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The Effects of the COVID-19 Pandemic on Penetrating Neurotrauma at a Level 1 Trauma Center

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- **BACKGROUND/OBJECTIVE:** The COVID-19 pandemic has had a profound impact on the global delivery of health care. Recent data suggest a possible impact of the pandemic on patterns of neurotrauma. The aim was to assess the impact of the pandemic on the incidence of neurotrauma, with a focus on cranial gunshot wounds (cGSWs) at a large Midwestern level 1 trauma center.

- **METHODS:** We conducted a retrospective review of our trauma registry from March through September 2020 and compared it to the same months in 2019. Odds ratios were utilized to assess for differences in patient demographics, injury characteristics, rates of neurotrauma, and rates of cGSWs.

- **RESULTS:** A total of 1188 patients presented with neurotrauma, 558 in 2019 and 630 in 2020. The majority of patients were male (71.33% in 2019; 68.57% in 2020) and Caucasian (78.67% in 2019; 75.4% in 2020). Patients presented with cGSWs more frequently in 2020 (n [270, 7.78%]) than in 2019 (n [158, 4.48%]). The odds of suffering a cGSW in 2020 was 73.6% higher than those in 2019 (95% confidence interval = [1.0871, 2.7722]; P = 0.0209). The etiology of such injury was most commonly assault (n [16, 21.62% in 2019; n [34, 45.95% in 2020]), followed by self-inflicted injury (n = 4, 5.41% in 2019; 12, 16.22% in 2020).

- **CONCLUSIONS:** Despite the government-mandated shutdown, we observed an increase in the number of neurotrauma cases in 2020. There was a significant increase in the incidence cGSWs in 2020, with an increase in assaults and self-inflicted injuries. Further investigation into socioeconomic factors for the observed increase in cGSWs is warranted.

**INTRODUCTION**

The first cases of COVID-19 were reported in Ohio on March 9, 2020. That day, a state of emergency was declared, with a stay-at-home order issued in Ohio on March 23 to slow the viral spread. The COVID-19 pandemic has stressed our health care system, with heavily publicized and politicized strains on finite resources. Shortages in personal protective equipment, ventilators, personnel, and vaccine stock have been recognized with concerted responses by governments and health care organizations. These challenges have pushed organizations to develop strategies for responding to future situations when health care resources may be limited. Characterization of health care utilization in times of crisis is a critical aspect of developing an informed crisis response during a pandemic with stay-at-home orders. One unexpected observed result of the pandemic was a shift in the patterns of neurotrauma. A few
studies have examined the rates of neurotrauma in 2020, most of which observed the incidence of neurotrauma in major metropolitan areas. One such study looked at the rates of neurotrauma in New York City. Using institutional data on neurotrauma admissions at Mount Sinai Morningside, the authors found a significant decrease in the number of neurotrauma cases during the early parts of the stay-at-home period.4 Ryder Trauma Center in Miami reported similar findings, showing a significant decline in neurotrauma admissions at the beginning of the pandemic.5 The authors hypothesized various reasons for these findings, including travel restrictions, business closures, and increases in psychosocial stress.4,5

While some centers have reported an overall decrease in the number of neurotrauma cases, there have been reports of increased rates of cranial gunshot wounds (cGSWs) during this period. For example, Miami reported a 12% proportional increase of cGSWs to total neurotrauma cases.5 The increase in gun violence in 2020 has been attributed primarily to psychosocial determinants of the pandemic.6 This is consistent with known worsening of mental health disorders and suicidal tendencies during times of major economic crises and natural disasters.7-9

As earlier studies have assessed specific regional trends, more studies are needed to generalize the pandemic’s effects on the incidence of neurotrauma. This work aimed to assess the impact of the pandemic on rates of neurotrauma at a large Midwestern level 1 trauma center responsible for providing trauma care for a population of approximately 2.2 million people. Specifically, we compare the impact of stay-at-home orders on cGSW incidence and present evidence to guide future policy management in times of mandated lockdown.

METHODS

A retrospective chart review of a prospectively maintained institutional trauma registry was performed using 2 distinct periods for comparison: March 2019–September 2019 and March 2020 through September 2020. The 7-month period from March to September 2020 represents our study’s time frame of interest. Neurotrauma was defined as cerebral, spinal, or ocular injuries in patients at presentation with a known traumatic mechanism. International Classification of Diseases—10 codes were used to query the registry (Supplementary Table 1). This query yielded 558 patients in 2019 and 630 patients in 2020, for a total of 1188 patients who presented to the emergency department. Of these patients, 90 had penetrating injuries, with 51 presenting following cGSWs (Figure 1).

Our study protocol is consistent with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines and received approval from our institutional review board with a waiver of the requirement to obtain informed consent and authorization for the use of protected health information as the research was determined to present no more than minimal risk.

For all neurotrauma patients, we extracted the following variables from the registry: age, race, gender, initial hospital Glasgow Coma Scale (GCS) score, head Abbreviated Injury Scale score, Injury Severity Score, mortality, and cause of trauma. Mechanisms of injury were categorized as falls, motor vehicle accidents, motorcycle crashes, GSWs, bicycle accidents, struck pedestrians, and “other.” To further characterize penetrating neurotrauma, individual electronic health records were reviewed for additional variables, including motive, pertinent medical history, pupillary response on arrival, initial/discharge GCS score, discharge disposition, and survival at 6 months after injury. For patients with penetrating neurotrauma, the past medical history (PMH), including alcohol use, drug use, terminal illness, history of depression, or any other psychiatric diagnosis, was also recorded. Computed tomography characteristics included the presence of intraventricular hemorrhage, basal cistern compression, injury anatomy, presence of multiple penetrating injuries, bullet trajectory, and transtentorial injury. Bullet trajectories were classified as tangential, penetrating, and perforating. A tangential trajectory was defined as oblique impact without bullet entry into the parenchyma, a penetrating trajectory was defined as a parenchymal injury with a retained missile, and a perforating trajectory was defined as a through-and-through parenchymal injury with identifiable cranial entry and exit wounds.

To assess total and penetrating neurotrauma changes between 2019 and 2020, groupings were analyzed for between-group differences as median ± interquartile range for continuous variables and percentage totals for categorical variables. To investigate the odds of presentation with any neurotrauma in 2020, odds ratios (ORs) were calculated for categorical variables. Demographics and injury characteristics were also examined for ORs with
significance verified utilizing Fisher’s exact test. Additionally, ORs were calculated for the PMH to investigate the odds conferred for presentation with penetrating neurotrauma during the period. A P value < 0.05 was determined to be statistically significant. Analysis was performed using SAS, version 9.4 (SAS, Cary, North Carolina, USA).

RESULTS
Total Neurotrauma
We observed 558 neurotrauma cases in 2019 and 630 in 2020 (OR = 1.129 [1.0071, 1.2657]). The mean age of patients identified was 53.0 years (range = 14–99) in 2019 and 48.9 years (range = 14–101) in 2020. There was no statistical significance in the racial makeup of the trauma population during the study period. Men comprised 71.3% of the patients identified in 2019 and 68.6% in 2020 (P = 0.03). Injury severity did not differ between study periods, with no differences observed in the initial hospital GCS score, head Abbreviated Injury Scale score, Injury Severity Score, or mortality between the 2 groups (Table 1). Significant differences were noted in the mechanism of injury between groups (Figure 2).

Patients in the 2020 group were less likely to have had cranial neurotrauma as a result of a fall (42.3% vs. 34.3%) (OR = 0.7119 [0.5627, 0.9005]) and more likely as a result of the GSW (4.48% vs. 7.78%) (OR = 1.7981 [1.0951, 2.9523]).

cGSW Characteristics
Comparisons for penetrating cranial injuries are summarized in Table 2. The mean age was 30.1 years in 2019 and 31.9 years in 2020. There were no significant differences between cGSW rates in either males or females. The racial distribution of

| Table 1. Neurotrauma Demographics 2019 versus 2020 |
|-------------------------------|-----------------|-----------------|
| Characteristic                | 2019 n (%)      | 2020 n (%)      | Fisher’s Table P (pr ≤ P) OR [95% CI] |
|-------------------------------|-----------------|-----------------|--------------------------------------|
| Number of traumas             | 558             | 630             | 1.1290 [1.0071, 1.2657]               |
| Age mean [Min–Max]            | 53.04 (14–99)   | 48.91 (14–101)  | <0.0001 (0.4821)                      |
| Race                          |                 |                 |                                      |
| White                         | 439 (78.67)     | 475 (75.40)     | 0.8307 [0.6330, 1.0902]               |
| Black                         | 89 (15.95)      | 121 (19.21)     | 1.2527 [0.9270, 1.6928]               |
| Asian                         | 7 (1.25)        | 5 (0.79)        | 0.6297 [0.3987, 1.9955]               |
| Hispanic                      | 13 (2.33)       | 19 (3.02)       | 1.3037 [0.6378, 2.6846]               |
| Other                         | 10 (1.79)       | 10 (1.59)       | 0.8830 [0.3651, 2.1396]               |
| Gender                        |                 |                 |                                      |
| Male                          | 398 (71.33)     | 432 (68.57)     | 0.8771 [0.6838, 1.1250]               |
| Female                        | 160 (28.67)     | 198 (31.43)     | 1.1461 [0.8889, 1.4623]               |
| Initial hospital GCS total mean [95% CI] | 11.84 [3.03, 20.65] | 11.54 [2.31, 20.78] | <0.0001 (–) |
| Head AIS mean [95% CI]        | 3.31 [1.14, 5.48] | 3.35 [1.12, 5.59] | –                                      |
| ISS mean [95% CI]             | 20.11 [4.02, 44.23] | 20.57 [4.58, 45.73] | –                                      |
| Outcome                       |                 |                 |                                      |
| Survived                      | 481 (96.20)     | 551 (87.60)     | 1.1308 [0.8067, 1.5853]               |
| Deceased                      | 77 (13.80)      | 78 (12.40)      | 0.8843 [0.6308, 1.2396]               |
| Mechanism of injury           |                 |                 | <0.0001 (–)                           |
| Fall                          | 236 (42.29)     | 216 (34.29)     | 0.7119 [0.5627, 0.9005]               |
| MVA                           | 122 (21.86)     | 143 (22.70)     | 1.0494 [0.7979, 1.3801]               |
| MCC                           | 58 (10.39)      | 64 (10.16)      | 0.9748 [0.6689, 1.4195]               |
| GSW                           | 25 (4.48)       | 49 (7.78)       | 1.7981 [1.0951, 2.9523]               |
| Bicycle                       | 10 (1.79)       | 8 (1.27)        | 0.7048 [0.2762, 1.7985]               |
| Pedestrian                    | 20 (3.58)       | 18 (2.86)       | 0.7912 [0.4142, 1.5114]               |
| Other                         | 87 (15.61)      | 132 (20.94)     | 4.0850 [2.7482, 6.0723]               |

Bold values indicate results were significant.
OR, odds ratio; CI, confidence interval; GCS, Glasgow Coma Scale; AIS, Abbreviated Injury Scale; ISS, Injury Severity Score; GSW, gunshot wound; MVA, motor vehicle accidents; MCC, motorcycle crash.
penetrating cranial injuries significantly differed across both periods (\(P = 0.0134\)), with black people presenting with the highest proportion of penetrating cranial injuries (50.0% in 2019 and 48.3% in 2020). In contrast, black people only made up 15.95% in 2019 and 19.21% in 2020 of the total neurotrauma admissions. The most common motive for cGSWs in both years was assault (56.7% vs. 60.0%), followed by self-inflicted (13.3% vs. 20.0%) and accidental (20.0% vs. 18.3%) injuries. The difference in motive observed between 2019 and 2020 was statistically significant (\(P = 0.0043\)). The PMH was not associated with increased odds of presenting with a cGSW. Of the penetrating injuries, 44.4% of patients had imaging for review with intracranial findings. The remaining patients did not have imaging obtained upon arrival, likely due to clinical instability or death on arrival. There were no significant differences between groups regarding intraventricular hemorrhage, basal cistern compression, or ventricle involvement. There were no significant differences between mean arrival and discharge GCS scores (Table 2). There was a statistically significant difference in the proportion of patients presenting with bilaterally reactive pupils (\(P = 0.0025\)), increasing from 48.3% in 2019 to 59.3% in 2020. This was an observed increase in the rate of discharge home from 27.6% in 2019 to 37.3% in 2020 (\(P = 0.0002\)). This correlated with an increase in survival rate at 6 months from 41.4% in 2019 to 54.2% in 2020 (\(P = 0.0188\)).

DISCUSSION

Traumatic injuries, intentional and unintentional, are the leading cause of death in individuals younger than 45 years of age and the third leading cause of death across all age groups.\(^{10}\) There were nearly 61,000 traumatic brain injury—related deaths in 2019.\(^{11}\) Our data demonstrate a 12.9% increase in neurotrauma rates in the equivalent 6-month period between 2019 and 2020. We found that the proportion of mechanisms of injury changed with the pandemic, with a decrease in falls and an increase in penetrating neurotrauma (Table 1). The change in the proportion of falls may be secondary to social distancing recommendations, with fewer citizens traveling out of their homes for recreation and work. Since the pandemic, 71% of Americans have transitioned to work from home, a 51% increase when compared to rates prior to the pandemic.\(^{12}\) No significant differences in the mechanism of injury were noted between age groups.

Significant differences in the discharge disposition (\(P = 0.0002\)) and survival at 6 months (\(P = 0.0188\)) were observed. The 2020 group had a higher proportion of patients discharged home with penetrating injuries. The reason for this is unclear, given a lack of significant differences between groups in mean arrival GCS score, discharge GCS score, and imaging characteristics. One hypothesis for the increased rates of discharge home is that there were barriers to facility placement in 2020 due to restrictions on family visitation, facility capacity, nursing home capacity, and fear of viral exposure.\(^{13-15}\) Another possible explanation is that the injury patterns seen in 2020 were less severe than those seen in 2019. We did note significantly more patients in 2020 with bilaterally reactive pupils, which is a favorable prognostic marker. However, we did not find significant differences in radiographic and clinical characteristics of injury severity due to the low number of events. In our study, we collected the discharge GCS score; however, better characterization of a patient’s functional capacity to carry out activities of daily living, such as the modified Rankin Scale, may be helpful to explain differences in discharge disposition further.

In addition to the increase in penetrating injuries, a significant increase in the mechanisms of assault and self-inflicted injuries was seen in 2020, with rates doubling and tripling, respectively (Table 2). The increase in total and self-inflicted penetrating injuries seen in our cohort could be secondary to the psychosocial effects of mandatory isolation and associated increased risk of
Table 2. Penetrating Cranial Injuries Demographics 2019 versus 2020

| Characteristic                  | Full Sample (n = 90) | 2019 (n = 30) (%) | 2020 (n = 60) (%) | P-value Fisher’s Table (pr ≤ P) |
|---------------------------------|----------------------|-------------------|-------------------|---------------------------------|
| Age mean (Min-Max)              | 31.32 (14—86)        | 30.10 (16—63)     | 31.93 (14—86)     | –                               |
| Gender                          |                      |                   |                   | 0.0779 (0.0926)                  |
| Female                          | 6 (6.67)             | 4 (13.33)         | 2 (3.33)          |                                 |
| Male                            | 84 (93.33)           | 26 (86.67)        | 58 (96.67)        |                                 |
| Race                            |                      |                   |                   | 0.0134 (0.7096)                  |
| White                           | 39 (43.33)           | 12 (40.00)        | 27 (45.00)        |                                 |
| Black                           | 44 (48.89)           | 15 (50.00)        | 29 (48.33)        |                                 |
| Asian                           | 1 (1.11)             | 1 (3.33)          | 0                 |                                 |
| Hispanic                        | 5 (5.56)             | 2 (6.67)          | 3 (5.00)          |                                 |
| Other                           | 1 (1.11)             | 0                 | 1 (1.67)          |                                 |
| Motive                          |                      |                   |                   | 0.0043 (0.3323)                  |
| Assault                         | 53 (58.89)           | 17 (56.67)        | 36 (60.00)        |                                 |
| Self                            | 16 (17.78)           | 4 (13.33)         | 12 (20.00)        |                                 |
| Accident                        | 17 (18.89)           | 6 (20.00)         | 11 (18.33)        |                                 |
| Unknown/other                   | 4 (4.44)             | 3 (10.00)         | 1 (1.67)          |                                 |
| History*                        | n                    | n                 | n                 | OR (P)                          |
| Alcohol                         | 5                    | 2                 | 3                 | 0.74 (0.75)                      |
| Drug                            | 5                    | 2                 | 3                 | 0.74 (0.75)                      |
| Terminal                        | 0                    | 0                 | 0                 | –                               |
| Depression                      | 13                   | 4                 | 9                 | 1.15 (0.83)                      |
| Psychiatric                     | 13                   | 4                 | 9                 | 1.15 (0.83)                      |
| None                            | 40                   | 15                | 25                | 0.71 (0.45)                      |
| Unknown                         | 26                   | 8                 | 18                | 1.18 (0.74)                      |
| Pupil response on arrival       |                      |                   |                   | 0.0025 (0.2959)                  |
| Both reactive                   | 49 (55.68)           | 14 (48.28)        | 35 (59.32)        |                                 |
| None reactive                   | 27 (30.68)           | 13 (44.83)        | 14 (23.73)        |                                 |
| One reactive                    | 4 (4.55)             | 1 (3.45)          | 3 (5.08)          |                                 |
| Globe rupture                   | 7 (7.95)             | 1 (3.45)          | 6 (10.17)         |                                 |
| Unknown                         | 1 (1.14)             | 0                 | 1 (1.69)          |                                 |
| Neurosurgery GCS mean [95% CI]  | 9.27 [-1.21,19.74]   | 9.47 [-1.79,20.72]| 9.17 [-1.12,19.46]| –                               |
| Discharge GCS mean [95% CI]     | 10.32 [-0.61,21.24]  | 9.54 [-1.94,21.01]| 10.70 [0.07,21.34]| –                               |
| Discharge disposition           |                      |                   |                   | 0.0002 (0.3418)                  |
| Home                            | 30 (34.09)           | 8 (27.59)         | 22 (37.29)        |                                 |
| SNF                             | 1 (1.14)             | 0                 | 1 (1.69)          |                                 |
| IPR                             | 1 (1.14)             | 1 (3.45)          | 0                 |                                 |
| LTACH                           | 7 (7.95)             | 3 (10.34)         | 4 (6.78)          |                                 |
| Expired                         | 23 (26.14)           | 11 (37.93)        | 12 (20.34)        |                                 |
| Withdrawal of care              | 9 (10.23)            | 2 (6.90)          | 7 (11.86)         |                                 |
While Mount Sinai Morningside is a level 2 trauma center in a major metropolitan setting, its prepandemic volumes largely mirror the other parts of the country prior to their shutdown. Ryder Trauma Center in Miami, FL, is a level 1 trauma center; however, the other large urban centers in the region had much smaller volumes in its catchment area, compared to other large urban centers. The increased rate of neurotrauma in our cohort highlights the need for hospitals to anticipate and be prepared for increased encounters when another pandemic arises despite alterations to activity. One significant improvement in care delivery that occurred due to the pandemic was the widespread adoption of telemedicine. However, the severity of the cases at our institution reinforces the importance of having adequate neurosurgical coverage at trauma centers even during a high resource utilization time such as a pandemic. In addition, the rates of trauma, especially neurotrauma, during a stay-at-home period can have a more considerable impact than solely hospital coverage and data reporting. Policymakers can use these data to anticipate what regions and health care centers will be expected to see an increase in population number and resource utilization during situations in which large amounts of the population are required to quarantine. An example is the significant exodus of people from heavily populated urban centers to more suburban and rural regions. The increased rates of cGSWs can potentially influence gun law policy and represent the need for accessible and affordable mental health resources.

**Limitations**

Our study is not without limitations. First, our data include data from a single institution in a metropolitan Midwestern city that is the only level one trauma center in this region, so presumably, our center receives the most severe cases, including penetrating neurotrauma. This impacts the generalizability of our study for primarily urban environments but offers a generalizable population study for other Midwest cities. Additionally, it is unknown how many neurotrauma patients expired at the scene or arrived at outside institutions with unsurvivable injuries. Many patients in our registry often had incomplete data regarding specifics of their movements during their shutdown or over the same period in Ohio. In addition, it was reported that many individuals left the city for other parts of the country prior to their shutdown. Ryder Trauma Center in Miami, FL, is a level 1 trauma center; however, the study period was truncated from the onset of the stay-at-home period (March 1, 2020, to April 30, 2020). Our study was performed after the conclusion of the stay-at-home period (May 29, 2020), which allowed for the analysis of trends across multiple months. Therefore, we believe our study contributes to previous publications that investigated neurotrauma during the stay-at-home period. Our institution looks into a Midwest level 1 trauma center that services a mix of urban, suburban, and rural communities in its catchment area, compared to other large urban studies.

The increased rate of neurotrauma in our cohort highlights the need for hospitals to anticipate and be prepared for increased encounters when another pandemic arises despite alterations to activity. One significant improvement in care delivery that occurred due to the pandemic was the widespread adoption of telemedicine. However, the severity of the cases at our institution reinforces the importance of having adequate neurosurgical coverage at trauma centers even during a high resource utilization time such as a pandemic. In addition, the rates of trauma, especially neurotrauma, during a stay-at-home period can have a more considerable impact than solely hospital coverage and data reporting. Policymakers can use these data to anticipate what regions and health care centers will be expected to see an increase in population number and resource utilization during situations in which large amounts of the population are required to quarantine. An example is the significant exodus of people from heavily populated urban centers to more suburban and rural regions. The increased rates of cGSWs can potentially influence gun law policy and represent the need for accessible and affordable mental health resources.

**Table 2. Continued**

| Characteristic | Full Sample (n = 90) | 2019 (n = 30) (%) | 2020 (n = 60) (%) | P-value Fisher’s Table (pr ≤ P) |
|---------------|---------------------|------------------|------------------|-------------------------------|
| Survival at 6 months |                     |                  |                  |                               |
| Yes           | 44 (50.00)          | 12 (41.38)       | 32 (54.24)       | 0.0188 (0.3670)               |
| No            | 33 (37.50)          | 14 (48.28)       | 19 (32.20)       |                               |
| Unknown       | 11 (12.50)          | 3 (10.34)        | 8 (13.56)        |                               |

CI, confidence interval; GCS, Glasgow Coma Scale; SNF, skilled nursing facility; IPR, inpatient rehab; LTACH, long term acute care hospital.

*Responses are not exclusive.

**CONCLUSION**

The COVID-19 pandemic, with its stay-at-home orders and changes in behavior, is associated with significant changes in patterns of neurotrauma, with an observed increase in patient volumes and incidence of cGSWs at our institution. Psychosocial aspects of the lockdowns and the economic impact of the pandemic may have contributed to increased rates of assault and self-inflicted penetrating injuries. While other centers have published decreased rates...
of neurotrauma, our experience highlights the importance of continued preservation of resources and flexibility for rapid expansion of hospital capacity in the event of a future pandemic or situation when health care resources may be limited. Understanding health care utilization in times of crisis is critical to developing response plans in the future, which may need to be tailored to the geographic region of interest.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

George L. Yang: Conceptualization, Methodology, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Project administration. Mark D. Johnson: Conceptualization, Methodology, Writing — original draft, Writing — review & editing, Visualization, Project administration. Daniel Solomon: Conceptualization, Investigation, Data curation, Writing — original draft, Writing — review & editing, Visualization, Project administration. Andrew M. Ferguson: Methodology, Formal analysis, Writing — review & editing. Reid A. Johnson: Conceptualization, Writing — review & editing. Christina Gerges: Conceptualization, Writing — review & editing. James M. Wright: Conceptualization, Writing — review & editing. Ann M. Parr: Conceptualization, Writing — review & editing. Laura B. Ngwe-nya: Conceptualization, Methodology, Writing — review & editing, Supervision, Project administration.

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### Supplementary Table 1. Trauma Registry International Classification of Diseases–10 Codes

| Category | Category Descriptor | Etiology, Anatomic Site, Severity, Extension |
|----------|---------------------|---------------------------------------------|
| T54      | Toxic effect of corrosive substances | 3X1A                                         |
| T65      | Toxic effect of other and unspecified substances | 891A                                         |
| T71      | Asphyxiation | 162A                                         |
| V00      | Pedestrian conveyance accident | 131A                                         |
| V03      | Pedestrian injured in collision with a car, pick-up truck, or van | 00XA, 10XA, 19XA, 99XA                     |
| V04      | Pedestrian injured in collision with a heavy transport vehicle or bus | 00XA, 10XA                                  |
| V05      | Pedestrian injured in collision with a railway train or railway vehicle | 00XA, 10XA, 90XA                            |
| V09      | Pedestrian injured in other and unspecified transport accidents | 20XA, 29XA                                  |
| V11      | A pedal cycle rider injured in collision with the other pedal cycle | 0XXA                                        |
| V13      | A pedal cycle rider injured in collision with a car, pick-up truck, or van | 4XXA                                        |
| V14      | A pedal cycle rider injured in collision with a heavy transport vehicle or bus | 4XXA                                        |
| V17      | A pedal cycle rider injured in collision with a fixed or stationary object | 4XXA                                        |
| V18      | A pedal cycle rider injured in noncollision transport accident | 0XXA, 4XXA                                  |
| V19      | A pedal cycle rider injured in other and unspecified transport accidents | 49XX                                        |
| V20      | A motorcycle rider injured in collision with a pedestrian or animal | 0XXA, 4XXA                                  |
| V22      | A motorcycle rider injured in collision with a two- or three-wheeled motor vehicle | 4XXA                                        |
| V23      | A motorcycle rider injured in collision with a car, pick-up truck, or van | 4XXA, 5XXA, 9XXA                            |
| V24      | A motorcycle rider injured in collision with a heavy transport vehicle or bus | 4XXA                                        |
| V27      | A motorcycle rider injured in collision with a fixed or stationary object | 0XXA, 4XXA, 5XXA                            |
| V28      | A motorcycle rider injured in noncollision transport accident | 0XXA, 1XXA, 4XXA, 5XXA                      |
| V29      | A motorcycle rider injured in other and unspecified transport accidents | 40XX, 9XXA                                  |
| V43      | A car occupant injured in collision with a car, pick-up truck, or van | 51XX, 52XX, 53XX, 62XX, 63XX, 92XX           |
| V44      | A car occupant injured in collision with a heavy transport vehicle or bus | 5XXA, 6XXA                                  |
| V47      | A car occupant injured in collision with a fixed or stationary object | 0XXA, 1XXA, 5XXA, 6XXA                      |
| V48      | A car occupant injured in noncollision transport accident | 1XXA, 2XXA, 4XXA, 5XXA, 6XXA, 8XXA, 9XXA     |
| V49      | A car occupant injured in other and unspecified transport accidents | 40XXA, 49XXA, 50XXA, 58XXA, 88XXA, 9XXA     |
| V53      | An occupant of a pick-up truck or van injured in collision with a car, pick-up truck, or van | 5XXA, 6XXA                                  |
| V54      | An occupant of a pick-up truck or van injured in collision with a heavy transport vehicle or bus | 5XXA, 6XXA                                  |
| V57      | An occupant of a pick-up truck or van injured in collision with a fixed or stationary object | 5XXA, 6XXA                                  |
| V58      | An occupant of a pick-up truck or van injured in noncollision transport accident | 5XXA, 6XXA                                  |
| V59      | An occupant of a pick-up truck or van injured in other and unspecified transport accidents | 40XXA, 50XXA, 9XXA                          |
| V68      | An occupant of a heavy transport vehicle injured in noncollision transport accident | 4XXA, 6XXA                                  |
| V80      | An animal rider or occupant of an animal-drawn vehicle injured in transport accident | 010A, 918A                                  |
| V84      | An occupant of a special vehicle mainly used in agriculture injured in transport accident | 0XXA, 5XXA                                  |
| V85      | An occupant of a special construction vehicle injured in transport accident | 5XXA                                        |
| V86      | An occupant of a special all-terrain or other off-road motor vehicle injured in transport accident | 05XXA, 09XXA, 55XXA, 56XXA, 58XXA, 65XXA, 69XXA |
| Category | Category Descriptor | Etiology, Anatomic Site, Severity, Extension |
|----------|---------------------|------------------------------------------|
| V89      | Motor or nonmotor vehicle accident, type of vehicle unspecified | 2XXA |
| V91      | Other injury due to accident to watercraft | 8XXA |
| V96      | Accident to nonpowered aircraft causing injury to the occupant | 12XA |
| W01      | Fall on the same level from slipping, tripping, and stumbling | 0XXA, 190A, 198A |
| W03      | Other fall on the same level due to collision with another person | XXXA |
| W05      | Fall from a nonmoving wheelchair, nonmotorized scooter, and motorized mobility scooter | 0XXA |
| W06      | Fall from a bed | XXXA |
| W07      | Fall from a chair | XXXA |
| W09      | Fall on and from playground equipment | 8XXA |
| W10      | Fall on and from stairs and steps | 0XXA, 1XXA, 8XXA, 9XXA |
| W11      | Fall on and from a ladder | XXXA |
| W13      | Fall from, out of, or through building or structure | 0XXA, 1XXA, 2XXA, 4XXA, 8XXA |
| W14      | Fall from a tree | XXXA |
| W16      | Fall, jump, or diving into water | 022A, 522A, 92XA |
| W17      | Other fall from one level to another | 4XXA, 89XA |
| W18      | Other slipping, tripping, and stumbling and falls | 01XA, 09XA, 11XA, 12XA, 20XXA, 30XXA, 39XA |
| W19      | Unspecified fall | XXXA |
| W20      | Struck by a thrown, projected, or falling object | 8XXA |
| W21      | Striking against or struck by sports equipment | 02XA, 03XA, 04XA, 07XA, 8XXA |
| W22      | Striking against or struck by other objects | 8XXA |
| W25      | Contact with sharp glass | XXXA |
| W26      | Contact with other sharp objects | 0XXA, 8XXA |
| W27      | Contact with a nonpowered hand tool | 0XXA |
| W29      | Contact with other powered hand tools and household machinery | 4XXA |
| W30      | Contact with agricultural machinery | 8XXA |
| W31      | Contact with other and unspecified machinery | 1XXA, 89XA |
| W32      | Accidental handgun discharge and malfunction | 0XXA |
| W34      | Accidental discharge and malfunction from other and unspecified firearms and guns | 0XXA |
| W37      | Explosion and rupture of a pressurized tire, pipe, or hose | 8XXA |
| W39      | Discharge of firework | XXXA |
| W40      | Explosion of other materials | 8XXA |
| W50      | Accidental hit, strike, kick, twist, bite, or scratch by another person | 1XXA |
| W51      | Accidental striking against or bumped into by another person | XXXA |
| W54      | Contact with dog | 0XXA |
| W55      | Contact with other mammals | 12XXA, 22XA |
| X00      | Exposure to uncontrolled fire in building or structure | 0XXA, 1XXA |
| X04      | Exposure to ignition of highly flammable material | XXXA |
| X06      | Exposure to ignition or melting of other clothing and apparel | 2XXA |
| X08      | Exposure to other specified smoke, fire, and flames | 8XXA |
| X10      | Contact with hot drinks, food, fats, and cooking oils | 2XXA |

Continues
| Category | Category Descriptor                                                                 | Etiology, Anatomic Site, Severity, Extension |
|----------|-------------------------------------------------------------------------------------|---------------------------------------------|
| X12      | Contact with other hot fluids                                                      | XXXA                                        |
| X58      | Exposure to other specified factors                                                 | XXXA                                        |
| X72      | Intentional self-harm by handgun discharge                                          | XXXA                                        |
| X73      | Intentional self-harm by rifle, shotgun, and larger firearm discharge                | 1XXA                                        |
| X74      | Intentional self-harm by other and unspecified firearm and gun discharge             | 8XXA                                        |
| X76      | Intentional self-harm by smoke, fire, and flames                                     | XXXA                                        |
| X80      | Intentional self-harm by jumping from a high place                                   | XXXA                                        |
| X82      | Intentional self-harm by crashing of a motor vehicle                                | 8XXA                                        |
| X83      | Intentional self-harm by other specified means                                      | 8XXA                                        |
| X93      | Assault by handgun discharge                                                        | XXXA                                        |
| X94      | Assault by rifle, shotgun, and larger firearm discharge                              | 0XXA                                        |
| X95      | Assault by other and unspecified firearm and gun discharge                           | 8XXA                                        |
| X99      | Assault by a sharp object                                                           | 1XXA, 8XXA                                 |
| Y00      | Assault by a blunt object                                                           | XXXA                                        |
| Y03      | Assault by crashing of a motor vehicle                                              | 0XXA                                        |
| Y04      | Assault by bodily force                                                             | 0XXA, 2XXA, 8XXA                           |
| Y08      | Assault by other specified means                                                    | 02XXA, 89XXA                               |
| Y09      | Assault by unspecified means                                                        |                                             |
| Y22      | Handgun discharge, undetermined intent                                              | XXXA                                        |
| Y29      | Contact with a blunt object, undetermined intent                                    | XXXA                                        |
| Y35      | Legal intervention                                                                  | 003A, 891A                                 |