visit divided by the total number of patient registrations.

For the analysis model, factors associated with EDLOS were selected if supported by the literature, expert clinical consensus [20] [3, 21, 22] and availability in the electronic registry. Clinical factors were hospital resources, such as diagnostics, physician initial assessment time, consultation, or hospital occupancy. Non-clinical factors were patient demographics, urgency, ambulance arrival, shift, weekday/weekend, hourly or daily volume.

Ontario[23] and Australian [24] government targets were used. In Ontario, P4R was e 90% of patients meeting their respective total EDLOS target (d4 hours for low urgency discharged patients, d8 hours for high urgency discharged patients, and d25 hours [ideal target d8hrs] for admitted patients). The 90th percentile TPIA was 3.6 hrs[23]. In Victoria (Australia), NEAT was for 75% of all ED patients to have an EDLOS d4 hours.

The primary outcome was time target achievements of Sunnybrook and Austin hospital. The secondary outcome were variables associated with failure to meet Ontario targets.

Data were stratified by high and low urgency discharges and admissions. The 90th percentile EDLOS target was determined for both hospitals by descriptive statistics. Factors were analyzed with two-by-two odds ratio tables with Woolf approximation for 95% confidence intervals. Significant factors ($p<0.05$) were chosen for multi-variable regression analyses with binary targets of d4 or d8 and d8 hours for low urgency discharges, high urgency discharges and hospital admissions, respectively. The modeling process used a forced entry, stepwise, backwards method. The model with significant factors ($p<0.05$) and the lowest Akaike's information criterion was chosen. To control for heteroskedacity, models were run robust. All statistical analyses were performed with Stata.

Results

Table 1 compares the hospitals demographics and characteristics. For both years, less 0.70% and 0.01% of Sunnybrook and Austin data points were missing, duplicated or discrepant, respectively. By 2016, Sunnybrook and Austin annual censuses increased by 10.2% and 19.2% respectively.

Compared to Sunnybrook, Austin had higher volume, more male, younger patients with lower urgency. The Austin re-directed more than two percent of patients to the co-located general practitioner. Sunnybrook and Austin increased manpower hours over four years. Austin had a dedicated radiologist, greater allied health worker hours and more consulting-admitting services than Sunnybrook. CT, ultrasound, MRI and troponin I rates were lower at the Austin.

In 2012, Austin had double the hospital beds for acute admissions than Sunnybrook (714 vs. 341) with lower hospital occupancy (87.6% vs. 97.6%). By 2016, Austin increased observation unit beds with higher patient throughput. By 2016, Austin increased hospital bed capacity by 30.3% (+216). Sunnybrook decreased by 10.8% (-38). Compared to Sunnybrook, Austin's ward admission rate was slightly higher in 2012 but similar in 2016. Sunnybrook had admissions discharged from the ED while waiting for a ward bed. Austin had a higher number of low urgency discharges and fewer high urgency discharges.

In both years, Sunnybrook failed Ontario targets for TPIA and EDLOS with minimal change over time. Austin met all the Ontario targets except for low urgency discharges. Austin improved for all EDLOS, but not TPIA in 2016 compared to 2012.

Sunnybrook failed NEAT in 2012 (36.4%) without improvement in 2016. The Austin failed NEAT for both years with 10% improvement from 2012 to 2016 (55.0% to 65.2%).

For low urgency discharges, Sunnybrook's 2012 top three factors strongly associated with four-hour target failure were MRI, consultation and CT. There was no change for 2016. Compared to Sunnybrook, Austin's 2012 top factors were TPIA >2, CT and consultation. Ranking changed in 2016 to CT, TPIA >2 and US (Table 2). The crude odds ratio [(95% CI) for the Austin's low urgency discharges reaching targets over Sunnybrook was not significant (1.0 [0.9-1.0]) in 2012, but significant in 2016 (1.65 [1.54-1.76])

For high urgency discharges, Sunnybrook's top three 2012 factors predicting failure of the eight-hour time target were: MRI, consultation and TPIA>2. The factors changed to consultation, MRI and CT in 2016. Austin's top three factors were consultation, MRI and TPIA >2hrs in 2012 and CT, US, TPIA >2 in 2016 (Table 3). The crude odds ratio for Austin's high urgency discharges reaching targets over Sunnybrook was 3.5 [3.3-3.8] in 2012 and 5.5 [5.1-6.0] in 2016.

For admissions, 2012 and 2016 Sunnybrook factors strongly associated with failure to meet the eight-hour target were: bed request > six hours and time to ward bed >

1 hour. Austin factors were similar (Table 4) for both years. The crude odds ratio for the Austin's admissions reaching targets over Sunnybrook was 7.8 [7.4-8.1] in 2012 and 8.9 [8.4-9.4] in 2016.

Discussion

Sunnybrook failed all targets with minimal to no improvement over four years. Austin was successful in reaching all Ontario targets except low urgency discharges. It failed the Australian target in both years, but improved performance.

A hospital's patient population, programs and health delivery infrastructure can put it at a disadvantage for reaching time targets. Sunnybrook is a regional trauma and oncology center. Compared to Austin, it has a population that requires more complex investigations, such as cross-sectional imaging. Sunnybrook does not have co-located services to divert some female, low urgency and private patients. There are smaller numbers of independent physicians, consulting-admitting services, allied health and no dedicated radiologist at Sunnybrook. Austin allows admitted patients to be transferred to the ward before being assessed by the consulting service. In contrast, Sunnybrook requires the consulting services to assess and admit the patients in the ED. Secondary to high Sunnybrook occupancy, some patients awaiting admission wait so long that they are eventually discharged. The Ontario P4R program does not adjust for its hospitals' environment and patient characteristics nor does it provide specific funding for system capacity. Consequently, funding can be withheld for a hospital that deserves funding for crowding factors which are beyond its control[2, 3]. This may be one of the reasons why Sunnybrook failed to improve.

Despite the performance differences between the hospitals, the high impact factors influencing EDLOS were similar. For discharges, physician initial assessment time, consultation, and diagnostics, such as cross-sectional imaging and troponin, were top factors. For admissions, high impact factors were time to bed request and ward bed. Emergency department operations must integrate with hospital consulting services, diagnostics and operations in order to increase efficiency. At the Austin, the evening and nightshift were found to be a higher impact factor for prolonged EDLOS compared to Sunnybrook. Further investigation is recommended.

The Austin used NEAT funding on the high impact output factor of ward bed time. It created assessment units, increased the number of observation unit, subacute, hospital beds and residential outreach services. The result was improved admission and high urgency EDLOS. The Austin also redesigned the front of the ED by streaming for rapid assessment. Although, the 90th percentile TPIA worsened, EDLOS for discharges improved. Sunnybrook mainly used P4R for input-throughput factors. It funded an ambulance offload ED nurse, ED physician assistant, outpatient internal medicine clinic, push alert technology, electronic bed management system and operational costs for internal medicine short stay beds. However, overall governmental funding restrictions led to a net decrease in hospital beds. There was little impact on EDLOS or reaching performance targets. Given this study's odds ratio findings and Austin's improvement, health systems should prioritize output over input-throughput solutions.

By 2016, Austin's observation unit admissions increased with a greater overall admission rate than Sunnybrook. Further evaluation could include cost-effectiveness of these admissions. Did the observation unit prevent low urgency admissions or did it delay diagnosis-management for an admission that was more appropriate for hospitalization [25]? Further analysis can determine which population suffers from the longest ward bed time. Using this data, adjustments to the program can be made.

Limitations:

It could be argued that comparing the two hospitals could not be made because of population and infrastructure differences. However, both hospitals were striving for the same end-point: to decrease ED wait times under a pay-for-performance strategy. By comparing differences in improvement within the same hospital, hospital characteristics and strategies associated with target improvement can be determined and prioritized. A qualitative study on why tests are ordered, or how decisions are made, would be useful.

Sunnybrook triage scoring may be different from the Austin affecting the high and low urgency discharge volume. Finally, other input factors could have been considered in the model, such as medical student supervision or physician-patient ratios, however this data was not available.

Conclusion

Hospital characteristics can be barriers to time target achievement. By determining the factors in reaching time targets, through its own administrative database, a hospital can determine and prioritize interventions to shorten EDLOS. Despite the health care system or type of hospital, important factors are mainly clinical resources. Increasing output resources made a greater impact on shortening EDLOS than input-throughput interventions.

Table 1: Emergency Patients from Sunnybrook Hospital and Austin Health – Demographics, Urgency, Resource Consumption, Disposition.

Descriptor	2012 Sunnybrook Canada	2012 Austin Health Australia	2016 Sunnybrook Canada	2016 Austin Health Australia
Visits	57,208	71,747	63,020	85,546
Age	53 [IQR: 34 – 72]	44 [IQR: 22-68]	55 [IQR: 35–72]	44 [IQR: 21-67]
Female	54.8% (31,346)	48.4% (34,746)	54.6% (34,377)	49.3% (42,192)
CTAS/ATS 1-3	87.7% (50,183)	56.3% (40,380)	88.6% (55,826)	55.6% (47,546)
CTAS/ATS 4-5	12.3% (7,025)	43.7% (31,3667)	11.4% (7,194)	44.4% (37,995)
Direct to Consult Service	5.5% (3,168)	n/a	7.0% (4,434)	n/a
Arrive by Ambulance	23.0% (13,140)	29.2% (20,948)	22.8% (14,387)	27.6% (23,603)
ED Stretchers	36	32	36	25-38*
Observation Unit Stretchers	None	8	None	14
Paediatric ED Unit	No	Yes	No	Yes
Emergency Consultant Staffing	72hrs/day	60hrs/day	80hrs/day for Monday 72hrs/day for rest	88hrs/day
Postgraduate Trainees	32-72hrs/day	194hrs/day	32-72hrs/day	187hrs/day
Mid-level Practitioners	16hrs/day	10hrs/day	16-32hrs/day	17hrs/day
Physiotherapists	No	0 hrs	No	8hrs/day
Allied Health:	8hrs/day 1-2 workers variable on weekend	15hrs/day Team of 4-5 7days/week	Unchanged	Unchanged
Pharmacist	8hrs/day No Script Fills	17hrs/day Script Fills	Unchanged	Unchanged
Dedicated Radiologist	No	Yes	No	Yes
Diagnostic Imaging				
Total Number of XR Pts	40.7% (23,294)	40.1% (28,761)	37.5% (23,664)	31.2% (26,697)
Total Number of CT Pts	20.4% (11,644)	12.5% (8,974)	22.1% (13,902)	12.6% (10,738)
Total Number of US Pts	7.2% (4,147)	2.8% (1,992)	6.2% (3,927)	3.4% (2,906)
Total Number of MRI Pts	1.0% (591)	0.2% (147)	1.3% (796)	0.6% (497)
Patients With Troponin Ordered	30.7% (17,553)	4.4% (3,185)	25.3% (15,939)	3.0% (2,559)
Consultation Rate	26.5% (15,169)	39.2% (28,128)	25.5% (16,095)	36.2% (31,007)
Number of Admitting Services	29	45	28	47
All-Comers Admission Rate	22.3% (12,757/57,208)	35.0% (25,100)	21.9%(13,785/63,020)	37.0% (31,629)
Admissions Discharged from ED	1.8% (224/12,757)	n/a	3.8%(525/13,785)	n/a
Admissions Observation Unit	n/a	10.8% (7,730)	n/a	15.9% (13,586)
Admissions Hospital	21.9% (12,533/57,208)	24.2% (17,370)	21.0%(13,260/63,014)	21.1% (18,043)
Discharges	73.8% (42,239)	56.0% (40,175)	75.8% (47,769)	55.9% (47,793)
Deaths	0.2% (131)	0.1% (83)	0.2%(114)	0.1% (59)
LWBS	3.6% (2,081)	6.3% (4,481)	3.0%(1,871)	5.0% (4,309)
Redirect to GP Clinic	n/a	2.7% (1,908)	n/a	2.1% (1,756)
Number of Hospital Beds	341	714	313	930
Hospital Occupancy				
Average	97.6%	87.6%	99.6%	89.7%
Maximum	113.4%	100%	114.3%	100%
Number of ICU Beds	58	20	54	22
Private Hospitals	No	Yes	No	Yes

CTAS – Canadian Triage Urgency Scale, ATS-Australian Triage Score, XR – Xray, US- Ultrasound, CT – Computed Tomography, MRI – Magnetic Resonance Imaging, ICU – Intensive Care Unit

Table 2: Emergency Patients from Sunnybrook Hospital and Austin Health - Multivariate Analysis: Top Factors' Odds Ratios of Reaching Emergency Department Length-of-Stay Time Targets for Discharged Low Urgency Patients.

	Sunnybrook 2012 Discharged CTAS45 (n=6573)	Austin Health 2012 Discharged CTAS45 (n=20786)	Sunnybrook 2016 Discharged CTAS45 (n=6801)	Austin Health 2016 Discharged CTAS45 (n=25405)
Variable	OR EDLOS>4hrs vs EDLOS≤4hrs [95% CI]	OR EDLOS>4hrs vs EDLOS≤4hrs [95% CI]	OR EDLOS>4hrs vs EDLOS≤4hrs [95% CI]	OR EDLOS>4hrs vs EDLOS≤4hrs [95% CI]
Magnetic Resonance Imaging (Yes vs. No)	31.68 [6.03-166.54]	4.71 [2.22-10.00]	40.68 [7.03-235.30]	3.99 [2.34-6.78]
Consultation (Yes vs. No)	20.98 [14.10-31.22]	6.99 [5.83-8.38]	20.43 [14.19-29.42]	2.06 [1.22-3.49]
Computed Tomography (Yes vs. No)	16.48 [10.07-26.98]	7.16 [5.92-8.66]	21.65 [14.63-32.03]	10.96 [9.30-12.92]
TPIA>2hrs (Yes vs. No)	15.80 [13.35-18.71]	11.62 [10.40-12.99]	9.66 [8.32-11.21]	10.94 [10.00-11.96]
Troponin (Yes vs. No)	13.37 [6.30-28.37]	2.93 [1.98-4.34]	9.23 [5.03-16.93]	3.31 [2.20-4.97]
Ultrasound (Yes vs. No)	7.61 [5.25-11.04]	4.51 [3.55-5.74]	7.03 [4.76-10.40]	4.30 [3.48-5.33]

TPIA – Time to Emergency Physician Initial Assessment

Table 3: Emergency Patients from Sunnybrook Hospital and Austin Health - Multivariate Analysis: Top Factors' Odds Ratios of Reaching Emergency Department Length-of-Stay Time Targets for Discharged High Urgency Patients.

	Sunnybrook 2012 Discharged CTAS13 (n=35890)	Austin Health 2012 Discharged CTAS13 (n=19389)	Sunnybrook 2016 Discharged CTAS13 (n=40793)	Austin Health 2016 Discharged CTAS13 (n=22387)
Variable	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]
Magnetic Resonance Imaging (Yes vs. No)	19.33 [12.94-28.87]	8.16 [3.07-21.70]	10.47 [7.55-14.51]	-
Consultation (Yes vs. No)	10.23 [9.38-11.14]	8.82 [7.62-10.21]	12.78 [11.82-13.81]	2.96 [1.78-4.91]
PIA>2hrs (Yes vs. No)	5.63 [5.22-6.06]	3.89 [3.13-4.85]	4.29 [4.00-4.60]	3.37 [2.88-3.94]
Computed Tomography (Yes vs. No)	4.24 [3.92-4.59]	3.01 [2.52-3.59]	5.22 [4.84-5.63]	5.54 [4.72-6.50]
Ultrasound (Yes vs. No)	3.47 [3.13-3.83]	3.87 [2.77-5.42]	3.11 [2.79-3.46]	3.38 [2.43-4.72]
Shift: Day	Reference	Reference	Reference	Reference
Evening	1.23 [1.14-1.32]	4.09 [3.40-4.93]	1.05 [0.97-1.14]	2.26 [1.87-2.73]
Night	2.15 [1.96-2.35]	3.44 [2.62-4.51]	1.74 [1.54-1.96]	2.27 [1.68-3.05]

TPIA – Time to Emergency Physician Initial Assessment, - not part of regression model

Table 4: Emergency Patients from Sunnybrook Hospital and Austin Health - Multivariate Analysis: Top Factors' Odds Ratios of Reaching Emergency Department Length-of-Stay Time Targets for Ward Admissions.

	Sunnybrook 2012 Ward Admissions (n=12509)*	Austin Health 2012 Ward Admissions (n=16901)*	Sunnybrook 2016 Ward Admissions (n=13127)*	Austin Health 2016 Ward Admissions (n=16425)*
Variable	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]	OR EDLOS>8hrs vs EDLOS≤8hrs [95% CI]
Time to Bed Request > 6hrs	45.30 [37.75-54.36]	46.07 [33.23-63.88]	53.56 [44.49-64.67]	42.57 [31.98-56.67]
Time to Ward bed > 1hr	22.39 [18.67-26.87]	57.35 [39.31-83.67]	18.49 [15.68-21.80]	27.08 [19.87-36.90]

*Dayshift Reference omitted – so sample size is smaller than admission volume
TPIA – Time to Physician Initial Assessment

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Title:

Comparison of emergency department time performance between a Canadian and an Australian academic tertiary hospital

Date:

2019-08-01

Citation:

Cheng, I., Taylor, D., Schull, M. J., Zwarenstein, M., Kiss, A., Castren, M., Brommels, M., Yeoh, M. & Kerr, F. (2019). Comparison of emergency department time performance between a Canadian and an Australian academic tertiary hospital. EMERGENCY MEDICINE AUSTRALASIA, 31 (4), pp.605-611. <https://doi.org/10.1111/1742-6723.13247>.

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