The Effect of Intra-hospital Trauma Volume Status on Patient Outcomes

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Background

Owing to the greater experience and resources, higher volume trauma centers have been shown to have improved survival compared those with lower volume. Despite this improved survival, it has been suggested that, within individual higher volume trauma centers, patient volume at any given time may exceed resources thereby adversely impacting patient outcomes. However, to date no study has evaluated the specific relationship between daily patient volume and patient outcomes.

Methods

Data Sources

• The UAB trauma registry, which provided demographic, injury, and clinical information for trauma/burn service consults and admissions

•Hospital census data provided information regarding hourly patient census

•Quality Improvement (QI) data provided information regarding complications

Study Design, Population, and Variable Definitions

Design: Longitudinal (i.e., time-series)

Population: Patients admitted to the trauma/burn service in an ACS-verified Level I trauma center

Time periods of observation: 1/1/2001-11/11/2004 (38 beds max), 11/12/2004-1/2/2007 (56 beds max), and 1/3/2007-3/31/2008 (76 beds max)

Independent variable of interest: % of maximum beds available (i.e., max volume), categorized into tertiles

Dependent variables:

•Death

• Complications grouped into disease/injury related (DR), delay of care (DC), unplanned deviation from care (UDC), and system impairment/inadequacy (SI)

Statistical analysis

Poisson regression—adjusted for injury severity—was used to estimate risk ratios (RRs) and associated 95% confidence intervals (95% CIs) for the association between daily census and the rate of patient complications and mortality

Results

Table 1 – Comparison of demographic and injury characteristics among volume tertile groups

	Lower tertile	Middle tertile	Upper tertile	p-value
Total patient-days	53,188	53,060	56,162	
Median census	68	74	66	
Median % max volume (range)	100.0 (68.4-117.9)	128.6 (118.4-139.3)	157.9 (139.5-215.8)	
Median age	39.6	41.0	40.5	<0.0001
Male (mean daily %)	71.0	69.4	69.5	<0.0001
Severity* (mean daily %)				
Minor	32.7	37.2	38.2	<0.0001
Moderate	23.1	23.4	23.6	0.11
Major/Severe	44.2	39.3	38.1	<0.0001
Glasgow Coma Scale score ≤ 8 (mean daily %)	26.1	20.9	21.4	<0.0001
Type of Injury (mean daily %)				
Blunt	68.9	72.3	73.1	<0.0001
Burn	19.4	16.5	16.2	<0.0001
Penetrating	11.7	11.2	10.7	<0.0001

* Defined as an Injury Severity Score of 1-15 for mild, 16-25 for moderate, and 26+ for major/severe blunt and penetrating injuries or a total burn surface area of 1-15 for mild, 16-25 for moderate, and 26+ for major/severe burn injuries

Table 2 – Relative risks* (RR) and 95% confidence intervals (95% CI) for the association between volume tertile and complications and death

	Lower tertile		Middle tertile		Upper tertile	
	N	RR (95% CI)	N	RR (95% CI)	N	RR (95% CI)
Deaths (%)	**213**	**Reference**	**204**	**1.05 (0.86-1.27)**	**234**	**1.13 (0.94-1.36)**
Total complications	**517**	**Reference**	**567**	**1.26 (1.12-1.43)**	**703**	**1.49 (1.32-1.68)**
Delay of care	55	Reference	66	1.28 (0.89-1.84)	95	1.72 (1.22-2.43)
Disease related	178	Reference	156	1.06 (0.85-1.32)	191	1.25 (1.01-1.55)
Unexpected deviation of care	26	Reference	33	1.31 (0.78-2.20)	39	1.43 (0.86-2.39)
System impairment/inadequacy	258	Reference	312	1.40 (1.18-1.66)	378	1.61 (1.37-1.90)

* Adjusted for severity of injury

Discussion

Summary

• The increased mortality and complication risk in the higher volume tertile suggests that patient outcomes are dependent upon trauma service volume status.

• This could be due to overflow patients being placed in non-trauma service beds, and thus possibly not having received optimal trauma care throughout their hospitalization.

• Interestingly, complications arising from unexpected deviations of care, which resulted from lack of equipment resources, were not more likely to occur during high-volume states. This suggests that that an increased patient load does not place an unacceptably high burden on hospital equipment.

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Strengths

• This is the first study to examine how fluctuations in patient volume affect mortality and complications rates among a single hospital population.

• Inclusion of a large sample size provide precise estimates of the association between patient volume and mortality and complication risk.

• Review of QI data prevents misclassification of complication status

Limitations

• While multiple years of data were used, the maximum number of beds available doubled from 38 to 76

• Because of this, percent-over-max volume was correlated with time period, with higher values for earlier time periods. If time period was associated with complications, this would bias the results towards the earlier, higher percent-over-max volume periods.

• To avoid this, tertiles were estimated by time period, thus avoiding any bias by time period

Conclusion

The results of the current study suggest that higher patient volumes, which can result in decreases in the available hospital resources such as number of beds and staff, increase patients' risk of both complications and mortality. The increase in complication risk can be mitigated by increasing available staff during times of increased patient volume.

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