Increased Firearm Injury During the COVID-19 Pandemic: A Hidden Urban Burden

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BACKGROUND: Public health measures were instituted to reduce COVID-19 spread. A decrease in total emergency department volume followed, but the impact on injury is unknown. With lockdown and social distancing potentially increasing domicile discord, we hypothesized that intentional injury increased during COVID-19, driven primarily by an increase in penetrating trauma.

STUDY DESIGN: A retrospective review of acute adult patient care in an urban Level I trauma center assessed injury patterns. Presenting patient characteristics and diagnoses from 6 weeks pre to 10 weeks post statewide stay-at-home orders (March 16, 2020) were compared, as well as with 2015-2019. Subsets were defined by intentionality (intentional vs nonintentional) and mechanism of injury (blunt vs penetrating). Fisher exact and Wilcoxon tests were used to compare proportions and means.

RESULTS: There were 357 trauma patients that presented pre stay-at-home order and 480 that presented post stay-at-home order. Pre and post groups demonstrated differences in sex (35.6% vs 27.9% female; $p = 0.02$), age (47.4 ± 22.1 years vs 42 ± 20.3 years; $p = 0.009$), and race (1.4% vs 2.3% Asian; 63.3% vs 68.3% Black; 30.5% vs 22.3% White; and 4.8% vs 7.1% other; $p = 0.03$). Post stay-at-home order mechanism of injury revealed more intentional injury ($p = 0.0008$). Decreases in nonintentional trauma after adoption of social isolation paralleled declines in daily emergency department visits. Compared with earlier years, 2020 demonstrated a significantly greater proportion of intentional violent injury during the peripandemic months, especially from firearms.

CONCLUSIONS: Unprecedented social isolation policies to address COVID-19 were associated with increased intentional injury, especially gun violence. Meanwhile, emergency department and nonintentional trauma visits decreased. Pandemic-related public health measures should embrace intentional injury prevention and management strategies. (J Am Coll Surg 2021;232:159−. © 2020 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

In October 2019, reports began emerging from Wuhan, China about a novel coronavirus that could result in severe respiratory failure. It was not until late February 2020 to early March 2020 that the gravity of this situation became clear and US public health initiatives emerged to address the crisis.[1-3] Fund reallocation and lockdown practices as directed by stay-at-home orders (SAHOs) were instituted in several states in March 2020. Pennsylvania

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Abbreviations and Acronyms

ED	= emergency department
ISS	= Injury Severity Score
IVT	= intentional or violent trauma
MOI	= mechanism of injury
MVC	= motor vehicle crash
NIT	= nonintentional trauma
PPMC	= Penn Presbyterian Medical Center
SAHO	= stay-at-home order

declared a state of emergency on March 6, 2020 and issued an SAHO on March 16, 2020.[4-7]

The Pennsylvania SAHO effectively cancelled elective procedures and severely curtailed inpatient and outpatient medical visits to increase hospital capacity to care for COVID-19 patients and reduce viral spread by limiting contact in high-risk locations.[8,9] Concurrently, emergency department (ED) visits nationwide declined abruptly, a trend noted globally as well.[10-16] The decline in ED visits was ascribed to patient fear of contracting SARS-CoV-2 infection—a fear that seemed unimpacted by nonviral acute illness. Mandated SAHOs along with unprecedented levels of unemployment might have impacted these behavioral changes.[17] Although decreases in presentations of acute non-injury-related illness were reported, it was less clear whether injury-related ED visits would decrease in parallel.

With the pandemic surge, anecdotal lay press reports noted increases in intentional or violent trauma (IVT), such as firearm violence, stabbings, and assaults.[18-20] Some attempted to link locations with increases in IVT to locally high rates of successful social distancing and isolation, including in Philadelphia.[21-24] Nationwide, as government officials trend rates of both crash and violent injury,[25,26] such data can guide adaptations of policy, healthcare access, and public health measures.

We therefore sought to evaluate the incidence of trauma and nontrauma patients presenting to the ED of an urban, metropolitan, Level I trauma center during the COVID-19 crisis. We hypothesized that although acute care ED use declined, intentional injury care—and specifically firearm-related injury care—would increase.

METHODS

Institution and data

Approval for this study was secured from the University of Pennsylvania's Office of Regulatory Affairs IRB. A retrospective trauma and ED registry review evaluated patients presenting for emergency care to Penn Presbyterian Medical Center (PPMC), 1 of 4 Level I adult trauma centers in Philadelphia County that is underpinned by ground ambulance, air ambulance, and police drop-off services to transport injury care.

The PPMC trauma registry follows strict state requirements articulated by the Pennsylvania Trauma Outcomes Systems Foundation with dedicated registrars who collect admitted patient data daily. The PPMC ED database provides basic demographic characteristics for all ED patients, including data from all visits, discharges, and admissions. Abstracted data included demographics (age, sex, and race), mechanism and cause of injury, injury descriptors, injury severity, diagnostic and therapeutic procedures, and outcomes (disposition and hospital length of stay). We queried publicly available data on the number of Philadelphia patients with COVID-19.[27,28]

Patients and time periods

For trauma and ED visits, all patients aged 14 years and older who received emergency or injury care at PPMC during the specified dates were included. Assessment periods bracketed the Pennsylvania SAHO (March 16, 2020) to include variations that might reflect influences besides the SAHO. Therefore, we assessed care between February 1 and May 30, 2020 and compared care with the same times in each year from 2015 to 2019, accounting for annual and seasonal variation.

Data analysis

IVTs were defined as assaults, firearm-related injury, and stabbings; all others were labeled as nonintentional injuries (NIT; eg fall, found down, motor vehicle crash, and pedestrian crash). This categorization intended to separate trauma inflicted with the intent to harm vs all others. Intentional injuries were then subclassified into firearm- or stabbing-related penetrating injury. All other intentional trauma was considered blunt assault.

For the primary analysis, we compared the incidence and proportion of cases within each mechanism of injury (MOI) in the weeks before and after SAHO. These data were contrasted to the city-wide new daily COVID-19 cases in Philadelphia. Planned analyses were parsed on the basis of race, intentionality (IVT vs NIT), and penetrating vs blunt trauma within IVT.

Except when otherwise noted as proportion of cases, data were expressed as a daily frequency with 95% CIs. Data were missing for key variables in < 1% of cases. We therefore conducted a complete case analysis. Fisher exact test for proportions and Wilcoxon test for continuous variables compared group data as appropriate. Two-tailed significance was set at $p < 0.05$. Data analysis was facilitated using R statistical software, version 4.0.0 (R Core Team, 2018). We generated plots using the "ggplot2" package.

RESULTS

Trauma rates and characteristics in the time period before and after the stay-at-home order

Trauma patient triage in the city of Philadelphia did not change during the time periods evaluated and the 4 Level I trauma centers received similar proportions of all types of injured patients as in the past (eTable 1). Similarly, no intentional rearrangement of ambulance volume was directed to favor bringing COVID-19 victims to one city hospital over another. Pre- (n = 357) and post-SAHO (n = 480) 2020 trauma patient data are presented

Table 1. Comparison of 2020 Data Before and After Pennsylvania Stay-at-Home Order

Characteristic	Before SAHO (n = 357)	During SAHO (n = 480)	p Value
Sex, f, n (%)	127 (35.57)	134 (27.92)	0.019
Race, n (%)			0.032
Asian	5 (1.40)	11 (2.29)	0.45
Black	226 (63.31)	328 (68.33)	0.14
Other	17 (4.76)	34 (7.08)	0.12
White	109 (30.53)	107 (22.29)	0.008
Age, y, mean ± SD	47.36 ± 22.13	42.90 ± 20.32	0.009
Mechanism of injury, all, n (%)			0.0006
IVT, all	70 (19.61)	148 (30.83)	0.0002
Assault (blunt)	33 (9.24)	56 (11.67)	0.31
Penetrating IVT, all	62 (17.37)	140 (29.91)	<0.0001
Stabbing	25 (7.00)	38 (7.92)	0.69
Gunshot wound	45 (12.61)	110 (22.92)	0.0001
Nonintentional, all	168 (47.06)	164 (34.17)	0.0002
Fall	132 (36.97)	135 (28.12)	0.007
Found down	18 (5.04)	17 (3.54)	0.30
MVC	86 (24.09)	112 (23.33)	0.81
Pedestrian vs motor vehicle	18 (5.04)	12 (2.50)	0.060
Injury Severity Score, mean ± SD	7.54 ± 9.13	7.94 ± 8.84	0.29
Assault (blunt)	7.19 ± 10.07	6.24 ± 6.29	0.56
Stabbing	2.60 ± 2.86	5.91 ± 6.97	0.066
Gunshot wound	12.51 ± 16.63	10.08 ± 12.32	0.83
Fall	7.41 ± 6.13	8.56 ± 7.09	0.20
Found down	6.53 ± 8.12	3.00 ± 4.11	0.078
MVC	6.61 ± 7.09	7.46 ± 8.76	0.88
Pedestrian vs motorized vehicle	8.43 ± 7.48	6.80 ± 6.78	0.59
Outcome, alive, n (%)	343 (96.08)	460 (95.83)	1.00

IVT, intentional/violent; MVC, motor vehicle crash; SAHO, stay-at-home order.

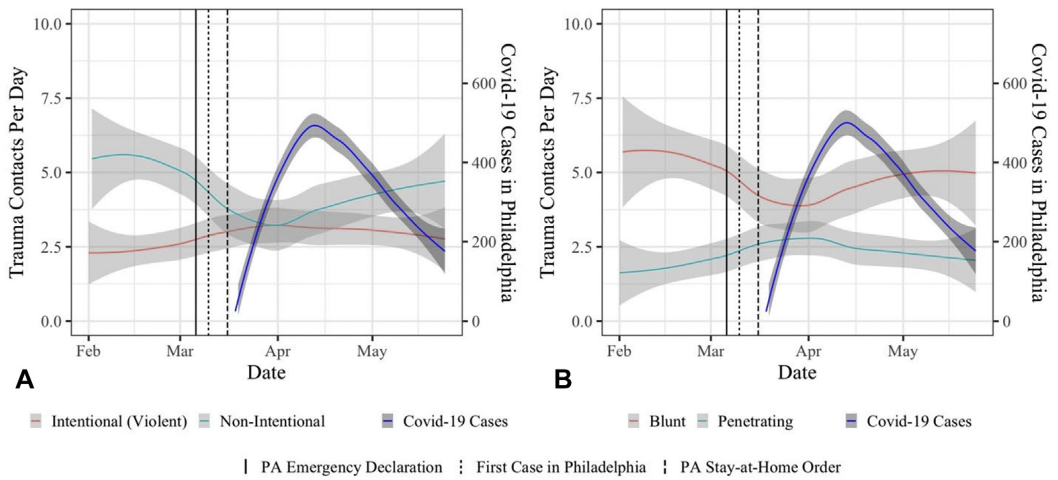

Figure 1. Comparison of 2020 types of trauma. (A) Intentional vs nonintentional trauma (2020). (B) Blunt vs penetrating cases (2020).

in Table 1. These data disclosed significant differences in sex (35.6% vs 27.9% female; p = 0.019) and age (47.4 ± 22.1 years vs 42.9 ± 20.3 years; p = 0.009). A higher proportion of non-White trauma patients was noted in the post-SAHO period (69.5% vs 77.7%; p = 0.008) (eTables 2 and 3).

The proportion of patients presenting after a fall decreased (36.9% vs 28.1%; p = 0.007) and firearm injuries nearly doubled (gunshot wounds 12.6% vs 22.9%; p < 0.0001). No differences were noted for other MOIs when comparing the 2 time frames (p > 0.05). All combined penetrating trauma increased post SAHO (17.4% vs 29.9%; p < 0.0001). There was no significant difference in mortality or severity of injury as measured by the trauma Injury Severity Score (ISS) in the overall cohorts or those stratified by MOI (Table 1 and eTable 4).

When evaluated by race alone (eTable 2), White patients pre- and post-SAHO periods had similar MOI distributions. Meanwhile, Black patients post SAHO demonstrated greater numbers of firearm injuries (18.1% vs 28.7%; p = 0.005) and Black patients presenting post SAHO suffered more from any type of penetrating trauma (23.9% vs 36.2%; p = 0.00009); no difference in ISS or mortality was noted for this cohort either (eTable 3).

COVID-19 cases and differences in types of trauma

IVT significantly increased post SAHO. Both before and during the lockdown, there were more NIT cases than IVT, but post SAHO there was a significant rise in IVT

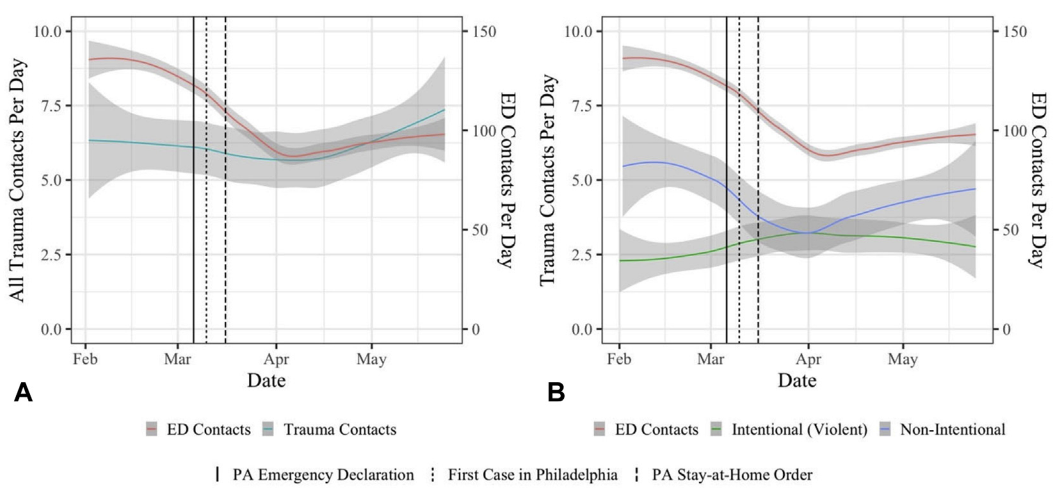

Figure 2. Comparison of 2020 trauma and emergency department (ED) visits. (A) ED vs all trauma contacts (2020). (B) ED vs trauma contacts (2020).

Table 2. Comparison of Data Across Earlier Years and 2020 after Stay-at-Home Order (March 16, 2020)

Characteristic	2015 (n = 519)	2016 (n = 547)	2017 (n = 514)	2018 (n = 566)	2019 (n = 572)	2020 (n = 480)	p Value
Sex, f, n (%)	184 (35.52)	166 (30.35)	157 (30.60)	185 (32.69)	184 (32.17)	134 (27.92)	0.17
Race, n (%)							0.04
Asian	16 (3.10)	14 (2.56)	12 (2.34)	11 (1.94)	18 (3.15)	11 (2.29)	0.79
Black	302 (58.53)	339 (61.97)	344 (67.06)	376 (66.43)	356 (62.24)	328 (68.33)	0.005
Other	42 (8.14)	32 (5.85)	27 (5.26)	24 (4.24)	30 (5.24)	34 (7.08)	0.49
White	156 (30.23)	162 (29.62)	130 (25.34)	155 (27.39)	168 (29.37)	107 (22.29)	0.036
Age, y, mean ± SD	45.40 ± 21.43	46.17 ± 21.48	45.47 ± 20.08	46.55 ± 20.72	46.92 ± 20.85	42.90 ± 20.32	0.31
Mechanism of injury, all, n (%)							0.018
IVT, all	109 (21.00)	119 (21.76)	104 (20.23)	130 (22.97)	120 (20.98)	148 (30.83)	0.0008
Assault (blunt)	69 (13.29)	63 (11.52)	74 (14.40)	67 (11.84)	68 (11.89)	56 (11.67)	0.68
Penetrating IVT, all	108 (21.01)	112 (20.59)	98 (19.10)	124 (21.95)	116 (20.35)	140 (29.91)	0.003
Stabbing	36 (6.94)	45 (8.23)	37 (7.20)	40 (7.07)	39 (6.82)	38 (7.92)	0.94
Gunshot wound	73 (14.07)	74 (13.53)	67 (13.04)	90 (15.90)	81 (14.16)	110 (22.92)	0.0002
Nonintentional, all	235 (43.35)	234 (42.78)	214 (41.63)	259 (45.76)	264 (46.15)	164 (34.17)	0.001
Fall	174 (33.53)	177 (32.36)	168 (32.68)	201 (35.51)	198 (34.62)	135 (28.12)	0.17
Found down	23 (4.43)	30 (5.48)	19 (3.70)	31 (5.48)	26 (4.55)	17 (3.54)	0.53
MVC	116 (22.35)	131 (23.95)	122 (23.74)	110 (19.43)	120 (20.98)	112 (23.33)	0.40
Pedestrian vs motorized vehicle	28 (5.39)	27 (4.94)	27 (5.25)	27 (4.77)	40 (6.99)	12 (2.50)	0.035
Outcome, alive, n (%)	492 (94.80)	521 (95.25)	499 (97.08)	543 (95.94)	548 (95.80)	460 (96.03)	0.55
Injury Severity Score, mean ± SD)	8.55 ± 10.66	7.90 ± 10.21	8.03 ± 10.21	7.86 ± 8.84	8.37 ± 10.69	7.94 ± 8.84	0.65
Assault (blunt)	5.51 ± 5.74	5.98 ± 6.28	6.06 ± 5.88	5.15 ± 4.48	6.00 ± 6.51	6.24 ± 6.29	0.67
Stabbing	4.34 ± 6.73	4.11 ± 11.10	3.72 ± 5.61	3.55 ± 5.45	4.76 ± 6.74	5.91 ± 6.97	0.36
Gunshot wound	16.61 ± 20.34	11.38 ± 15.01	12.77 ± 16.83	13.29 ± 15.40	14.89 ± 18.01	10.08 ± 12.32	0.13
Fall	7.71 ± 6.26	8.01 ± 7.53	9.33 ± 10.49	8.06 ± 6.30	7.67 ± 8.42	8.56 ± 7.09	0.77
Found down	6.59 ± 7.24	5.56 ± 9.02	3.18 ± 3.30	3.32 ± 3.88	5.80 ± 6.46	3.00 ± 4.11	0.18
MVC	8.18 ± 8.38	8.76 ± 10.83	6.46 ± 6.57	7.88 ± 7.32	7.64 ± 9.11	7.46 ± 8.76	0.44
Pedestrian vs motorized vehicle	8.84 ± 9.49	8.04 ± 10.34	9.48 ± 9.23	5.67 ± 4.70	10.15 ± 11.08	6.80 ± 6.78	0.96

IVT, intentional/violent; MVC, motor vehicle crash.

(19.81% pre SAHO to 30.83% post SAHO), and a decrease in NIT from 80.2% to 69.2% (p = 0.0002) (Table 1 and Fig. 1). The post-SAHO period also demonstrated steadily decreasing NIT (Fig. 1A) Similarly, in the weeks that followed SAHO, penetrating trauma (gunshot wounds and stabbings) incidence remained the same or increased slightly, while blunt trauma decreased (Fig. 1B). During the post-SAHO period, the city-wide new daily COVID-19 case incidence rose steadily and peaked in mid-April (Fig. 1).

Trauma patients and nontrauma emergency department visits

Trauma patient and noninjury care ED visits at the same facility were compared before and after the SAHO was enacted. ED visits declined as the pandemic surged, with a sharp decline noted after the SAHO; total trauma patient volume remained consistent across periods (Fig. 2A). With respect to intentionality, with SAHO the NIT declined in parallel to total noninjury ED visits, and IVT visits increased (Fig. 2B).

Comparisons across 2015-2020

To distinguish the impact of the SAHO from seasonal crossover from winter (and the holiday seasons) to spring, pre-, and post-SAHO period data from 2020 were compared with those from 2015-2019 (Table 2). Only the rate of motor vehicle crashes (MVCs) was different during the pre-SAHO period comparing 2020 with 2015-2019, with reduced MVCs noted in 2020 (p = 0.008); demographics and other domains, including overall trauma volume, sex, and age distribution remained

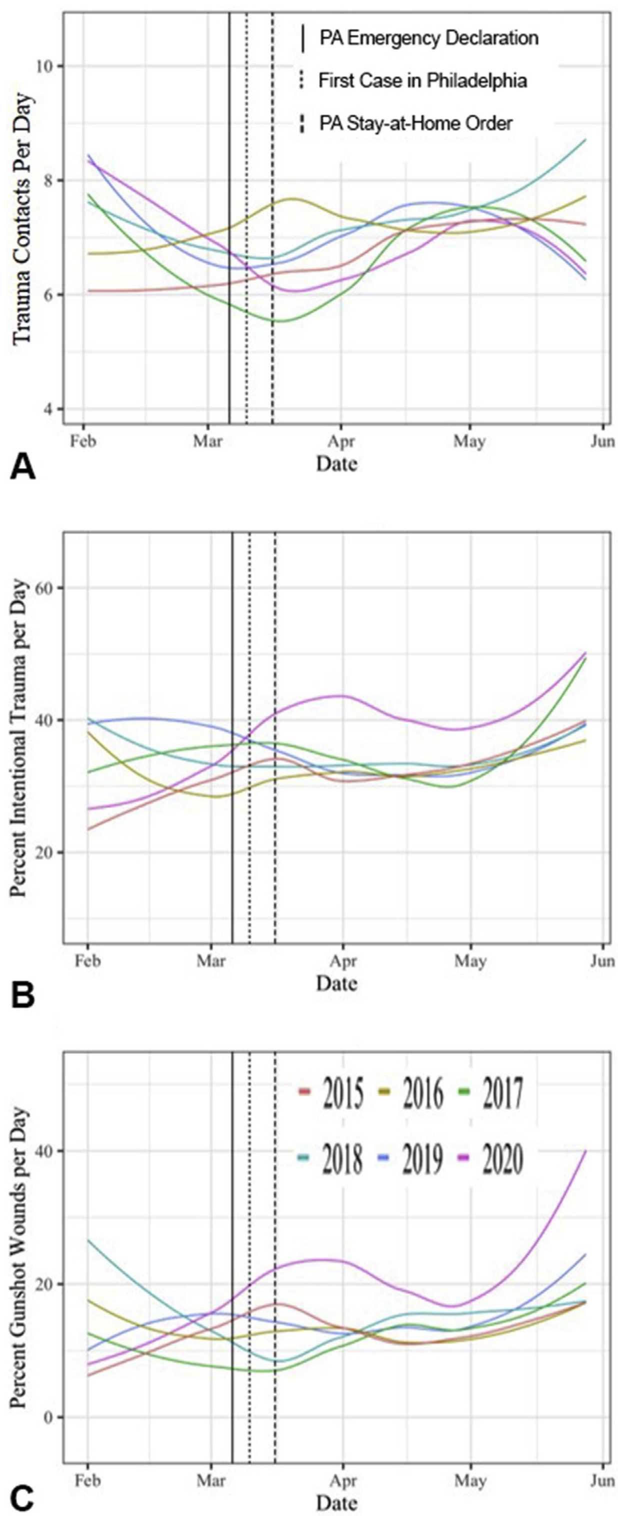

Figure 3. Comparison of data from 2015 to 2020. (A) Trauma cases by year. (B) Percent intentional trauma by year. (C) Percent gunshot wounds by year.

similar (eTable 4). The 2020 post-SAHO period (after March 16, 2020) demonstrated similar changes in race composition compared with the same periods in 2015 through 2019. A greater number of Black patients ($p = 0.0006$) and a lower number of White patients ($p = 0.036$) was a durable finding in comparing all years against 2020 during this period. Strikingly, a vast percent increase in gunshot wounds was noted (62.4%; $p = 0.00002$) during the post-SAHO 2020 period compared with that in 2015-2019. Other differences included a modest decrease in pedestrian injury ($p = 0.035$) and changes overall in MOI ($p = 0.018$; Table 2 and Fig. 3). Post-SAHO 2020 trauma volumes demonstrated a greater proportion of penetrating injury ($p = 0.003$) and IVT ($p = 0.00009$) than earlier years. No differences were noted for ISS within or across groups, and mortality was similar across all years.

DISCUSSION

COVID management has a number of elements that do not appear to directly interface with injury care. Public health measures directed at viral transmission reduction both inside and outside of healthcare facilities might seem remote from urgent, emergent acute health conditions, or injury management. Nonetheless, public health measures like SAHO reshape the fabric of human interaction in ways that impact the frequency at which any healthcare is sought. For instance, social isolation derails key elements of social interaction, including interpersonal communication, basic supply availability, and finances, therefore altering healthcare access and use.

We normally expect the frequency of ED visits for urgent or emergent conditions, such as myocardial ischemia, appendicitis, or stroke, to remain relatively stable, even with socioeconomic disturbances. A pandemic presents a unique environment where fear of contagion in the hospital can impede a patient's willingness to present for care. Our data support this notion and align with other reports on reduced acute care frequency on contagion fear. This is further supported by the steady decrease in ED visits as the prevalence of COVID-19 increased. This was not likely driven by the virus itself, but rather by the fact that as public reports of COVID-19 cases increased, so did contagion fear and compliance with SAHO. This theory would need testing, as the reason for overall decreased visits to the ED in Philadelphia or elsewhere was not explored in this study. However, given the reduced social contact mandated by a SAHO, the belief that injury frequency would also decrease during a pandemic is intuitively attractive. Indeed, reduced ED acute care visits were paralleled by decreases in NIT visits. Unfortunately, the opposite was noted for IVT at our center, meriting additional inquiry.

Major societal disruptions directly affect urban violence and injury through the interface between public health measures and injury care. The duration of societal disruption appears to be an important element driving increases in injury. Although New York City noted no change in homicide rate after 9/11, Houston saw substantial increases in violent injury after Hurricane Katrina.[29,30] Perhaps, the longer-lasting social disturbance duration correlates with economic instability and unemployment compared with the point devastation of 9/11—in spite of its great emotional and political impact.[31] Public health measures during a pandemic have broad overlap with financial peril because enforced economy reductions, social distancing, and reduced mechanisms for social outlet are shuttered. Therefore, increased social tension plausibly forces individuals to stay in close quarters, perhaps increasing intentional or violent injury in domiciles or communities. Although assault and other forms of blunt violent trauma might also be expected to increase, we only saw an increase in penetrating violent injury only with no increase in blunt assault IVT. This lack of a significant increases in nonpenetrating violent injury was similar in both White and Black populations. It is unclear how this can be explained other than the existing pervasiveness of gun violence in the city, which was further compounded by the high-tension circumstances around the SAHO, bolstering the preexisting public health problems in these communities. Specifically, the isolated increase in gunshot wounds could be driven by decreased numbers of people present in city streets and urban spaces, allowing violence and crime to progress unwitnessed and unchecked by overtaxed law enforcement agencies.

We suggest that there might be 2 distinct harms from social isolation: patients who do not present to the ED for potentially life-threatening acute care conditions to avoid virus exposure, and increasing violent injury in the midst of an overburdened law enforcement system. Both events can impact epidemiologic reporting and analysis, critically stressing already challenged Emergency Medical Services and law enforcement agencies.

Trauma patient volumes in urban health systems characteristically vary in nature and severity across season and time of year.[32] These seasonal variations are typical and locally related to social norms, weather patterns, scheduled public events, and other environmental factors.[33,34] Our data demonstrate an association between pandemic-related public health measures and both trauma patient volume and injury profile at an urban Level I trauma center. Social isolation policies instituted in March 2020 were associated with a sharp increase in IVT, in spite of a decrease in NIT and overall ED patient volume. Decreases in MVCs were anticipated as the early SAHO period was anecdotally characterized by markedly decreased road traffic. A corresponding decrease in pedestrian injury was similarly expected. Because the increase in IVT is unique compared with the preceding 5 years, trauma and public health systems are presented with an opportunity to mitigate future occurrences during periods of social norm disruption.

Neither injury severity nor patient mortality changed across periods. This was a surprising finding because during other periods of major disturbances, 2 key behaviors have been observed that can increase both ISS and mortality: participation in dangerous behavior (that can predispose to trauma) due to higher risk thresholds, and inadvertent existence in a dire circumstance that can predispose to greater injury severity.[35] That neither was observed in our study serves to strengthen the link between social isolation and IVT. In addition, our data suggest that within the catchment area for our urban center, the increase in IVT asymmetrically impacts Black populations more than White.

We found increases in gunshot wounds that disproportionately affected young, Black men—the urban demographic already overrepresented across decades of inner-city firearm-related intentional injury.[36] Ironically, similar urban subpopulations also appear at greater risk of COVID-19 infection and mortality.[37,38] Although injury caused by interpersonal violence not only increased in an absolute number, it also greatly increased as a proportion of overall trauma patient volume. This unique increase should inform essential local and regional public health preparations and strategies for social distancing as we anticipate ongoing public health measures ahead of the upcoming winter flu season. Relatedly, trauma centers, Emergency Medical Services and law enforcement operating in areas impacted by SAHO should prepare for increases in local trauma patient flow, especially in cities like Philadelphia, where police vehicles transport penetrating injury victims to hospital directly from the scene.

In preparing for the next health crisis, as well as adapting to the current ongoing one, public health measures should plan to mitigate untoward impacts on specific populations and leverage both the inpatient care and the outreach efforts of the US trauma system to help achieve that goal. The American College of Surgeons Committee on Trauma and state verification systems should incorporate programs to combat this into their recurrent verification assessments. Hospitals and hospital networks cannot, and should not, be the sole funders of these activities. Instead, both state and federal funding should be directed to support injury reduction and prevention programs with a targeted focus on IVT. Crafting partnerships between trauma centers, their surrounding communities, and the local public health and law enforcement departments, as well as federal agencies, such as the Bureau of Alcohol, Tobacco, Firearms and Explosives and the US Customs and Border Protection, can be of substantial benefit in bolstering such efforts. It must be noted that the firearm injury epidemic is not limited to pandemic periods and needs ongoing and focused attention past the pandemic period. Firearm violence impacts approximately 33,000 Americans per year with a large disparity between White and non-White victims. Mass casualty and active shooter events are only a small fraction of US firearm violence, even though they garner the most focused attention.[39]

This was a single-institution study that encompassed 1 region of West Philadelphia and therefore might not be readily extrapolatable to other regions. We used the severity of the COVID-19 pandemic and case surge to present the daily reports that the city population was receiving and informed how their behavior changed in staying in their homes, understanding that this is a poor surrogate for how SAHO compliance progressed. Adherence to social isolation guidelines is difficult to quantify, capture, or predict and public behavior in other crises might be different. Suicide attempts were not included in the group of IVT because the trauma registry does not capture this sample well (they often do not present to the trauma bay but to the main ED), although conceivably this group of self-inflicted injuries might have been greatly affected by the SAHO-mandated isolation that might have worsened depression and other suicide-related behaviors. We also did not assess unemployment rates or geolocate injury occurrences to link them with socioeconomic factors in specific locales. Specific triggers of the increased IVT were inferred from context but not from dedicated patient-level query. Finally, we were unable to determine the physical location of where the violent injury had occurred (ie inside vs outside and home vs place of work), as this information is rarely available in the electronic medial record for trauma victims and is not captured by the Trauma Registry.

This inquiry approached the impact of an SAHO on total ED care and trauma care during a period of reduced transient population through the catchment area. This approach allowed a more focused assessment of the resident population and the impact of the SAHO on injury profiles, with the goal of discerning one or more avenues of supporting local population health and survival.

CONCLUSIONS

Trauma volumes and routine ED visits appear to decrease with social isolation during a mandated public health approach to pandemic management. Decreases in MVCs and nonintentional injury were evident and anticipated during the period of lockdown. However, increased intentional violent injury, particularly penetrating trauma, was noted with an asymmetric racial allocation in young Black men. Because the increase in IVT associated with the SAHO issued to help address viral containment appears distinct from the rate of IVT in the prior 5 years, additional inquiry is warranted, and specific action should be undertaken addressing the impact of social isolation on injury. Although pandemic care serves as the current trigger, natural and man-made disasters can establish many of the same circumstances that promote intentional injury. Public and private health system leaders should develop partnerships that embrace medical professional organization support to proactively reduce violent injury, and specifically firearm-related injury, during periods of social isolation.

Author Contributions

Study conception and design: Abdallah, Zhao, Kaufman, Pascual

Acquisition of data: Pascual

Analysis and interpretation of data: Abdallah, Zhao

Drafting of manuscript: Abdallah, Zhao, Kaufman, Pascual

Critical revision: Hatchimonji, Swendiman, Kaplan, Seamon, Schwab

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Invited Commentary

COVID-19 and Firearm Injury: A Uniquely American Problem

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The COVID-19 pandemic has impacted the healthcare sector in many ways. One of the unfortunate outcomes that appears to be associated with the pandemic, or perhaps with our response to the pandemic, is a substantial rise in firearm-related injury. This end point is unique to the US compared with Western European countries. Although many countries and cities quickly reported a considerable and sustained decrease in trauma volume,[1-3] only the US reported a net decrease in blunt mechanism of injury trauma volume and a concomitant, substantial increase in firearm-related injuries in many large cities.[4] The current study by Abdallah and colleagues[5] validates these reports. The authors found a 23% relative decrease in falls from standing but a near 100% relative increase in intentional firearm-related injuries in Philadelphia, PA, before and after implementation of stay-at-home orders (SAHO) due to COVID-19. Similar observations have been made in the Washington, DC area (personal communication, M. Chodos MD, September 2020), as well as in Chicago, IL and Los Angeles, CA.[4] Yet neither Abdallah's report nor reports from other trauma centers noted a concomitant increase in blunt-force assault, suggesting no change in the incidence of domestic abuse/non-firearm-related interpersonal violence. It appears too simplistic to blame SAHO alone for the isolated rise in firearm-related injury post-COVID-19.

Firearm sales hit all-time records shortly after the spread of COVID-19 within the US. For example, there were 1.2 million more background check requests related to firearm purchases in March 2020 compared with March 2019. The number of firearms sold legally in the US doubled from March 2020 to August 2020 compared with the same time period in 2019 (12,233,000 vs 6,386,000 sales).[6] Because of the many ways to obtain a firearm without a background check and because of the lack of a national registry of firearms in the US, it is almost a certainty that the actual number of firearm-related transactions that occurred within this time frame is much higher than reported. One has to concede that ready availability of firearms is a key distinguishing characteristic that can underlie the difference in penetrating trauma volume between the US and other Western countries and the substantial increase in penetrating trauma post-COVID-19. Supporting this is the finding that there was no change in the incidence of stabbings in Philadelphia before and after COVID-19.

Abdallah and colleagues[5] suggest that duration of SAHO and its resultant social and financial impact may be a large contributor to the incidence of interpersonal violence. Although this is certainly plausible, the fact that it impacted firearm-related injury only presents a key finding that should not be overlooked by policymakers, public health officials, and disaster management personnel in anticipation of future events. In short, in areas that already have a predilection for firearm-related violence (such as large, urban settings), an additional, prolonged stressor can disproportionately impact the at-risk population and should serve as a target for early outreach and mitigation efforts.

One key shortcoming of this article, along with all other reports related to the incidence of firearm-related injury before and after COVID-19, is a lack of focus on suicide. Given that approximately 66% of all firearm-related deaths are due to suicide and not homicide, one might conjecture that the incidence of suicide would increase as a function of SAHO, social distancing, poor access to mental health services, and ready availability of firearms. Unfortunately, this is a difficult area to investigate because suicide is far more prevalent in rural and suburban settings where there are fewer trauma centers. Because there is no registry of firearm-related injury outside of the National Trauma Databank, which only contains data submitted by trauma centers, it is extremely difficult to determine the incidence of suicide due to firearm injury. A registry to identify both cases that were pronounced dead on-scene (and never entered into a hospital registry) and cases that were treated at either a trauma or nontrauma center is needed to provide an understanding of the impact of SAHO, sense of social isolation, fear of contagion, and prevalence of firearms on suicide.

eTable 1. Comparison of Patient Residence ZIP Codes Before and after Pennsylvania Stay-at-Home Order (March 16, 2020)

	Before SAHO (n = 357)		During SAHO (n = 480)		
ZIP code	n	%	n	%	p Value
Hospital*	31	8.68	58	12.08	0.14
Neighborhood	154	43.14	203	42.29	0.83
Other	172	48.18	219	45.62	0.48

*Limited to only the ZIP code in which the trauma center is located.
SAHO, stay-at-home-order.

eTable 2. Comparison of 2020 Data Before and after Pennsylvania Stay-at-Home Order (March 16, 2020) for White Patients

Characteristic	Before SAHO (n = 109)	During SAHO (n = 107)	p Value
Sex, f, n (%)	42 (38.5)	36 (33.6)	0.48
Age, y, mean ± SD	56.0 ± 22.2	55.5 ± 21.2	0.86
Mechanism of injury, all, n (%)			0.76
IVT, all	7 (6.4)	10 (9.3)	0.46
Assault (blunt)	7 (6.4)	10 (9.3)	0.46
Penetrating IVT, all	5 (4.6)	10 (9.3)	0.19
Stabbing	4 (3.7)	4 (3.7)	1.0
Gunshot wound	3 (2.8)	6 (5.6)	0.33
Nonintentional, all	73 (67.0)	63 (58.9)	0.26
Fall	63 (57.8)	57 (53.3)	0.58
Found down	7 (6.4)	3 (2.8)	0.33
MVC	22 (20.2)	24 (22.4)	0.74
Pedestrian vs motorized vehicle	3 (2.8)	3 (2.8)	1.00
Injury Severity Score, mean ± SD	8.0 ± 7.1	8.7 ± 7.0	0.33
Assault (blunt)	10.0 ± 8.8	6.0 ± 4.5	0.32
Stabbing	3.2 ± 4.5	7.8 ± 9.4	0.62
Gunshot wound	4.7 ± 4.0	9.5 ± 6.6	0.28
Fall	8.1 ± 6.6	8.9 ± 6.7	0.48
Found down	7.2 ± 8.9	5.7 ± 4.5	0.79
MVC	9.1 ± 8.4	9.9 ± 8.2	0.69
Pedestrian vs motorized vehicle	6.0 ± 6.2	9.7 ± 11.0	0.82
Outcome, alive, n (%)	106 (97.2)	105 (98.1)	1.0

IVT, intentional/violent; MVC, motor vehicle crash; SAHO, stay-at-home order.

eTable 3. Comparison of 2020 Data Before and After Pennsylvania Stay-at-Home Order (March 16, 2020) for Black Patients

Characteristic	Before SAHO (n = 226)	During SAHO (n = 328)	p Value
Sex, f, n (%)	81 (35.8)	85 (25.9)	0.014
Age, y, mean ± SD	43.2 ± 20.9	39.6 ± 18.8	0.095
Mechanism of injury, all, n (%)			0.018
IVT	60 (26.5)	124 (37.8)	0.006
Assault (blunt)	22 (9.7)	42 (12.8)	0.28
Penetrating IVT, all	54 (23.9)	116 (35.4)	0.005
Stabbing	19 (8.4)	30 (9.1)	0.88
Gunshot wound	41 (18.1)	94 (28.7)	0.005
Nonintentional trauma, all	83 (36.7)	87 (26.5)	0.011
Fall	58 (25.7)	69 (21.0)	0.22
Found down	11 (4.9)	10 (3.0)	0.37
MVC	61 (27.0)	75 (22.9)	0.27
Pedestrian vs motorized vehicle	14 (6.2)	8 (2.4)	0.044
Injury Severity Score, mean ± SD	7.5 ± 10.3	7.2 ± 8.0	0.39
Assault (blunt)	6.8 ± 11.1	5.5 ± 4.6	0.33
Stabbing	2.4 ± 2.7	6.1 ± 7.1	0.048
Gunshot wound	13.0 ± 17.3	9.0 ± 10.4	0.51
Fall	6.9 ± 5.7	8.3 ± 7.0	0.24
Found down	6.1 ± 8.1	1.1 ± 0.4	0.068
MVC	5.5 ± 6.3	6.2 ± 7.4	0.83
Pedestrian vs motorized vehicle	9.4 ± 8.3	4.8 ± 4.8	0.27
Outcome, alive, n (%)	215 (95.1)	313 (95.7)	0.84

IVT, intentional/violent; MVC, motor vehicle crash; SAHO, stay-at-home order.

eTable 4. Comparison of Data from 2015 to 2020 Before Stay-at-Home Order (March 16, 2020)

Characteristic	2015 (n = 268)	2016 (n = 331)	2017 (n = 293)	2018 (n = 313)	2019 (n = 315)	2020 (n = 357)	p Value
Sex, f, n (%)	87 (32.46)	107 (32.33)	95 (32.42)	94 (30.03)	112 (35.56)	127 (35.57)	0.65
Race, n (%)							0.20
Asian	11 (4.10)	10 (3.02)	5 (1.71)	6 (1.92)	4 (1.27)	5 (1.40)	0.17
Black	146 (54.48)	211 (63.75)	194 (66.21)	198 (63.26)	196 (62.22)	226 (63.31)	0.096
Other	18 (6.72)	24 (7.25)	19 (6.48)	18 (5.75)	18 (5.71)	17 (4.76)	0.80
White	93 (34.70)	86 (25.98)	74 (25.26)	91 (29.07)	97 (30.79)	109 (30.53)	0.13
Age, y, mean ± SD	50.71 ± 22.29	47.15 ± 21.00	47.50 ± 20.64	45.30 ± 20.82	48.71 ± 22.54	47.36 ± 22.13	0.23
Mechanism of injury, all							0.13
IVT, all, n (%)	45 (16.79)	64 (19.34)	58 (19.80)	78 (24.92)	60 (19.05)	70 (19.61)	0.25
Assault (blunt)	33 (12.31)	42 (12.69)	42 (14.33)	32 (10.22)	47 (14.92)	33 (9.24)	0.18
Penetrating IVT, all, mean ± SD	0.18 ± 0.38	0.18 ± 0.39	0.17 ± 0.37	0.25 ± 0.43	0.18 ± 0.39	0.17 ± 0.38	0.15
Stabbing, n (%)	16 (5.97)	20 (6.04)	25 (8.53)	23 (7.35)	21 (6.67)	25 (7.00)	0.85
Gunshot wound, n (%)	29 (10.82)	44 (13.29)	33 (11.26)	55 (17.57)	39 (12.38)	45 (12.61)	0.19
Nonintentional, all, n (%)	156 (58.21)	161 (48.64)	143 (48.81)	154 (49.20)	149 (47.30)	168 (47.06)	0.083
Fall	127 (47.39)	128 (38.67)	106 (36.18)	119 (38.02)	122 (38.73)	132 (36.97)	0.089
Found down	14 (5.22)	15 (4.53)	22 (7.51)	15 (4.79)	12 (3.81)	18 (5.04)	0.47
MVC	34 (12.69)	64 (19.34)	50 (17.06)	49 (15.65)	59 (18.73)	86 (24.09)	0.008
Pedestrian vs motorized vehicle	15 (5.60)	18 (5.44)	15 (5.12)	20 (6.39)	15 (4.76)	18 (5.04)	0.96
Injury Severity Score, mean ± SD	8.47 ± 9.03	8.15 ± 10.55	7.98 ± 10.01	8.40 ± 10.40	9.50 ± 11.46	7.54 ± 9.13	0.90
Assault (blunt)	6.33 ± 4.93	6.51 ± 7.22	6.05 ± 5.79	5.77 ± 6.48	6.12 ± 5.29	7.19 ± 10.07	0.81
Stabbing	4.14 ± 6.57	9.00 ± 17.52	6.29 ± 8.04	3.35 ± 3.17	3.48 ± 4.03	2.60 ± 2.86	0.046
Gunshot wound	12.79 ± 12.87	11.21 ± 12.92	15.44 ± 21.79	14.40 ± 17.90	21.33 ± 21.91	12.51 ± 16.63	0.27
Fall	7.93 ± 7.80	7.72 ± 9.24	8.04 ± 6.79	6.43 ± 5.48	8.95 ± 6.78	7.41 ± 6.13	0.91
Found down	9.50 ± 10.99	3.92 ± 6.76	4.89 ± 5.99	5.92 ± 4.56	7.67 ± 7.71	6.53 ± 8.12	0.89
MVC	8.11 ± 10.40	7.50 ± 9.44	6.28 ± 6.12	10.18 ± 9.28	8.14 ± 9.53	6.61 ± 7.09	0.73
Pedestrian vs motorized vehicle	13.00 ± 10.86	12.64 ± 12.97	11.30 ± 12.55	12.36 ± 12.06	5.57 ± 5.83	8.43 ± 7.48	0.069
Outcome, alive, n (%)	255 (95.15)	316 (95.47)	284 (96.93)	302 (96.49)	300 (95.24)	343 (96.08)	0.85

IVT, intentional/violent; MVC, motor vehicle crash.