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Ambulance Arrivals and ED Flow – A Queensland Perspective

Sankalp KHANNA^{a,1}, Justin BOYLE^a, Emma BOSLEY^b and James LIND^c ^aCSIRO Australian e-Health Research Centre, Brisbane, Australia ^bQueensland Ambulance Service, Brisbane, Australia ^cQueensland Health, Brisbane, Australia

Abstract. While it is widely accepted that whole of hospital solutions are necessary to reduce the ever-increasing burden on the public health system, little research has focussed on understanding the relationship between ambulance arrival related flow metrics and emergency department (ED) crowding. Queensland Ambulance Service (QAS) shares patient load across multiple hospitals, and receiving facilities strive to meet a Patient Off Stretcher Time (POST) target of 30 minutes. We examine ambulance arrival data from the QAS and ED patient arrival data from 15 major metropolitan hospitals across Queensland, to understand temporal variations in POST performance and examine the relationship between POST performance and ED crowding. The findings suggest a relationship between ED occupancy levels and both ambulances waiting at the ED door and average POST at larger hospitals. No relationship between POST and ED length of stay was found, perhaps due to competing ED National Emergency Access Targets (NEAT). Further modelling is recommended to formally test these observations.

Keywords. Bed Occupancy, Hospital Bed Capacity, Crowding, Prehospital Care, Ambulance-ED Interface.

Introduction

Hospital crowding continues to escalate and poses a growing threat to Australian hospitals [1]. Significant research has focussed on identifying bottlenecks in emergency and inpatient department flow [2], studying the impact of various stages of the patient journey through the emergency department (ED) [3], understanding ED timeliness targets [4], [5], and modifying these to being more patient outcome focussed [6]. However, very little research has focussed on the impact of the Ambulance-ED interface on hospital crowding.

In 2012, a Queensland Government initiated qualitative study examined the Ambulance-ED interface and made several recommendations to improve flow through this interface [7]. One initiative introduced by this study was the establishment of a 30 minute "Patient Off Stretcher Time" (POST) performance target. A recent study [8] examined data from before the establishment of this target and revealed that patients who were offloaded in less than 30 minutes had better outcomes compared to those that took longer to move through the Ambulance-ED interface. This previous work

¹ Corresponding Author: Sankalp Khanna, CSIRO Australian e-Health Research Centre, Brisbane, Australia; E-mail: Sankalp.Khanna@csiro.au.

however does not offer insight into the relationship between POST performance and ED crowding.

This study is focussed on understanding temporal variations in POST performance and the relationship between ED flow and POST compliance across metropolitan Queensland hospitals. It is hypothesised that understanding this relationship will provide hospital administrators with much needed insight into delivering improvements in both ED flow and POST performance.

1. Methods

The study employed administrative emergency department and ambulance data from July 2014 to October 2016 for all ambulance arrivals (from the Queensland Ambulance Service) and all patient arrivals (from Queensland Health) across fifteen (15) major metropolitan public hospitals in south-east Queensland. For the purpose of deidentification, the hospitals are represented here as belonging to their Peer Groups as defined by the Australian Institute of Health and Welfare [9]. These included five (5) Principal Referral hospitals (coded as PR1,PR2, PR3, PR4 and PR5), four (4) Public Acute Group A hospitals (coded as PA1,PA2, PA3 and PA4) and six (6) hospitals belonging to other acute, sub-acute and specialist categories grouped together as Other hospitals (coded as OTH1, OTH2, OTH3, OTH4, OTH5 and OTH6). The data fields obtained for the analysis are shown in Table 1. Ethics approval for this research was obtained from the Queensland Health Gold Coast Hospital and Health Service Human Research Ethics Committee.

Emergency Department Data		QAS Data	
Time Stamp Related Fields		Time Stamp Related Fields	
Description	Field Name	Description	Field Name
Arrival Related	Arrival.DateTime	Arrival Related	D_AT_DEST
	Admit.Bed.Requested.At		
Admission	Admit.Ward.Allocated.At	Demontrone Delete I	D OFF STRETCHER
Related	Admit.Ward.Ready.At	Departure Related	D_OFF_STRETCHER
	Admitted.At	Other Fields	
Departure	Departure.DateTime	Description	Field Name
Related	Departure.Ready.At	Estilles Lindicion	T DESTINATION
Other Fields		Facility Identifier	I_DESTINATION
Description	Field Name	Acuity	C_DISPATCH_CRITICALITY
Facility Identifier	Facility		
	FacilityCode	Local Ambulance	TLACN
Arrival Transport	Mode.of.Arrival.Code	Service Networks	I_LASN
Mode	Mode.of.Arrival.Desc	· Ambulance Station	T_STATION
Type of Visit	Type.of.Visit.Code		
	Type.of.Visit.Desc		
Departure Status	Departure.Status.Code		
	Departure.Status.Desc		
ED Length of Stav	Length.of.Stay		

Table 1. Relevant data fields obtained for analysis from ED and QAS Information Systems.

Collected ED and QAS records were checked for inconsistencies and profiled. QAS timestamps were found to be complete. Only 327 arrival and 498 departure timestamps appeared to be missing a time component, however on further investigation these were found to be instances where the time recorded was 12:00 AM (midnight). No out of scope episodes or negative time instances were found. The POST interval was calculated in minutes as the difference of QAS departure (Off Stretcher) and QAS arrival (at destination) timestamps.

Fifteen (15) ED episodes were excluded as they were out of the specified date Twenty-eight (28) ED episodes were found to be missing the range. Departure.DateTime timestamp. The greater of Departure.Ready.At and Admitted.At was employed as Departure.DateTime in these instances. Six (6) ED episodes were excluded as the Arrival.DateTime was greater than the Departure.DateTime. It was also noted that 327 ED episodes had an Arrival.DateTime equal to the Departure.DateTime. Departure status of patients leaving the ED was analysed and the status codes grouped to identify all episodes as one of the following – Admitted, DiedInED, Left and Other. Mode of arrival for patients arriving at the ED was also analysed and the status codes grouped to identify all episodes as one of the following - Ambulance or Other. The Admitted.At timestamp was found to be missing for 90,610 ED episodes identified as Admitted. The Departure.Ready.At timestamp or the Departure.DateTime timestamp was employed as the Admitted.At timestamp in these instances. The remaining 2,000,540 ED episodes and the 691,918 QAS episodes were profiled to obtain date spans and episode counts for each facility.

To explore variations in POST across month of year, day of week and hour of day, we analysed episode level QAS data at the Peer Group, HHS, and individual site levels. Variations in POST were analysed across Hour of Day, Day of Week and Month of Year.

To explore the ambulance handover process, we looked at the number of ambulances waiting at each facility at any given time across the analysis period. For this, ED and QAS data were aggregated at 1-minute and 15-minute intervals. Net patients arriving at and leaving (via the EDIS Arrival.DateTime and Departure.DateTime timestamps) the ED, and net Ambulances arriving at and clocking off (via the QAS At-Dest and Off_Stretcher timestamps) at the ED, were calculated for each of the 1-minute and 15-minute intervals. These were then aggregated to get cumulative counts of ambulances waiting at the ED at the end of each interval.

To explore the relationship between POST, EDLOS, Patients in ED and Ambulances waiting, ED and QAS data were aggregated at 15-minute intervals. Average POST and EDLOS was measured for all patients arriving in the 15-minute interval period. Net patients arriving at and leaving (via the EDIS Arrival.DateTime and Departure.DateTime timestamps) the ED, and net Ambulances arriving at and clocking off (via the QAS At-Dest and Off_Stretcher timestamps) at the ED, were calculated for each 15-minute interval. These were then aggregated to get a cumulative count of ambulances and patients at the ED at the end of each 15-minute timeslot.

Boxplots were employed to explore the above relationships. For the purpose of the boxplots representing POST and EDLOS, the y-axis limits were set to 120 mins and 720 mins respectively. Several outliers with extreme values were noted, especially for EDLOS. Since cumulative totals started with an assumption of 0 at the start of the analysis period (1 July 2014), and assuming that any patients/ambulances at the ED would have left within the first month (bringing this count to a correct number), the first 30 days were excluded from this analysis to get a more realistic count of patients and ambulances at the ED at the end of each timeslot (system warmup).

2. Results and Discussion

The histogram in Figure 1 presents the time in minutes that was spent at each facility by ambulances as part of the patient handover process. Counts below 6 are not shown as they reduce discrimination of higher level counts (therefore removing 3 of the hospitals from the graph). Each coloured bar indicates a distinct number of ambulances that were at the hospital at the same time, and the size of the bar represents the amount of time in minutes that the hospital had this number of ambulances waiting together as part of the handover process.



Figure 1. Time spent with 6 or more Ambulances at ED (1 August 2014 – 31 Oct 2016, n=1,185,120 mins).

While some individual sites did not spend significant time out of the examined period on each level, we observe numerous occasions where 6 or more ambulances were waiting to offload patients; with 2 Principal Referral hospitals each spending over 27,000 minutes i.e. the equivalent of 450 hours (2.3% of the total analysis time).

The heat-map in Figure 2 presents the maximum number of ambulances that were at each facility across any 15-minute interval in the week. The colour scale on the right provides an indication of the number, with darker shades of red indicating higher numbers.



Figure 2. Max ambulances waiting at each ED (each row) in any 15 minute period across each week.

Variations in POST across month of year, day of week and hour of day did not reveal significant differences across these categories, though mean values of POST appeared to be higher during the late afternoons across all peer groups. Figure 3 presents boxplots exploring variations in POST across the principal referral hospital for the 2015-2016 financial year. Similar patterns were observed across other peer groups.



Figure 3. Analysing variation in POST (Principal Referral Hospitals, July 2015 - June 2016).

Analysis of boxplots relating ambulance and ED flow across Principal Referral hospitals, and Public Acute Group A hospitals indicates an association between higher levels of ED occupancy and both the number of ambulances waiting to transfer care of patients at the ED, and the average POST time. Average EDLOS does not seem to be associated strongly with the number of ambulances waiting to transfer care of patients at the ED in these groups. Figure 4 presents these relationships across a typical hospital in this group. These findings were inconsistently observed in the Other hospitals group, with smaller hospitals not indicating any association between higher levels of ED, the number of ambulances waiting to transfer care of patients at the ED, and the average POST time, and the average POST.



Figure 4. Analysing ED and QAS Flow in 15 minute intervals: Typical Hospital.

The analysis reveals that while load sharing of ambulances across sites may help balance the load, Principal Referral sites still spend significant periods of time with multiple ambulances on site waiting to off-load patients. This time appears to be related to periods of higher ED occupancy and consequently higher average patient off stretcher times, though it does not appear to contribute to increased ED length of stay. The plateauing of EDLOS, despite building pressure to offload ambulance patients and return waiting ambulance resources back to the community, may be driven by behaviour patterns and the omnipresent pressure associated with NEAT compliance culture. This exploratory analysis suggests the need for further investigation into the relationship between ambulance arrivals and emergency department patient flow via statistical modelling and remains future work.

References

- [1] Australian Medical Association, "AMA Public Hospital Report Card 2018," Mar. 2018.
- [2] S. Khanna, J. Boyle, N. Good, and J. Lind, "Unravelling relationships: Hospital occupancy levels, discharge timing and emergency department access block," *Emerg Med Australas*, vol. 24, no. 5, pp. 510–517, Oct. 2012.
- [3] S. Khanna, J. Boyle, N. Good, A. Bell, and J. Lind, "Analysing the emergency department patient journey: Discovery of bottlenecks to emergency department patient flow," *Emerg Med Australas*, vol. 29, no. 1, pp. 18–23, Feb. 2017.
- [4] S. Khanna, J. Boyle, N. Good, and J. Lind, "New emergency department quality measure: from access block to National Emergency Access Target compliance," *Emerg Med Australas*, vol. 25, no. 6, pp. 565–572, Dec. 2013.
- [5] S. Khanna, D. Sier, J. Boyle, and K. Zeitz, "Discharge timeliness and its impact on hospital crowding and emergency department flow performance," *Emerg Med Australas*, vol. 28, no. 2, pp. 164–170, Apr. 2016.
- [6] C. Sullivan *et al.*, "The National Emergency Access Target (NEAT) and the 4-hour rule: time to review the target," *The Medical Journal of Australia*, vol. 204, no. 9, p. 354, May 2016.
- [7] Queensland Government, "Metropolitan Emergency Department Access Initiative (MEDAI) a report on Ambulance Ramping in metropolitan hospitals," 2012.
- [8] J. Crilly *et al.*, "Improved outcomes for emergency department patients whose ambulance off-stretcher time is not delayed," *Emerg Med Australas*, vol. 27, no. 3, pp. 216–224, May 2015.
- [9] Australian Institute of Health and Welfare, "Australian hospital peer groups. Health services series no. 66. Cat. no. HSE 170. Canberra: AIHW.," 2015.