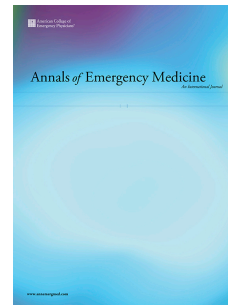


Journal Pre-proof



An analysis of changes in emergency department visits after a state declaration during the time of COVID-19

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Title: An analysis of changes in emergency department visits after a state declaration during the time of COVID-19

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Abstract

Objective: In the initial period of the COVID-19 pandemic there has been a substantial decrease in the number of patients seeking care in the ED. An initial step in estimating the impact of these changes is to characterize the patients, visits, and diagnoses for whom care is being delayed or deferred.

Methods: We conducted an observational study, examining demographics, visit characteristics, and diagnoses for all ED patient visits to an urban Level-1 trauma center before and after a state emergency declaration and comparing them to a similar period in 2019. We estimated percent change based on the ratios of before and after periods with respect to 2019 and the decline per week using Poisson regression. Finally, we evaluated whether each factor modified the change in overall ED visits.

Results: After the state declaration, there was a 49.3% decline in ED visits overall, 35.2% (95% CI: -38.4 to -31.9) as compared to 2019. Disproportionate declines were seen in visits by pediatric and older patients, women, and Medicare recipients as well as for presentations of syncope, cerebrovascular accidents, urolithiasis, abdominal and back pain. Significant proportional increases were seen in ED visits for upper respiratory infections, shortness of breath, and chest pain.

Conclusions: There have been significant changes in patterns of care-seeking during the COVID-19 pandemic. Declines in ED visits, especially for certain demographic groups and disease processes, should prompt efforts to understand these phenomena, encourage appropriate

care-seeking, and monitor for the morbidity and mortality that may result from delayed or deferred care.

Word count: 249

Journal Pre-proof

Introduction

As the novel coronavirus 2019 (COVID-19) pandemic has spread, state governments and health systems have enacted a range of mitigation strategies and operational changes to anticipate and address an increasing number of patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). At the same time, during the early days of the pandemic, health systems have also seen a decrease in the number of patients presenting for acute care unrelated to COVID-19¹. Less care sought and received for these acute conditions may put patients at significant risk for preventable morbidity and mortality in the future. The characteristics of those patients who are and are not presenting to emergency departments during the early days of the SARS-CoV-2 pandemic have not yet been substantially examined in the medical literature. We report changes in the characteristics of patients and presentations to the emergency department (ED) of an urban Level-1 Trauma Center before and after the statewide announcement of a “peacetime emergency” and public health measures to respond to the pandemic on March 13, 2020².

Methods

We conducted an observational study of visits to the ED of a Level 1 Trauma Center from a period of 28 days before through 28 days after the state’s emergency declaration on March 13th. The ED has an annual census of nearly 90,000 and is located in a metropolitan area that over the study period had not yet seen a surge in COVID-19 infections, having seen the state’s first confirmed case on March 6th. The declaration on March 13th included announcements about social-distancing measures, the closure of all non-essential business, to begin on March 16, and the closure of all schools, to begin on March 18. The state’s first stay-at-home order was declared on March 25. We chose the earliest of these dates to provide the most conservative

estimate of the potential effects of such measures on public willingness to seek care. We examined a cross-section of visits from February 15 to April 10, 2020, and for historical comparison, a similar period of weekdays and weekends from February 16 to April 12, 2019. Data were obtained through a systematic query of the electronic health record (EHR) as part of institutional operations and quality improvement and were therefore deemed by the institutional review board to be exempt from review. We obtained demographics, visit characteristics, and diagnoses for all visits during the above periods. Diagnoses were identified by coded individual diagnoses or according to a diagnostic grouper when there was more than one diagnostic code for the disease entities examined. The diagnoses examined were preselected by the authors to include the ten most common conditions presenting to the ED and a list of higher and lower acuity conditions provided by department and hospital administration, all of which are reported.

We estimated the ratios of before and after periods with respect to the same periods in 2019 using Poisson regression by including the period, year and period year interaction as fixed effects. The period year interaction corresponds to the log of the ratio of ratios, and thus we used this estimate to derive the percent change. In addition, we estimated the decline per week by including week as a continuous variable, and the interaction with period, year and period-year week, corresponding to an interrupted time series analysis. We evaluated the goodness of fit test for this model and scaled the model to correct for over-dispersion. We estimated the percent change with respect to 2019 for the total number of ED visits, by patient characteristics, diagnoses, and the decline per week. We used type III p-values to evaluate whether characteristics and diagnoses modified the ED volume decline by including a second order interaction for each factor with period and year. In addition, we analyzed total ED and total

hospital exclusive charges both overall and by acuity using a log normal distribution and a difference in differences to estimate the percent change. All analyses were performed in SAS 9.3 (SAS Institute, Cary, NC).

Results

After the state declaration, the ED experienced a gradual but significant decline from an average of 250 daily visits for the 28 days before to an average of 167 daily visits for the 28 days after. This represented a 7.7% (95% CI: 1.1 to 13.7%) weekly decline in ED visits, a 49.3% decline overall, and a 35.2% (-38.4 to -31.9%) decline with respect to 2019. We found significant changes in the decline after the state declaration by patient demographics and visit characteristics, particularly in patient age, gender, race, insurance, arrival mode, and disposition. There were significantly disproportionate declines in ED visits by patients under age 18 (-60.1%) and over age 65 (-41.3%), women (-40.2%), White and Asian patients (-37.8% and 40.2%, respectively), patients with Medicare (-40.8%) and other insurances (-74.1%; e.g. liability, no-fault, workman's compensation), as well as ambulatory patients (-38.1%) and those who left prior to evaluation or discharge (-75.6%).

When we examined diagnoses, we noted significantly decreases in the proportions of patients presenting with syncope (-70.5%), cerebrovascular accidents (-58.3%), abdominal pain (-43.3%), urolithiasis (-70.0%), and back pain (-50.7%). We also saw significant increases in the proportions of patients presenting with upper respiratory infections (-10.0%), shortness of breath (25.1%), and chest pain (-13.1%). For all other conditions, the declines in presentations were proportionate to the overall change in ED visits.

When we looked at charges, there was a 32.8% (-36.1 to -29.4%) reduction in total ED charges, and a 23.2% (-27.6 to -18.7%) reduction in hospital charges, with respect to 2019 when adjusted for inflation and without changes in billing or reimbursement rates between periods. Decreases in ED charges by acuity level were generally proportionate to the overall adjusted decline in ED visits, though the decline in ED charges for acuity level 5 visits was smaller (-26.2%, -43.5 to -3.5%). The decline in hospital charges for acuity level 1 visits was disproportionately large (-42.1%, -59.6 to -17.2%), while the decline in hospital charges for acuity levels 2 and 4 visits were smaller than the overall adjusted decline in ED visits (-19.2%, -26.7 to -10.9%; -17.6, -30.9 to -1.7%).

Discussion

Echoing anecdotal reports, we noted a temporal association between our state's emergency declaration and a gradual but significant overall decline in daily ED visits. We also noted significant though smaller declines in both ED and hospital charges, a difference that may be attributable to changes in acuity distribution. Both phenomenon have been experienced by EDs and health systems across the country, prompting staff furloughs and other responses even as preparations are made for a growing number of patients with SARS-CoV-2.

In addition, we found significant changes in ED patient demographics and visit characteristics. We found significant proportional decreases in visits by the overlapping populations of patients over 65 and Medicare recipients. There were also significant disproportionate declines in visits by pediatric and ambulatory patients, women, and certain racial categories. We also noted a disproportionate decline in the number of patients who left prior to evaluation or discharge. That change may be due in part to the substantial operational changes made in response to the

pandemic. Those changes have further streamlined patient triage, rooming, and evaluation, potentially decreasing triage bottlenecks that can occur when the department is more crowded.

We also found significant changes in the diagnoses of patients presenting to the ED. We saw significant proportional increases in ED visits for upper respiratory infections, chest pain, and shortness of breath. These are symptoms that might bring patients to the ED with concerns for COVID-19 infection, but they may also represent exacerbations of and presentations for other conditions. The most concerning finding of this report, however, is the overall decline in patients seen for acute and potentially life-threatening conditions unrelated to COVID-19¹. One might expect to find, as we did, a disproportionate decrease in presentations of less acute conditions such as back pain and other non-specific pain. However, we also found unexpectedly disproportionate declines in visits for conditions of substantially higher acuity like syncope, cerebrovascular accidents, and urolithiasis, similar to those noted elsewhere for presentations of myocardial infarction^{4,5}. Similar trends in patient presentations have been seen around the world⁶, during prior disease outbreaks⁷, and in the outpatient setting⁸.

These changes in patient presentation patterns may reflect concerns about contracting COVID-19 in health care settings, overburdening the health care system with unrelated complaints, and adhering to public health recommendations¹. It is also possible that they are related to changing patterns of activity leading to a change in disease incidence or to the increased availability of other venues for seeking care such as telemedicine. Changes in activity noted during the pandemic might contribute to diminished air pollution, traffic, and infectious disease transmission. Such phenomena could potentially contribute to improved population health over the long term and to a decreased incidence of exacerbations of respiratory conditions, COVID-19 infections³, or traumatic injuries in the short term. However, most of the other conditions seen

and managed in the emergency department would not be expected to suddenly decrease in incidence. Alternative care venues like telemedicine have also been developed and are expanding, offering valuable ways to provide continued outpatient care. Telemedicine providers can care for many non-acute concerns and ambulatory-care sensitive conditions, but patients with concerning symptoms or significant diagnostic uncertainty may still need to be referred to the ED for evaluation⁸. Most local telemedicine alternatives were not substantially established or bolstered until at least two weeks after the state announcement. As such, telemedicine would not be expected to have a major impact on the number of patients presenting with acute medical conditions over the study period.

These are still early days, and the timeline for the COVID-19 pandemic and resulting changes in patterns of ED utilization promise to be much longer than that covered in our preliminary study. This study is limited by its single center and cross-sectional nature, the short study time frame, and lack of adjustment for multiple potentially confounding factors related to patients and their presentations to the ED, including disease severity, comorbidities, and COVID-19 risk factors. However, we have found notable differential changes in the demographic factors, visits characteristics, and diagnoses of presentations to the ED. Further efforts should and are being made to reassure and affirm the appropriateness of seeking emergency care,⁹ particularly for the groups and disease processes that have been highlighted here and elsewhere.^{1,4,5} Further research will also be needed to examine these and other factors contributing to delayed or deferred care and to monitor for the morbidity and mortality that is likely to result^{5,8} and which may already be occurring¹⁰.

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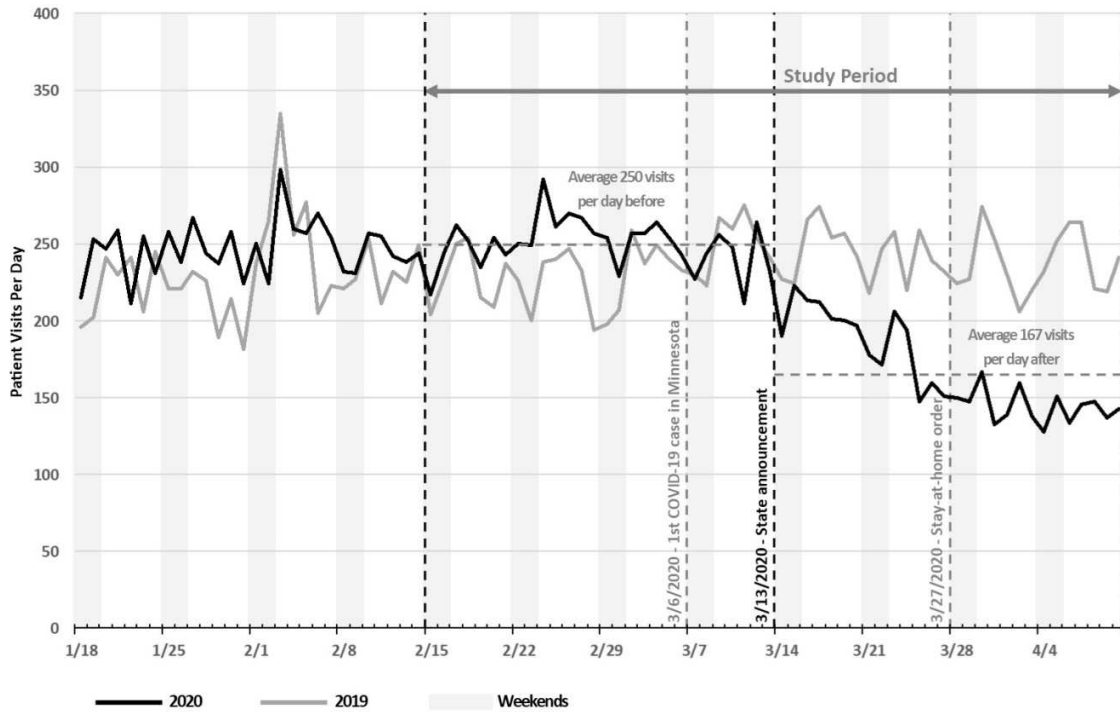


Figure 1. Trend of daily ED visits before and after state announcement

	Feb 16 – Mar 15, 2019	Mar 16 – Apr 12, 2019	Feb 15 – Mar 13, 2020	Mar 14 – Apr 10, 2020	% change 2020 with respect to 2019 (95% CI)	p-value ^a
<i>Total No. of ED visits</i>	6547	6744	6993	4666	-35.2 (-38.4 to -32.9)	
Demographics	N(%)	N(%)	N(%)	N(%)		
Age, median (IQR, range), y	44 (28-59, 0-106)	44 (28-58, 0-100)	42 (29-60, 0-102)	42 (29-59, 0-104)		
0-18 years	420 (6.4)	427 (6.3)	436 (6.2)	177 (3.8)	-60.1 (-68.0 to -50.2)	<0.001
18<65 years	4990 (76.2)	5186 (76.9)	5246 (75.0)	3723 (79.8)	-31.7 (-35.5 to -27.7)	
65≤ years	1137 (17.4)	1131 (16.8)	1311 (18.7)	766 (16.4)	-41.3 (-33.7 to -48.0)	
Sex						
Female	3342 (51.0)	3386 (50.2)	3585 (51.3)	2171 (46.6)	-40.2 (-44.4 to -35.8)	<0.001
Male	3205 (49.0)	3358 (49.8)	3408 (48.7)	2492 (53.4)	-30.2	

					(-35.0 to -25.1)	
Race						
Asian	374 (5.7)	416 (6.2)	475 (6.8)	316 (6.8)	-40.2 (-51.0 to -27.0)	0.035
African American	1902 (29.1)	1962 (29.1)	2005 (28.7)	1304 (28.0)	-37.0 (-42.6 to -30.7)	
White	3305 (50.5)	3489 (51.2)	3503 (50.1)	2302 (49.3)	-37.8 (-42.0 to -33.2)	
Hispanic or Latino	456 (7.0)	403 (6.0)	477 (6.8)	323 (6.9)	-23.4 (-36.9 to -6.9)	
Native American	114 (1.7)	95 (1.4)	99 (1.4)	62 (1.3)	-24.9 (-50.5 to 14.2)	
Native Hawaiian or OPI	21 (0.3)	19 (0.3)	16 (0.2)	13 (0.3)	-10.2 (-65.6 to 134.4)	
Other/multiracial	375 (5.7)	360 (5.3)	418 (6.0)	346 (7.4)	-13.8 (-29.6 to 5.6)	
Insurance						
Commercial	3315 (50.6)	3261 (48.4)	3452 (49.4)	2322 (49.8)	-31.6 (-36.3 to -26.6)	<0.001
Medicare	1119 (17.1)	1095 (16.2)	1128 (16.1)	654 (14.0)	-40.8 (-47.8 to -32.7)	
Medicaid	1193 (18.2)	1242 (18.4)	1175 (16.8)	782 (16.8)	-36.1 (-43.3 to -27.9)	
Self-pay	710 (10.8)	757 (11.2)	936 (13.4)	759 (16.3)	-23.9 (-33.9 to -12.5)	
Other	210 (3.2)	391 (5.7)	301 (4.7)	145 (3.1)	-74.1 (-80.0 to -66.5)	
Visits Characteristics						
Arrival						
Ambulatory	4575 (69.9)	4783 (70.9)	4872 (69.7)	3151 (67.5)	-38.1 (-41.8 to -34.3)	0.021
EMS, helicopter, fire	1823 (27.8)	1812 (26.9)	2000 (28.6)	1417 (30.4)	-28.7 (-35.1 to -21.7)	
Police	149 (2.3)	149 (2.2)	121 (1.7)	98 (2.1)	-19.0 (-42.9 to 14.9)	
ESI Acuity						
1 (high)	122 (1.9)	128 (1.9)	139 (2.0)	103 (2.2)	-29.4 (-50.5 to 0.8)	0.533
2	2096 (32)	2085 (30.9)	2198 (31.4)	1366 (29.3)	-37.5 (-42.9 to -31.6)	
3	2996 (45.8)	3271 (48.5)	3186 (45.6)	2252 (48.3)	-35.3 (-39.8 to -30.3)	
4	1109 (16.9)	1063 (15.8)	1216 (17.4)	760 (16.3)	-34.8 (-42.4 to -26.2)	
5 (low)	197 (3)	169 (2.5)	224 (3.2)	156 (3.3)	-18.8 (-39.2 to 8.5)	
Unknown	27 (0.4)	28 (0.4)	30 (0.4)	29 (0.6)		
Disposition						
Hospitalization	1658 (25.3)	1787 (26.5)	1811 (25.9)	1230 (26.4)	-37.0 (-42.9 to -30.5)	<0.001
Discharged	4661 (71.2)	4712 (69.9)	4933 (70.5)	3360 (72.0)	-32.6 (-36.5 to -28.5)	

AMA, eloped, LWBS	217 (3.3)	237 (3.5)	240 (3.4)	64 (1.4)	-75.6 (-82.5 to -66.0)	
Expired	11 (0.2)	8 (0.1)	9 (0.1)	12 (0.3)		
Diagnoses						
Dizziness (6) ^{bc}	166 (2.6)	190 (2.9)	178 (2.6)	103 (2.3)	-49.4 (-30.4 to -63.3)	0.123
Syncope (9) ^c	78 (1.2)	101 (1.5)	115 (1.7)	44 (1.0)	-70.5 (-53.4 to -81.3)	0.001
Headache (2) ^c	242 (3.7)	303 (4.5)	215 (3.1)	152 (3.3)	-43.5 (-56.8 to -26.2)	0.301
Cerebrovascular accident ^d	80 (1.2)	96 (1.4)	104 (1.5)	52 (1.1)	-58.3 (-73.3 to -34.9)	0.049
Chest pain (1) ^c	495 (7.6)	492 (7.3)	528 (7.6)	456 (9.8)	-13.1 (-27.2 to 3.7)	<0.001
STEMI/NSTEMI/Angina ^d	171 (2.6)	142 (2.1)	121 (1.7)	92 (2.0)	-8.4 (-35.5 to 30.0)	0.051
VTE disease ^c	43 (0.7)	40 (0.6)	38 (0.5)	24 (0.5)	-32.1 (-65.2 to 32.5)	0.890
Congestive heart failure ^c	145 (2.2)	134 (2.0)	144 (2.1)	115 (2.5)	-13.6 (-38.5 to 21.4)	0.093
Shortness of breath	149 (2.3)	157 (2.3)	198 (2.8)	261 (5.6)	25.1 (-6.4 to 67.3)	<0.001
URI/pharyngitis/sinusitis (7) ^d	260 (4.0)	253 (3.8)	282 (4.0)	247 (5.3)	-10.0 (-29.4 to 14.8)	0.007
Asthma/COPD ^d	261 (4.0)	253 (3.8)	264 (3.8)	179 (3.8)	-30.0 (-45.9 to -9.6)	0.550
Influenza/pneumonia ^d	215 (3.3)	153 (2.3)	358 (5.1)	152 (3.3)	-40.3 (-55.0 to -21.0)	0.531
COVID-19/coronavirus ^c	0 (0)	0 (0)	0 (0)	20 (0.4)		--
Abdominal pain (4) ^c	809 (12.4)	863 (12.8)	958 (13.7)	579 (12.4)	-43.3 (-50.8 to -34.8)	0.045
Appendicitis ^d	21 (0.3)	18 (0.3)	21 (0.3)	15 (0.3)	-16.7 (-66.6 to 107.85)	0.589
GB/biliary/pancreas ^d	75 (1.1)	86 (1.3)	66 (0.9)	49 (1.1)	-35.3 (-60.0 to 4.9)	0.998
Renal stone/colic ^d	44 (0.7)	62 (0.9)	52 (0.7)	22 (0.5)	-70.0 (-84.0 to -43.6)	0.014
Urinary tract infection ^d	214 (3.3)	243 (3.6)	240 (3.4)	156 (3.3)	-42.8 (-56.4 to -24.8)	0.365
Sepsis (3) ^c	154 (2.4)	146 (2.2)	183 (2.6)	148 (3.2)	-14.7 (-37.6 to 16.7)	0.081
Diabetes complications ^d	267 (4.3)	291 (4.5)	280 (4.2)	176 (3.9)	-42.3 (-55.1 to -25.85)	0.354
Diabetic ketoacidosis ^c	26 (0.4)	20 (0.3)	32 (0.5)	29 (0.6)	17.8 (-45.4 to 154.4)	0.126
Injuries ^d	1080 (16.5)	933 (13.8)	1005 (14.4)	607 (13.0)	-30.1 (-38.8 to -20.1)	0.212
Head injury (5) ^d	427 (7.0)	378 (5.9)	419 (6.4)	254 (5.8)	-31.5 (-44.4 to -15.7)	0.587
Fractures ^c	321 (4.9)	260 (3.9)	304 (4.3)	161 (3.5)	-34.6 (-49.2 to -15.9)	0.933
Dental complaints ^c	93 (1.4)	111 (1.6)	91 (1.3)	61 (1.3)	-43.8 (-63.3 to -14.1)	0.507

Back pain (8) ^d	357 (5.5)	349 (5.2)	342 (4.9)	165 (3.5)	-50.7 (-61.1 to -37.4)	0.022
Anxiety/stress ^d	249 (3.8)	292 (4.3)	251 (3.6)	195 (4.2)	-33.8 (-48.5 to -14.8)	0.860
Depression ^d	300 (4.8)	342 (5.3)	307 (4.6)	227 (5.1)	-35.1 (-48.5 to -18.3)	0.992
Suicidal ideation (10) ^c	196 (3.0)	225 (3.3)	201 (2.9)	179 (3.8)	-22.4 (-41.3 to 2.4)	0.196
Intoxication/Substance Use ^d	945 (16.9)	994 (17.3)	1040 (17.5)	765 (19.6)	-30.1 (-38.5 to -20.4)	0.203
Alcohol withdrawal ^c	53 (0.8)	69 (1.0)	60 (0.9)	60 (1.3)	-23.2 (-53.7 to 27.4)	0.507
Poisoning ^d	95 (1.5)	101 (1.5)	117 (1.7)	101 (2.2)	-18.8 (-44.8 to 19.5)	0.247

Table 1. Characteristics of ED patients and presentations before and after state declaration

Abbreviations: IQR, inter-quartile range; OPI, other Pacific Islander; EMS, Emergency Medical Services; ESI, Emergency Severity Index; AMA, against medical advice; LWBS, left without being seen; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; VTE, venous thromboembolic; URI, upper respiratory infection; COPD, chronic obstructive pulmonary disease; COVID-19, novel coronavirus disease 2019; and GB, gallbladder.

^a P-value represents the type III p-value for the interaction between the overall change in ED visits and the change in each category of patient and visit characteristics and diagnoses.

^b Numbers indicate historical top 10 diagnoses for visits to our ED.

^c Determined from a search of diagnosis names within the first 3 coder diagnoses.

^d Determined from a search of diagnostic related groups within the first 3 coder diagnoses.


```

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run;

```

```

%mend trendratio;
The GENMOD Procedure

```

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Deviance	8	18.3382	2.2923
Scaled Deviance	8	7.9872	0.9984
Pearson Chi-Square	8	18.3676	2.2959
Scaled Pearson X2	8	8	1
Log Likelihood		69189.7	
Full Log Likelihood		-82.5663	
AIC (smaller is better)		181.133	
AICC (smaller is better)		201.704	
BIC (smaller is better)		187.313	

Analysis Of Maximum Likelihood Parameter Estimates

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits	Wald Chi-Square	Pr > Chi Sq
Intercept		1	7.3227	0.0465	7.2316 7.4138	24826.5	<.0001
year	2020	1	0.1669	0.0641	0.0412 0.2926	6.77	0.0093
period	wk 5-8	1	0.1811	0.1181	-0.0505 0.4126	2.35	0.1253
year*period	2020 wk 5-8	1	0.2331	0.1801	-0.1199 0.5861	1.68	0.1955
week		1	0.0309	0.0168	-0.0019 0.0638	3.41	0.065
week*year	2020	1	-0.0402	0.0233	-0.0859 0.0055	2.97	0.0847
week*period	wk 5-8	1	-0.0422	0.0235	-0.0883 0.0038	3.23	0.0724
week*year*period	2020 wk 5-8	1	-0.0797	0.0349	-0.148 -0.0113	5.22	0.0223
Scale		0	1.5152	0	1.5152 1.5152		

Note:

The scale parameter was estimated by the square root of Pearson's Chi-Square/DOF.

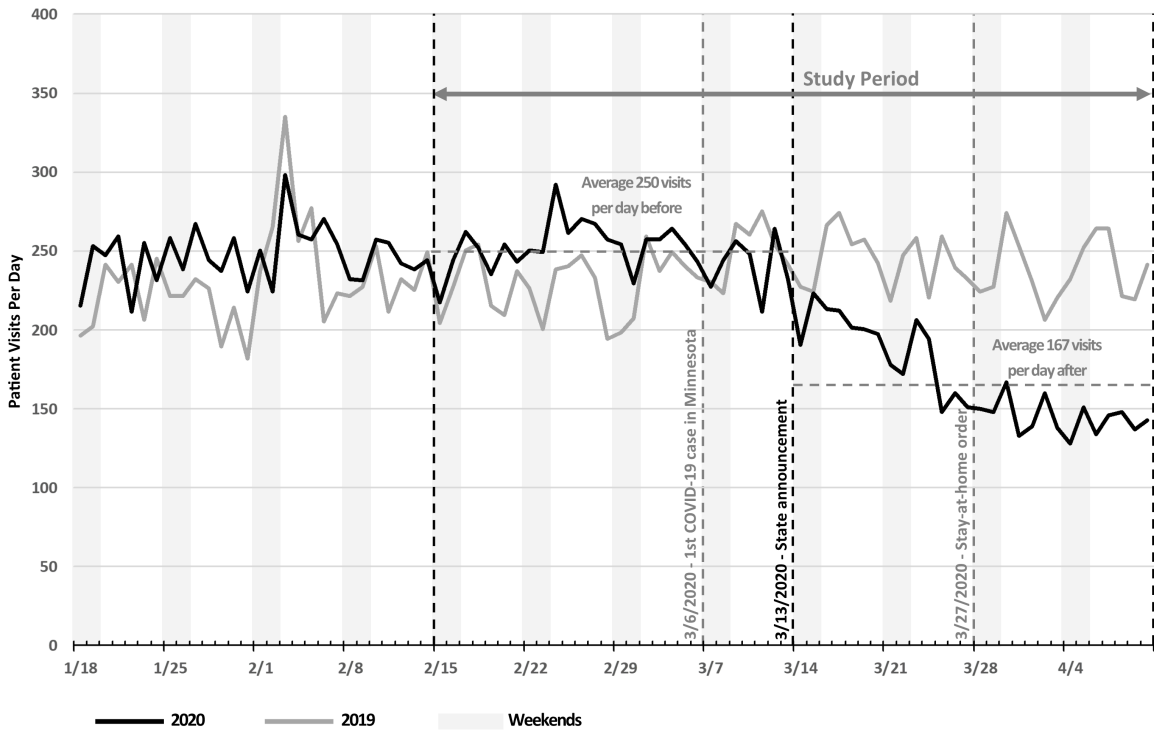
LR Statistics For Joint Tests

Source	Num DF	Den DF	F Value	Pr > F	Chi-Square	Pr > Chi Sq
year	1	8	6.78	0.0315	6.78	0.0092
period	1	8	2.34	0.1644	2.34	0.1259
year*period	1	8	1.68	0.2317	1.68	0.1956
week	1	8	3.41	0.1021	3.41	0.0649
week*year	1	8	2.97	0.123	2.97	0.0847

week*period	1	8	3.23	0.1101	3.23	0.0724
week*year*period	1	8	5.22	0.0516	5.22	0.0223

Contrast Estimate Results

Label	Mean Estimate	Mean		L'Beta Estimate	Standard Error	Alpha	L'Beta		Chi-Square	Pr > Chi Sq
		Confidence Limits					Confidence Limits			
wk5-8 trend vs wk1-4 trend 2020, normalized by 2019 Percent change decline per week	0.9234	0.8625	0.9887	-0.0797	0.0349	0.05	-0.148	-0.0113	5.22	0.0223
	-7.66	-13.75	-1.13							



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