

Gridlocked:

The Impact of Crowding on Patient Health Outcomes

Transforming Healthcare through Research Collaboration

Emily Kao

LBJ School of Public Affairs

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Research Goals

- Describe the emergency department crowding phenomenon in the U.S. and why the rise in visits causes alarm
- Offer a definition and metric of crowding that can be standardized across healthcare systems
- Identify whether a causal relationship exists between crowding and outcomes



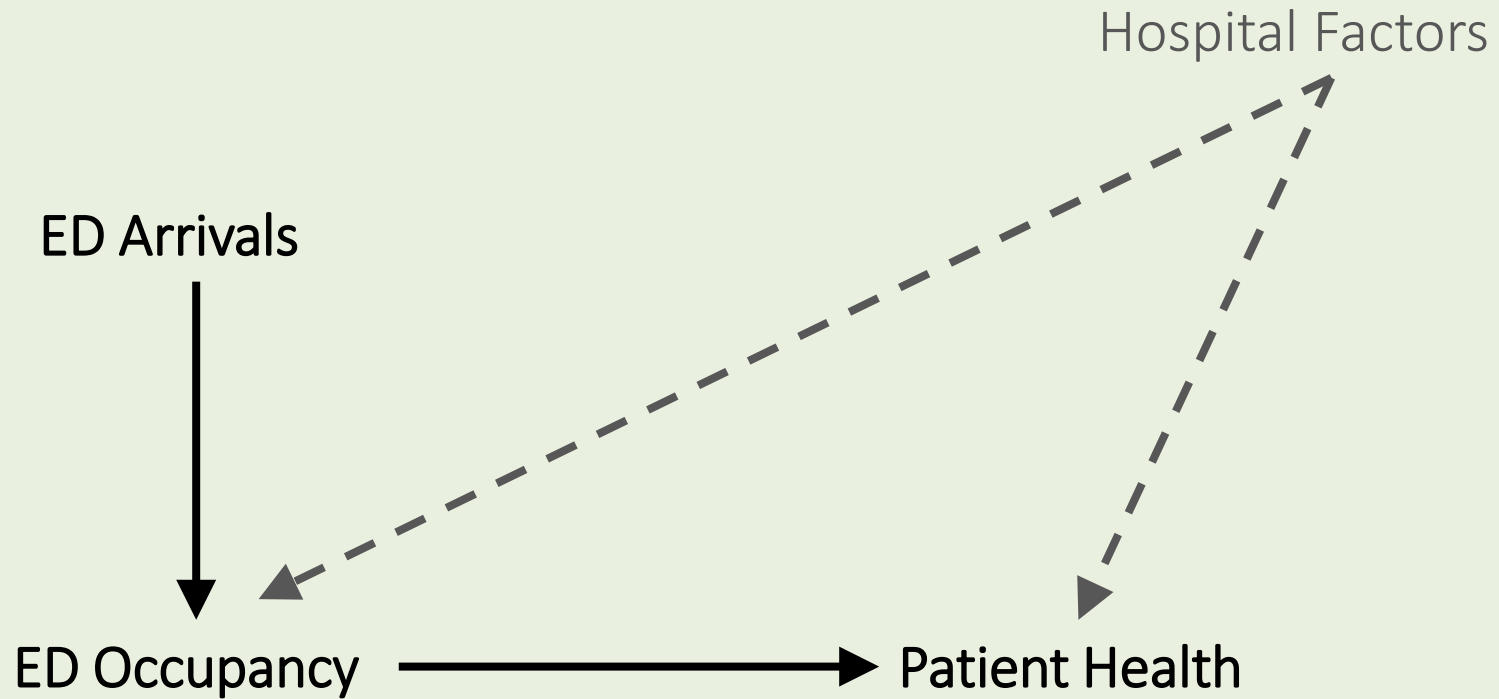
Does Crowding Matter?

- To what extent does ED crowding affect patient health, and how does it impact patients with different levels of acuity?
- To what extent does ED crowding affect ED utilization, measured as 72-hour unscheduled returns and 30-day unplanned readmissions?
- To what extent do organizational factors mediate the relationship between ED crowding and outcomes?

Outcome Measures

- All-cause mortality following 30 days of index ED visit
- Intermediary health outcomes that could increase risk of mortality following 30 days of index ED visit, namely
 - Severe sepsis
 - Diabetic ketoacidosis (DKA)
- 72-hour unscheduled return to the ED
- 30-day unplanned readmission to the ED

Research Approach



Arrival Density

Ratio of the number of patient arrivals to the ED j during a specified timeframe t (e.g., within prior 60 minutes of patient i arrival) on a given date to the mean number of ED arrivals during the same timeframe on the same day of week over the course of the study

$$\text{IV} = \ln \left[\frac{n_{jt}}{\left(\frac{\sum_{t=1}^{1440} n_{jt}}{i = jt} \right)} \right]$$

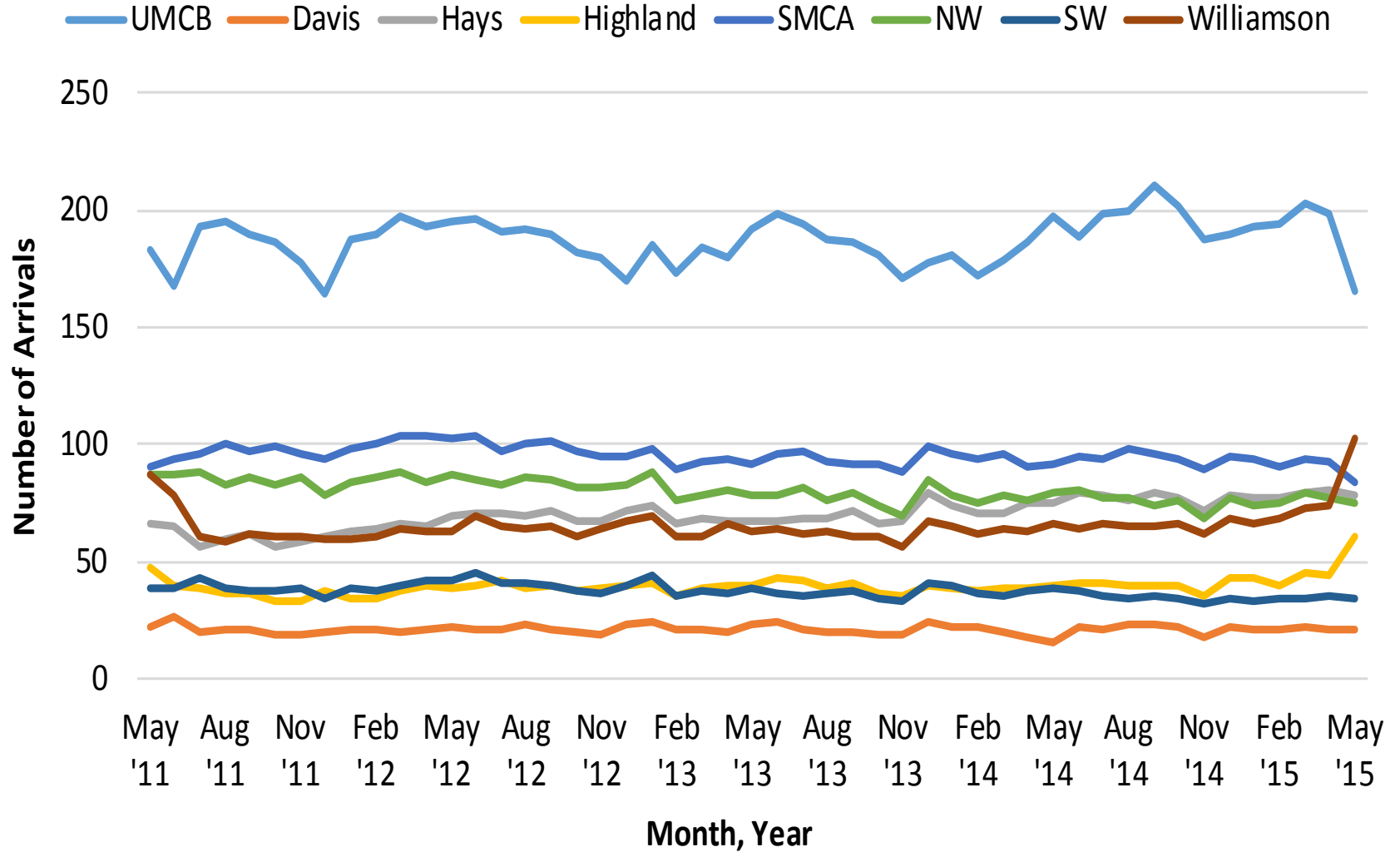
Data Source

- Seton Family of Hospitals, Emergency Departments
 - Austin
 - Brackenridge
 - Davis
 - Hays
 - Highland Lakes
 - Northwest
 - Southwest
 - Williamson
- All adult visits/encounters, May 16, 2011 – May 8, 2015
- Compass and Decision Support System
 - Compass: patient demographic and clinical data
 - DSS: CPT codes for diagnoses, treatments, and discharge

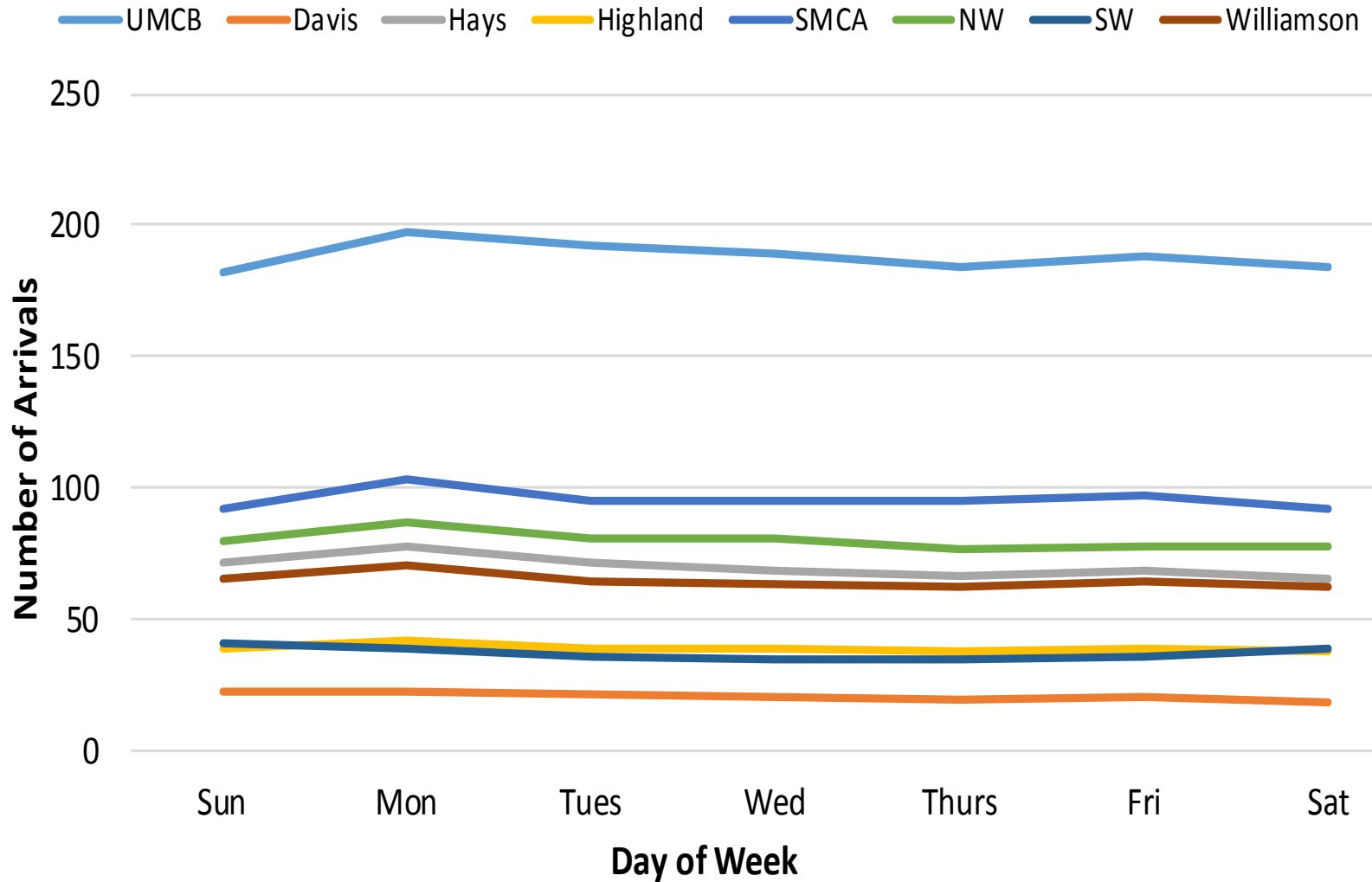
Study Population Characteristic	Number (n)	Percent (%)
TOTAL OBSERVATIONS	865,896	
PATIENT DEMOGRAPHICS		
SEX		
Male	386,427	44.6
Female	479,469	55.4
AGE		
18-24	121,215	14.0
25-44	347,763	40.2
45-64	259,801	30.0
65-74	64,813	7.5
75-99	72,027	8.3
100 or older	277	0.0
ETHNICITY		
Not Hispanic	703,614	81.3
Hispanic	162,282	18.7
RACE		
White	596,576	68.9
Black	104,961	12.1
Asian	6,134	0.7
American Indian or Alaska Native	949	0.1
Native Hawaiian or Pacific Islander	37	0.0
Other or multiple races	62,791	7.3
Missing race	93,863	10.8

Study Population Characteristic	Number (n)	Percent (%)
PATIENT CLINICAL		
ACUITY LEVEL		
Immediate	4,638	0.5
Emergent	172,081	19.9
Urgent	426,831	49.3
Semi-Urgent	209,231	24.2
Non-Urgent	16,904	2.0
Missing acuity level	36,211	4.2
HEALTH OUTCOME		
Death	2,712	0.3
Sepsis - any stage	5,681	0.7
Systemic inflammatory response syndrome (SIRS)	417	0.0
Sepsis	2,670	0.3
Severe sepsis	717	0.1
Septic shock	1,877	0.2
Diabetic ketoacidosis (DKA)	1,630	0.2
TYPE OF VISIT		
Initial visit only	432,938	50.0
Same day return	6,017	0.7
Return within 72 hours	9,673	1.1
Return within 30 days	38,490	4.4
Return within 1 year	175,947	20.3
Return after 1 year	201,260	23.2
Missing initial discharge date	1,571	0.2

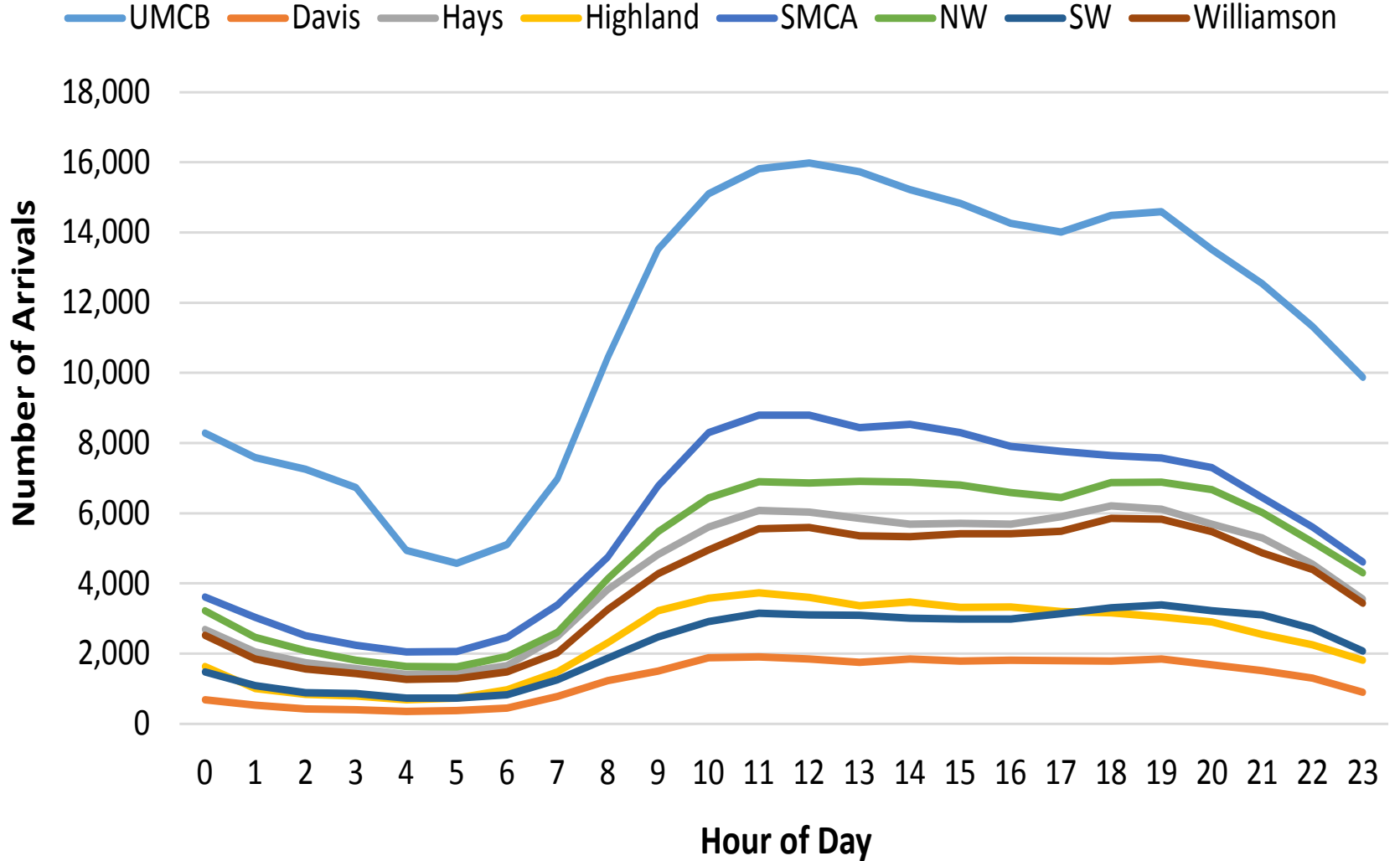
Average Arrivals by Month, Year



Average Arrivals by Day of Week



Arrivals by Hour of Day



Average Daily Census and Occupancy Rates for Seton Emergency Departments, 2011-2015

	Seton Hospital Emergency Department									
	UMCB	Davis	Hays	Highland	SMCA	Northwest	Southwest	Williamson	Total	Average
Annual Visits										
2011	41,881	4,596	13,833	8,577	22,103	19,433	8,824	14,795	134,042	16,755
2012	68,938	7,759	24,908	14,102	36,549	30,843	14,641	23,417	221,157	27,645
2013	67,243	7,818	25,318	14,300	34,165	28,747	13,578	22,950	214,119	26,765
2014	69,715	7,556	27,542	14,376	34,294	27,950	12,991	23,580	218,004	27,251
2015	24,936	2,708	10,088	5,671	11,790	9,766	4,376	9,239	78,574	9,822
<i>Total</i>	<i>272,713</i>	<i>30,437</i>	<i>101,689</i>	<i>57,026</i>	<i>138,901</i>	<i>116,739</i>	<i>54,410</i>	<i>93,981</i>	<i>865,896</i>	<i>108,237</i>
Daily Census										
2011	182.1	20.0	60.1	37.3	96.1	84.5	38.4	64.3	582.8	73
2012	188.4	21.2	68.1	38.5	99.9	84.3	40.0	64.0	604.3	76
2013	183.7	21.4	69.2	39.1	93.3	78.5	37.1	62.7	586.6	73
2014	190.5	20.6	75.3	39.3	93.7	76.4	35.5	64.4	597.3	74
2015	194.8	21.2	78.8	44.3	92.1	76.3	34.2	72.2	613.9	77
No. Occupied Beds										
2011	41,480	4,208	13,138	8,111	21,621	18,634	8,530	13,235	128,957	16,120
2012	68,782	7,759	24,754	14,102	36,074	30,595	14,551	23,364	219,981	27,498
2013	66,941	7,776	25,068	14,292	32,994	28,307	13,402	22,749	211,529	26,441
2014	67,984	7,419	27,293	14,156	33,815	27,492	12,829	23,256	214,244	26,781
2015	12,343	1,340	5,071	2,677	6,049	4,870	2,171	4,398	38,919	4,865
Avg. Occupancy Rate, weighted										
	73.54	35.44	43.83	37.22	48.83	38.81	44.05	20.48		50.63
Avg. Occupancy Rate, unweighted										
	77.62	42.57	49.31	42.39	55.84	44.41	50.38	24.05		55.25

* Daily census is calculated as the total number of annual visits divided by the total number of days in the reporting period .

** Average occupancy rate, weighted is calculated by averaging the average daily occupancy rates.

*** Average occupancy rate, unweighted is calculated by taking the simple average of total occupied beds in the study.

Number of New Arrivals Assigned to Beds across All 8 Seton Emergency Departments

HOUR	DAY							TOTAL		
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Beds	Visits	
00:00	3,704	3,231	2,991	2,973	2,941	3,087	3,545	22,472	24,140	
01:00	3,394	2,502	2,354	2,270	2,273	2,471	2,930	18,194	19,921	
02:00	2,989	2,118	2,016	2,078	1,942	2,267	2,771	16,181	17,012	
03:00	2,952	1,926	1,763	1,783	1,761	2,022	2,584	14,791	15,853	
04:00	2,247	1,675	1,616	1,525	1,569	1,590	2,021	12,243	13,300	
05:00	1,966	1,760	1,590	1,655	1,610	1,587	1,861	12,029	12,619	
06:00	2,116	2,088	1,983	1,838	1,989	1,908	2,011	13,933	14,877	
07:00	2,690	3,149	2,916	2,894	2,759	2,788	2,690	19,886	21,438	
08:00	3,982	4,870	4,468	4,483	4,284	4,155	3,856	30,098	31,407	
09:00	5,100	6,450	6,053	5,801	5,672	5,689	5,056	39,821	42,072	
10:00	6,057	7,540	6,879	6,602	6,436	6,632	5,997	46,143	49,652	
11:00	6,684	8,057	7,019	7,102	6,823	6,841	6,523	49,049	51,042	
12:00	6,653	7,828	7,131	7,051	6,712	6,951	6,527	48,853	51,836	
13:00	6,649	7,486	6,873	6,604	6,550	6,813	6,664	47,639	51,362	
14:00	6,626	7,388	6,640	6,708	6,501	6,637	6,610	47,110	49,154	
15:00	6,502	7,091	6,619	6,627	6,412	6,493	6,458	46,202	49,154	
16:00	6,176	7,056	6,578	6,553	6,235	6,490	6,111	45,199	48,874	
17:00	6,137	6,881	6,575	6,465	6,193	6,528	6,006	44,785	46,879	
18:00	6,106	7,119	6,950	6,871	6,517	6,585	6,017	46,165	49,332	
19:00	6,315	7,081	6,901	6,810	6,590	6,557	6,029	46,283	50,145	
20:00	6,011	6,547	6,371	6,206	6,219	6,072	5,983	43,409	45,600	
21:00	5,693	5,883	5,599	5,599	5,581	5,746	5,514	39,615	42,337	
22:00	4,987	4,985	4,979	4,972	4,798	5,080	5,138	34,939	37,903	
23:00	3,959	3,903	4,045	3,972	3,891	4,362	4,459	28,591	29,987	
TOTAL	Beds	115,695	124,614	116,909	115,442	112,258	115,351	113,361	813,630	--
	Visits	123,065	132,761	124,772	122,913	119,724	122,765	119,896	--	865,896

Average Occupancy Rate across All 8 Seton Emergency Departments

HOUR	DAY OF WEEK							AVG. OCCUPANCY RATE PER HOUR
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00:00	49.01	47.72	51.00	50.57	48.63	48.50	51.67	49.59
01:00	47.72	43.73	45.35	45.20	42.90	43.41	49.70	45.43
02:00	47.21	39.23	39.83	38.91	37.67	41.46	46.45	41.54
03:00	47.35	36.34	33.51	35.31	32.27	37.69	45.06	38.22
04:00	41.18	31.09	29.73	30.13	29.74	33.03	40.99	33.70
05:00	37.79	28.23	26.93	28.12	26.39	28.57	34.41	30.06
06:00	33.27	26.46	25.59	25.80	25.40	26.88	31.31	27.81
07:00	32.11	28.35	27.33	26.71	26.62	26.77	29.60	28.21
08:00	33.08	33.12	32.25	31.53	30.50	31.34	31.94	31.96
09:00	38.56	42.09	39.87	39.38	37.92	37.95	36.79	38.94
10:00	43.51	51.65	49.05	47.81	46.71	45.77	42.50	46.72
11:00	49.09	60.70	56.35	54.87	53.88	53.32	47.98	53.74
12:00	54.17	68.43	62.40	61.76	59.23	60.09	52.97	59.87
13:00	57.12	73.30	66.26	65.61	64.01	64.81	56.57	63.95
14:00	59.08	75.68	67.96	66.47	65.38	66.44	58.53	65.65
15:00	59.83	76.11	68.28	66.86	65.77	66.62	59.51	66.14
16:00	59.48	75.25	67.03	66.97	65.11	66.09	59.10	65.57
17:00	58.14	74.21	67.14	65.34	63.50	64.90	58.89	64.59
18:00	57.20	71.98	66.50	66.37	62.98	64.68	56.39	63.73
19:00	57.23	71.12	67.46	66.24	62.70	65.22	56.71	63.81
20:00	56.08	69.76	66.13	64.11	62.37	64.26	55.78	62.64
21:00	55.94	66.61	63.34	62.44	60.30	62.17	55.03	60.83
22:00	55.10	62.10	60.17	59.01	57.40	58.34	53.48	57.94
23:00	51.25	56.72	56.58	54.88	53.58	55.71	52.03	54.39
AVG. OCCUPANCY RATE PER DAY	49.19	54.58	51.50	50.85	49.21	50.58	48.47	50.63

*Amended 05/03/16 to reflect correction in occupancy rate at UMC Brackenridge

Average Occupancy Rate at University Medical Center Brackendridge

HOUR	DAY OF WEEK							AVG. OCCUPANCY RATE PER HOUR
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00:00	68.04	67.45	75.67	78.65	73.73	74.82	75.68	73.43
01:00	67.25	63.34	69.95	70.19	66.26	67.36	71.38	67.96
02:00	67.45	58.44	63.61	64.39	59.63	63.45	68.25	63.60
03:00	69.96	55.36	57.17	59.08	53.49	60.50	69.07	60.66
04:00	68.46	50.83	51.60	53.89	50.32	58.19	68.82	57.44
05:00	66.52	49.68	48.08	49.58	47.80	53.55	62.99	54.03
06:00	60.43	46.42	45.70	47.38	45.99	50.76	56.39	50.44
07:00	58.05	47.18	45.75	46.46	45.08	49.67	54.53	49.53
08:00	58.72	51.84	52.06	51.27	50.17	53.29	55.09	53.21
09:00	63.29	62.73	61.34	60.92	58.49	60.66	60.21	61.09
10:00	66.43	73.45	71.86	69.72	67.43	68.16	65.25	68.90
11:00	68.59	82.40	80.44	76.18	75.09	74.95	68.29	75.13
12:00	71.36	91.79	86.93	83.59	81.48	81.62	70.99	81.11
13:00	73.86	98.20	91.64	90.17	86.66	87.00	74.76	86.04
14:00	76.90	102.59	93.61	92.97	89.82	90.57	76.27	88.96
15:00	77.63	104.55	95.88	95.17	91.97	90.55	77.23	90.43
16:00	76.35	103.47	96.11	95.47	91.13	91.52	77.79	90.26
17:00	75.05	102.77	95.99	92.53	89.78	89.66	76.74	88.93
18:00	72.37	100.78	94.60	93.12	88.36	87.31	75.59	87.45
19:00	73.73	97.60	94.71	92.22	88.40	87.56	73.77	86.86
20:00	71.38	95.43	92.70	89.80	88.47	87.06	73.16	85.43
21:00	70.94	90.88	91.69	86.91	84.87	85.71	73.63	83.52
22:00	73.44	87.46	88.69	82.98	84.25	83.07	72.77	81.81
23:00	70.98	82.78	85.43	79.74	79.87	80.45	71.08	78.62
AVG. OCCUPANCY RATE PER DAY	69.47	77.81	76.30	75.10	72.44	74.06	69.57	73.54

*Amended 05/03/16 to reflect correction in total number of beds

Average Occupancy Rate at Seton Medical Center Williamson

HOUR	DAY OF WEEK							AVG. OCCUPANCY RATE PER HOUR
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
00:00	18.37	17.38	18.28	17.41	16.58	17.29	18.49	17.68
01:00	15.32	15.32	14.92	12.81	14.11	13.50	14.42	14.34
02:00	12.24	13.20	12.17	10.80	11.12	9.46	13.63	11.80
03:00	11.15	10.79	9.21	8.70	8.16	8.81	10.30	9.59
04:00	10.17	8.43	8.97	7.23	8.12	6.81	9.35	8.44
05:00	8.93	7.55	9.22	6.29	6.94	6.62	8.12	7.67
06:00	8.84	7.85	7.41	6.99	7.32	6.86	8.04	7.61
07:00	8.04	8.52	9.27	8.66	7.87	6.96	7.68	8.14
08:00	10.28	12.54	12.14	11.33	10.50	10.04	9.78	10.94
09:00	12.90	16.99	15.36	15.99	14.20	14.67	12.95	14.72
10:00	17.35	22.00	20.62	20.19	18.76	18.63	16.93	19.21
11:00	21.98	27.13	24.69	23.94	22.56	22.70	20.68	23.38
12:00	26.33	31.73	28.05	27.81	26.57	26.99	24.54	27.43
13:00	28.26	33.69	29.36	28.22	27.83	28.44	26.42	28.89
14:00	29.67	33.55	31.59	29.54	27.43	28.05	27.29	29.59
15:00	29.70	32.98	29.69	29.41	27.34	28.56	27.27	29.28
16:00	28.94	33.33	30.69	29.61	28.68	29.19	27.23	29.67
17:00	28.19	34.39	29.80	30.39	27.13	28.36	25.92	29.17
18:00	26.47	34.49	31.12	30.26	27.31	29.04	24.71	29.06
19:00	27.21	34.52	33.46	32.42	27.99	30.82	25.80	30.32
20:00	25.73	34.11	32.86	31.33	28.94	29.02	25.42	29.63
21:00	26.52	30.38	29.81	30.01	26.92	27.11	24.31	27.87
22:00	23.99	27.16	27.62	25.39	25.04	23.72	22.79	25.10
23:00	21.06	24.00	22.98	20.68	21.69	22.52	21.44	22.05
AVG. OCCUPANCY RATE PER DAY	19.90	23.00	21.64	20.64	19.55	19.76	18.90	20.48

Policy Implications



Thank you.

Emily Kao, Ph.D. Candidate
LBJ School of Public Affairs
The University of Texas at Austin
ekao@utexas.edu