Survivors of Self-inflicted Gunshot Wounds to the Head Characterization of Ocular Injuries and Health Care Costs

Amit K. Reddy, BS; Meredith S. Baker, MD; Rachel K. Sobel, MD; David A. Whelan, MHA; Keith D. Carter, MD; Richard C. Allen, MD, PhD

IMPORTANCE Suicides and attempted suicides are major public health issues in the United States and around the world. Self-inflicted gunshot wounds (SIGSWs) are a common method of attempting suicide, the head being the most commonly injured body region; however, the literature lacks an overview of the orbital and ocular injuries as well as outcomes associated with SIGSWs.

OBJECTIVES To characterize the ocular and orbital injuries and outcomes of patients presenting with SIGSWs and to examine the cost associated with these injuries.

DESIGN, SETTING, AND PARTICIPANTS Retrospective medical record review was performed of all patients who presented to the University of Iowa Hospitals and Clinics between 2003 to 2013 with the admitting diagnosis of self-inflicted injuries via firearms. Patients with no periorbital or ocular injuries and/or those who did not survive for at least 2 months following the incident were excluded.

MAIN OUTCOMES AND MEASURES Ocular injuries and outcomes and health care costs and reimbursements, which were generated by a financial report obtained from the hospital finance department that included data from both the hospital billing and cost accounting systems.

RESULTS All patients in this study (n = 18) were men with a mean age of 47.2 years. Eight patients (44.4%) displayed submental missile entry points, 7 (38.9%) displayed intraoral entry points, and 3 (16.7%) displayed pericranial entry points. Patients with pericranial entries sustained more severe ocular injuries and had poorer ocular outcomes. Seven patients (38.9%) were found at final follow-up to have visual acuity of 20/40 or better in each eye and all showed missile trajectories in the sagittal plane. The mean cost of treatment of these patients totaled $117,338 while the mean reimbursement amount was $124,388.

CONCLUSIONS AND RELEVANCE Data regarding ocular injuries and outcomes may assist ophthalmologists in the treatment of patients with SIGSWs in the future. Many patients had extremely functional vision at final follow-ups, which highlights the importance of specialists conducting examinations and reconstructive procedures promptly, carefully, and thoroughly. Cost and reimbursement data suggest that while these cases place a large financial burden on society, they may not burden hospital systems in the same way.

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Suicides and attempted suicides are major public health issues in the United States and around the world. According to the Centers for Disease Control and Prevention, suicide was the 10th leading cause of death in the United States in 2010. The most common method of successful suicide attempts was self-inflicted gunshot wounds (SIGSWs), and more than 75% were SIGSWs to the head. A number of studies have examined the risk factors associated with patients who present with SIGSWs to the head. Overall, these patients are more likely to be white, men, and unemployed. In addition, psychiatric risk factors include substance abuse and histories of major depression or bipolar disorder.

For every successfully completed suicide there are more than 12 unsuccessful attempts. However, surviving an SIGSW is relatively rare and makes up only 1% of all failed suicide attempts. Those who attempt suicide via SIGSW are relatively less likely to survive compared with those who use other methods of suicide. Additionally, it has been estimated that SIGSWs to the head are approximately 40% more lethal than gunshot wounds to other areas of the body.

Previous studies have discussed factors that make survival of an SIGSW more or less likely. Selden et al noted that 98% of patients with a score of 8 or less on the Glasgow Coma Scale did not survive. The orientation of the gun also appears to play a role in that missiles traveling in the sagittal direction are less lethal than ones traveling in the coronal direction. The importance of missile trajectory may be secondary to the different intracranial injuries, as injuries to the brain ventricular system or to both cerebral hemispheres were also associated with increased mortality. The positioning and type of firearm used may also impact lethality. Some researchers postulate that the use of long-barreled firearms placed underneath the chin causes the neck to be hyperextended, resulting in a missile trajectory that avoids intracranial structures. The use of handguns may lead to a reflex jerk that also extends the neck, causing a similar pathway, missing the brain.

Several studies have examined the reconstructive processes and outcomes for patients with SIGSWs, focusing on the brain, face, lower face, and midface. Although ocular injuries in these patients are often noted, existent literature lacks an overview of ocular injuries and outcomes associated with SIGSWs. Desai and Mahon reported a patient who had blindness in both eyes as a result of an SIGSW to the head. Additionally, Keane reported 4 cases of blindness after SIGSWs to the head, but details of these patients are limited.

The ophthalmologist often plays an important role in treating survivors of SIGSWs to the head. Patients who survive these episodes frequently exhibit missile trajectories that avoid more posterior structures of the head; however, this increases the likelihood of paths that include the periorbital region. We propose to analyze ophthalmologic data from SIGSWs to help ophthalmologists predict and treat common periorbital injuries in these incidents.

In addition to the physical and psychological burdens endured by the survivors of SIGSWs, there is also a financial burden on society. Along with the income lost while these patients are hospitalized, complex reconstructive procedures consume significant physician and hospital resources. By examining the cost and reimbursement data for these patients, we hope to contribute important information to the public policy debate surrounding firearms and medical and psychiatric care in the United States.

Methods
A retrospective review was performed of patients who presented to the University of Iowa Hospitals and Clinics (UIHC) between 2003 to 2013 with the admitting diagnosis of self-inflicted injuries via firearms. Institutional review board approval was obtained from the University of Iowa Hospitals and Clinics with a waiver of consent, due to the retrospective nature of the study, and 35 patients were identified. There were no patients with the admitting diagnosis whose medical records were not identified. Thirteen patients were excluded because they lacked periorbital or ocular injuries, 2 were excluded because they did not survive for at least 2 months following the incident, 1 patient was excluded because he did not have periorbital or ocular injuries and also did not survive at least 2 months, and 1 patient was excluded because complete medical records were unavailable. Eighteen patients were included. The following data were collected: age, sex, type of firearm used, trajectory of missile, ocular and orbital examination findings, ocular and orbital surgeries, time of final follow-up, ocular and orbital examination findings at final follow-up, admitting characterization of injury to the head, all other reconstructive surgeries, length of initial hospitalization, insurance provider, and previous medical and psychiatric histories.

Financial reports were obtained from the hospital finance department for all patients except for 2 (cases 1 and 2), for whom the reports were unable to be obtained. The financial report included data from both the billing and cost accounting systems. The billing system captured reimbursements to the hospital by either the patient or the patient’s health insurance provider. The cost accounting system estimated cost based on a combination of factors including staff time and expenses specifically allocated to a patient encounter. These factors included amount of supplies and drugs used and their cost to the hospital, the historical cost to use an operating room calculated on a per-minutes basis, costs associated with an inpatient bed per day, and an allocation of overhead, all of which are costs that exist in a hospital regardless of census or procedural volume. The UIHC’s cost accounting system is significantly more sophisticated than those at most academic medical centers, which assign cost based on a percentage of charges without attempting to link specific costs to a patient’s encounter. One way to interpret these 2 data points (reimbursements and costs) is that reimbursements represent the economic impact to society while costs represent how much the hospital spent to treat that patient.

Results
All patients in the study were men, 18 of whom met criteria for inclusion (Table 1). The mean age at the time of the SIGSW...
was 47.2 years, with a range of 18 to 85 years. Follow-up times ranged from 2 weeks to 52 months, with a mean of 18 months, median of 14 months, and interquartile range of 20 months. Nine patients used handguns (.22, .25, .38, .45, and unknown

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Table 1. Ocular and Orbital Details of Patients With Self-inflicted Gunshot Wound

<table>
<thead>
<tr>
<th>Case No./Sex/ Age, y</th>
<th>Weapon</th>
<th>Trajectory</th>
<th>Ocular</th>
<th>Orbital</th>
<th>Ocular/Orbital Surgeries</th>
<th>Follow-up, mo</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/18</td>
<td>Shotgun</td>
<td>Entry submental, bullet fragments into frontal brain region, sagittal</td>
<td>NLP OD; CF 1 ft, OS; choroidal rupture, hyphema, left eye</td>
<td>Periorbital ecchymosis, right; orbit fractures, bilateral; ecotropion, right lower eyelid; hemorrhage, left</td>
<td>None</td>
<td>52</td>
<td>Right: anophthalmia, hypertelorism; left: 20/120, full EOM and visual fields</td>
</tr>
<tr>
<td>2/M/52</td>
<td>.22 Handgun</td>
<td>Entry mouth, bullet fragments into left maxillary sinus and orbit, sagittal</td>
<td>20/50 OD; NLP OS; ruptured globe, left eye</td>
<td>Orbit fractures, left; palpebral conjunctiva wound, left; laceration, left lower eyelid</td>
<td>Exploration of open globe, left; enucleation, left; laceration repair, left lower eyelid</td>
<td>15</td>
<td>Right: 20/20, full EOM and visual fields; left: anophthalmia, orbit fractures</td>
</tr>
<tr>
<td>3/M/61</td>
<td>Handgun</td>
<td>Entry midforehead, bullet fragments into frontal brain region, frontal sinuses, right orbit axial</td>
<td>NLP OD; 20/40 OS; RAPD, right; sluggish pupillary response, left</td>
<td>Orbit fractures, right; hemorrhage, right; optic nerve injury, right; proptosis, right</td>
<td>None</td>
<td>2</td>
<td>Right: NLP; EOM deficiency in all directions; left: 20/20, full EOM and visual fields</td>
</tr>
<tr>
<td>4/M/45</td>
<td>.22 Rifle</td>
<td>Entry mouth, bullet into right frontal and parietal lobes, sagittal</td>
<td>20/40 OD; 20/25 OS; sluggish pupillary response, right; EOM deficiency in all directions, right</td>
<td>Periorbital ecchymosis, right; orbit fractures, right; hemorrhage, right; chemosis, right</td>
<td>None</td>
<td>2</td>
<td>Right: 20/20, full EOM and visual fields; light sensitivity, proptosis, problems focusing; left: 20/20, full EOM and visual fields</td>
</tr>
<tr>
<td>5/M/19</td>
<td>.22 Handgun</td>
<td>Entry mouth, bullet into left frontal brain region, sagittal</td>
<td>20/30 OD; NLP OS; RAPD (left eye); EOM deficiency in all directions, left; severe pain, left eye</td>
<td>Orbit fractures, left; ptosis, left upper eyelid</td>
<td>Evisceration, left; temporal tarsorrhaphy, left; ptosis repair (external levator advancement), left</td>
<td>34</td>
<td>Right: 20/16, full EOM and visual fields; left: anophthalmia</td>
</tr>
<tr>
<td>6/M/85</td>
<td>.25 Handgun</td>
<td>Entry mouth, exit left zygoma area, sagittal</td>
<td>20/40 OD; 20/200 OS (no change from prior to SIGSW); chronic ET, left; amблиопия, left</td>
<td>Orbit fractures, left</td>
<td>None</td>
<td>0.5</td>
<td>Right: 20/40, full visual fields and EOM; left: 20/200; full visual fields, EOM deficiency due to chronic ET, amблиопия, orbit fractures</td>
</tr>
<tr>
<td>7/M/46</td>
<td>.22 Handgun</td>
<td>Entry mouth, bullet fragments into right posterior frontal lobe, sagittal</td>
<td>NLP OD; LP OS; RAPD right eye</td>
<td>Orbit fractures, right; hemorrhage, right; optic nerve injury, right; proptosis, right; CN III injury, right; laceration, upper right eyelid; chemosis, right</td>
<td>Cantharotomy/ cantholysis, right lower and upper eyelids</td>
<td>11</td>
<td>Right: NLP, RAPD, sensory exotropia; left: 20/70, full EOM, temporal field vision loss</td>
</tr>
<tr>
<td>8/M/55</td>
<td>Shotgun</td>
<td>Entry submental, exit right zygoma, supraorbital nasal wall, sagittal</td>
<td>20/125 OD; 20/40 OS; efferent pupillary defect, right; EOM deficiency in all directions, right; EOM deficiency supra, left</td>
<td>Orbit fractures, bilateral; laceration, right upper and lower eyelids; enophthalmos, right; chemosis, bilateral</td>
<td>Laceration repair, right; orbital floor fracture repair, right</td>
<td>49</td>
<td>Right: 20/20, full visual fields and EOM, efferent pupillary defect, enophthalmos; left: 20/15; EOM defect supra, full visual fields</td>
</tr>
<tr>
<td>9/M/66</td>
<td>Shotgun</td>
<td>Entry mouth, bullet fragments into frontal brain region, sagittal</td>
<td>CF OD; NLP OS; ruptured globe, left eye; sluggish pupillary response, right</td>
<td>Orbit fractures, bilateral, laceration, left eyelid</td>
<td>Exploration and repair of open globe, left; laceration repair, left eyelid; enucleation, left eyelid; secondary ocular implant, left; temporary tarsorrhaphy, left</td>
<td>47</td>
<td>Right: 20/25, 20/25 pinhole, full visual fields and EOM, pseudophakia; left: anophthalmia</td>
</tr>
<tr>
<td>10/M/58</td>
<td>.20 Shotgun</td>
<td>Entry submental, bullet fragments into left zygoma/ temporal region, sagittal</td>
<td>Unable to assess vision, bilateral; sluggish pupillary response, right</td>
<td>Periorbital ecchymosis, left; chemosis, bilateral</td>
<td>None</td>
<td>26</td>
<td>Bilateral: full recovery</td>
</tr>
<tr>
<td>11/M/80</td>
<td>Shotgun</td>
<td>Entry mouth, exit right zygoma region, sagittal</td>
<td>20/40 OD; 20/60 OS</td>
<td>Orbit fractures, right; ecotropion, right; exposure keratopathy, right; chemosis, right; CN VII palsy, right</td>
<td>Inferior orbital rim repair, right; ecotropion repair, right lower eyelid; right medial pilar tarsorrhaphy</td>
<td>3</td>
<td>Right: 20/30, 20/30 pinhole, full EOM and visual fields, enophthalmos, mild chemosis, mild SPK; left: 20/30, 20/30 pinhole, full EOM and visual fields</td>
</tr>
<tr>
<td>12/M/49</td>
<td>.45 Handgun</td>
<td>Entry submental, bullet fragments into frontal sinuses, sagittal</td>
<td>CF OD; LP OS; RAPD left eye</td>
<td>Periorbital ecchymosis, bilateral; orbit fractures, bilateral, laceration, left upper and lower eyelids</td>
<td>Repair of canalicular laceration, left; orbital floor fracture repair, left</td>
<td>19</td>
<td>Right: 20/30, full EOM and visual fields, telecanthus; persistent tearing; left: 20/60, EOM large XT and hyper, full visual fields, telecanthus, persistent pain and tearing, ptosis upper eyelid</td>
</tr>
</tbody>
</table>

(continued)
Table 1. Ocular and Orbital Details of Patients With Self-inflicted Gunshot Wound (continued)

<table>
<thead>
<tr>
<th>Case No./ Sex/ Age, y</th>
<th>Weapon</th>
<th>Trajectory</th>
<th>Examination</th>
<th>Ocular/Orbital Surgeries</th>
<th>Follow-up, mo</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>13/M/41 .45 Handgun</td>
<td>Entry submental, bullet into nasal bone region, sagittal</td>
<td>20/20 OD; 20/25 OS; EOM restriction on lateral gaze, left</td>
<td>Orbit fractures, bilateral</td>
<td>None</td>
<td>9</td>
<td>Right 20/20, full visual fields and EOM, orbit fractures, hypoglossus, enophthalmos; left: 20/20; full visual fields and EOM</td>
</tr>
<tr>
<td>14/M/22 .38 Handgun</td>
<td>Entry left temporal region, exit right zygoma region, coronal</td>
<td>20/125 OD; NLP OS; RAPD, left eye; EOM deficiency in all directions, left; traumatic macular hole, right</td>
<td>Periorbital ecchymosis, bilateral; orbit fractures, bilateral; hemorrhage, bilateral; optic nerve injury, left; enophthalmos, left; chemosis, left</td>
<td>Orbital floor fracture repair, left; vitrectomy with membrane peel and silicone oil, right; vitrectomy with removal of silicone oil, right</td>
<td>19*</td>
<td>Right: 20/60, full EOM and visual fields; left: NLP (plan for enucleation)</td>
</tr>
<tr>
<td>15/M/26 Not identified</td>
<td>Entry submental, exit left maxilla, sagittal</td>
<td>20/30 OD; CF 3 ft OS; RAPD, left eye; sluggish pupillary response, bilateral; hyphema, left</td>
<td>Orbit fractures, bilateral; hemorrhage, left; optic nerve injury, left; laceration, left eyelid; chemosis, left</td>
<td>Exploration of globe, left; laceration repair, left upper eyelid</td>
<td>17</td>
<td>Right: 20/20, full EOM and visual fields; left: 20/25, full EOM; visual field partial superior and inferior temporal, superior and inferior nasal deficiencies, lagophthalmos, lower lid retraction, persistent tearing</td>
</tr>
<tr>
<td>16/M/35 Not identified</td>
<td>Entry right orbital region, exit right superoposterior skull, axial/sagittal</td>
<td>NLP OD; LP OS; ruptured globe, right eye; RAPD, right eye; sluggish pupillary response, left</td>
<td>Periorbital ecchymosis, right; orbit fractures, right; hemorrhage, right; chemosis, bilateral</td>
<td>Repair of open globe, right; enucleation, right; temporary tarsorrhaphy, right</td>
<td>7</td>
<td>Right: anophthalmia; pain behind socket; left: 20/40, 20/40 ph; full EOM and visual fields</td>
</tr>
<tr>
<td>17/M/51 .12 Shotgun</td>
<td>Entry submental bullet fragments into frontal brain region, sagittal</td>
<td>CF 1 ft OU; RAPD, right eye; EOM deficiency in all directions, bilateral</td>
<td>Periorbital ecchymosis, bilateral; orbit fractures, bilateral; optic nerve injury, right; laceration, right eyelid; paralytic ectropion, left lower eyelid; hypoglossus, right; chemosis, bilateral; nasolacrimal duct obstruction, right</td>
<td>Medial canthoplasty with transnasal wiring, repair of inferior orbital rim and orbital floor, left; ectropion repair, left lower eyelid; dacryocystorhinostomy, bilateral; removal of retained orbital foreign body, right lower eyelid</td>
<td>13</td>
<td>Right: 20/25, full EOM and visual fields; left: 20/25, full EOM and visual fields</td>
</tr>
<tr>
<td>18/M/41 Handgun</td>
<td>Entry submental, bullet fragments into frontal sinuses, sagittal</td>
<td>20/200 OD; 20/20 OS; RAPD, right eye; EOM deficiency supra, right; central scotoma, right; choroidal rupture, right; hyphema, right</td>
<td>Periorbital ecchymosis, bilateral; orbit fractures, bilateral; hemorrhage, bilateral; ptosis, right upper eyelid; laceration, right eyelid; enophthalmos, right; chemosis, right</td>
<td>Laceration repair with dilation and probing, right medial canthus; orbital floor fracture repair, right; medial canthoplasty with transnasal wiring</td>
<td>2*</td>
<td>Right: 20/150, full EOM and visual fields; right upper lid ptosis, right hypertropia, RAPD, enophthalmos; choroidal rupture; left: 20/20, full EOM and visual fields</td>
</tr>
</tbody>
</table>

Abbreviations: CF, counting fingers; CN, cranial nerve; EOM, extraocular motility; ET, esotropia; LP, light perception; NLP, no light perception; RAPD, relative afferent pupillary defect; SIGSW, self-inflicted gunshot wound; SPK, superficial punctate keratopathy; XT, exotropia; hyper, hypertropia.

*Patient had further follow-up appointments scheduled past the writing of this article.

Patients presented with different entry points, planes of missile trajectory, and exit/lodging points. Eight patients (44.4%) displayed submental entry points with missiles traveling superiorly in the sagittal plane and 7 patients (38.9%) displayed intraoral entries with missiles again traveling superiorly in the sagittal plane. Not surprisingly, individuals with submental entry were much more likely to present with mandibular fractures. Seven (87.5%) of the 8 patients with submental entry had mandibular fractures, while only 2 (28.6%) of the 7 patients with intraoral entry had mandibular fractures. Those with intraoral entries were more likely to exhibit intracranial injuries and were also significantly more likely to be seen at final follow-up with unilateral anophthalmia or no light perception (NLP) visual acuity. Four (57.1%) of the patients with intraoral entry had this outcome compared with only 1 (12.5%) of the patients with submental entry. Moreover, the only patient who did not present with orbital fractures displayed a submental entry wound.

In addition to the patients with sagittal missile trajectory planes, 2 patients (11.1%) displayed forehead/orbital entries with missiles traveling posteriorly in the axial plane and 1 patient (5.56%) had a temporal entry with the missile traveling in the coronal plane. These 3 patients with entry points around the cranium and/or coronal missile trajectories (cases 3, 14, and 16) exhibited more severe injuries. For example, all 3 of these patients had intracranial injuries while less than half of the remaining patients had such injuries. All 3 patients also presented with unilateral relative afferent pupillary defects (RAPD) and all presented at final follow-up with either unilateral anophthalmia or NLP visual acuity. Additionally, case 3 was the only patient found to still have extracocular motility (EOM) deficiencies in all directions at final follow-up.

Patients also showed varying missile exit and lodging points. Only 6 patients (33.3%) exhibited clear exit wounds, 3 of which were in the zygoma region (though 1 of these was from...
a missile traveling coronally), 1 in the maxillary region, 1 in the nasal wall, and 1 in the superior cranium. The remaining 12 patients (66.7%) showed no exit wounds but were found to have either the bullet or multiple metallic fragments in various parts of the head and face, including intracranially in 7 patients. Four patients (22.2%) in our study (cases 6, 8, 11, and 15) displayed a wound from a missile exiting prior to reaching the orbital and cranial regions. None of these patients were found to have unilateral anophthalmia or NLP visual acuity at final follow-up, in comparison with more than half of the remaining patients.

Seven patients (38.9%) were found at final follow-up to have visual acuity of 20/40 or better in each eye. Three of these patients (42.9%) displayed wounds from a missile exiting prior to reaching the orbital region while only 1 of the remaining 11 patients (9.1%) exhibited this kind of wound. All 7 of these patients showed missile trajectories in the sagittal plane and none presented with a ruptured globe, compared with 4 (36.4%) of the remaining patients. Additionally, only 2 of these 7 patients (28.6%) presented with unilateral RAPD, while 7 of the remaining 11 patients (63.6%) were found to have unilateral RAPD. In addition to these 7 patients, 3 (16.7%) at final follow-up had visual acuity in both eyes better than or equal to 20/200 pinhole (including 1 patient who had poor vision prior to the SIGSW), while 8 (44.4%) had unilateral anophthalmia or NLP visual acuity.

Seven patients (38.9%; cases 3, 7, 10, 14, 15, 16, and 17) had histories of depression. Histories of alcohol abuse were also found in 7 patients (38.9%; cases 5, 9, 10, 13, 15, 16, and 18), 2 of whom (cases 5 and 16) also had histories of illicit drug use. Two patients (11.1%; cases 1 and 16) had previous suicide attempts, both by overdoses.

We collected costs to the UIHC for providing services to these 18 patients as well as the reimbursements obtained by the hospital (Table 2). Data on costs and reimbursements for 2 patients (cases 1 and 2) were unable to be obtained. For the remaining patients, the average cost of the provided treatments totaled $117,338, with a median of $104,377. The mean reimbursement amount from insurance providers and/or the patients themselves came to $124,388, with a median amount of $148,760. The maximum cost and reimbursement were $321,422 and $267,004, respectively (both case 9). The minimum cost was $3,856 (case 6) and the minimum reimbursement was $8,202 (case 5). These totals do not include the costs and reimbursements for hospitals and providers other than UIHC.

### Discussion

For patients who survive SIGSWs to the head, the injuries sustained are often devastating and require multiple complex procedures performed by a diverse team of specialists.16 The intricate nature of the face, likelihood of injury to the central nervous system, and psychiatric considerations all increase the challenges of reconstruction and rehabilitation.15,17 This study aims to assist ophthalmologists in the treatment of such patients as well as examine the costs and socioeconomic factors associated with these injuries.

The trajectory of the missile frequently plays a role in the severity of subsequent injuries. The relatively low proportion of patients with missile trajectories in the coronal plane may be explained by the exclusion of patients from this study who did not survive at least 2 months after the SIGSW. Previous studies support that missiles traveling in the coronal plane are more lethal than those traveling in the sagittal plane.5,6 Additionally, the patients in this study with coronal and/or cranium tra-
jectories who did survive the SIGSW exhibited more severe injuries with regards to pupil reactivity, visual acuity, and EOM. It is not surprising that all patients in the study are men. While women attempt suicide at higher rates than men, men are more likely to use firearms. Men are also more likely to direct an SIGSW to the head region while women tend to aim toward the abdominal area.

While the injuries of several patients were too severe for visual acuity recoveries, more than half of the patients at final follow-up possessed best-corrected visual acuity in each eye of 20/200 or better, with most in this category demonstrating the best-corrected visual acuity of 20/40 or better in each eye. It appears as though many of these patients’ visual acuities can be restored to near normal following an SIGSW, leaving them with extremely functional vision despite the apparent devastation that may be seen during initial examination. This highlights the importance of specialists conducting examinations and reconstructive procedures promptly, carefully, and thoroughly.

Data measuring the average costs and reimbursements of these cases suggest that UIHC approximately “breaks even” or makes a small profit in the treatment of these patients. This implies that while these cases place a large burden on society—one source estimates an annual cost of $11 billion in lost productivity alone in the United States—they may not similarly burden hospital systems. However, with a small sample size of patients treated at 1 institution, it is prudent to question if such favorable reimbursements may be due to these particular patients possessing better health insurance coverage than the average population. Data support that the state of Iowa has a relatively low rate of uninsured patients, 11% compared with the national average of 16%. Many reports indicate that the implementation of the Patient Protection and Affordable Care Act will reduce uninsured rates across the country, particularly in those states that participate in the Medicaid expansion. This suggests that hospital reimbursements in the treatment of these patients may further increase.

There is little question that considerable resources are being consumed in treating these injuries that many would argue are “preventable,” either through earlier psychiatric intervention or decreased access of these patients to firearms. The majority of these patients had previous psychiatric diagnoses (77.8%) and/or previous suicide attempts (11.1%), suggesting that improved psychiatric therapy may have been helpful in preventing the SIGSW. It may be interesting for future studies to compare the expenses of implementing such preventive practices with the cost to treat these complicated patients.

Limitations to this study include the retrospective method, the relatively small sample size all from 1 institution, and the bias due to multiple providers and examiners. Additionally, the obvious difficulty in conducting the initial examinations of patients presenting with SIGSWs may have impacted the fullness and accuracy of these examinations.

Conclusions

Despite the seemingly devastating injuries on presentation in patients with SIGSWs, many of them demonstrate excellent functional vision at final follow-up. As such, it is important that physicians treat these patients quickly and thoroughly. For ophthalmologists in this setting, it is important to consider the missile trajectory for its predictive value regarding intracranial and perforbial injuries. The cost and reimbursement data suggest that while these cases place a large burden on society, they may not burden hospital systems; however, the small sample size and the state of Iowa’s low rate of uninsured patients may have played a role in this finding. Clinicians on these multidisciplinary teams should engage the psychiatric team early on and reinforce long-term care with these psychiatric providers. As debates about gun control evolve in this country, the psychological and financial costs of these tragic events should be considered.

ARTICLE INFORMATION

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Author Contributions: Dr Allen had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: All authors. Acquisition, analysis, or interpretation of data: All authors. Drafting of the manuscript: Reddy, Baker, Allen. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Reddy, Sobei, Whelan, Allen. Obtained funding: Reddy, Carter. Study supervision: Baker, Allen.
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OPHTHALMIC IMAGES

Posterior Polymorphous Amyloid Degeneration
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A, An 87-year-old woman with bilateral posterior polymorphous amyloid degeneration showing deep corneal stromal punctate/droplike lesions (arrowheads) on right eye retroillumination. B, Histopathological examination disclosed numerous amorphous, deep corneal stromal deposits (hematoxylin-eosin, original magnification ×40). C and D, Congophilic deposits with apple-green birefringence (Congo red, original magnification ×100). E, Deposits stained for amyloid AP (immunoperoxidase, original magnification ×400), but not for amyloid AA and AL. F, Electron microscopy, clusters of 9-nm diameter, nonbranching filaments with no periodicity (original magnification ×129 300).