# Cost-Driven Injury Prevention: Creating an Innovative Plan to Save Lives With Limited Resources

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**Background:** Pedestrian injury costs >$20 billion annually. Countermeasures such as blinking crosswalks can be expensive but expectedly vital to injury prevention efforts. We aimed to create a new framework of cost-driven surveillance. The purpose of our study was to carry out a detailed analysis of the hospital cost and its relationship to location of pedestrian injury. Targeting identified "high cost areas" with effective countermeasures could save lives and be most cost-effective. Our hypothesis is that pedestrian injury creates a tremendous public funding burden and that hotspot sites can be mapped based on corresponding hospital costs.

**Methods:** We conducted a retrospective analysis of billing records of 694 auto versus pedestrian victims treated at Level I trauma center in our city in the sample year 2004. Total cost was computed using cost to charge ratios for hospital and ambulance fees and actual cost of professional fees. City district "price tags" were assigned per detailed patient cost data to corresponding spatial analysis of intersections. $\chi^2$ analyses were conducted on demographic variables. Multiple regression analysis determined predictors of total cost.

**Results:** The total cost of injury was $9.8 million, whereas the total charge was $20.8 million. Ninety percent of victims resided in our City. Thirty-one percent were admitted and cost of their care accounted for 76% of the total. Admitted patients were older than nonadmitted patients (47 years vs. 38 years; $t = 5.45$; $p = 0.00$). Spatial analysis determined that of 11 city districts, three districts accounted for almost 50% of the total cost. Seventy-six percent of the total cost was publicly funded. The strongest predictors of cost were length of stay ($\hat{a} = 0.77$; $t(220) = 30.42$; $p = 0.000$) and ventilator days ($\hat{a} = 0.51$; $t(220) = 6.69$; $p = 0.000$).

**Conclusions:** These findings provide a roadmap to target costly hot spots for city planning of preventive countermeasures. In a climate of limited resources, this kind of roadmap outlines the three regions that could most benefit from countermeasures from both an injury prevention and cost-containment standpoint. Cost-driven surveillance is useful in city strategic planning for cost-effective and life-saving pedestrian injury prevention.

**Key Words:** Cost, Pedestrian injury, Injury prevention, Charge.

(*J Trauma.* 2011;70: 985–990)

Submitted for publication March 23, 2010.
Accepted for publication January 18, 2011.

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Supported by the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, R49 CE001178-03.
Podium Presentation at the Western Trauma Association Annual Meeting, March 5, 2010, Teluride, Colorado.
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DOI: 10.1097/TA.0b013e318210f5b1

According to the National Highway Traffic Safety Administration, there were 37,261 deaths from motor vehicle crashes in the United States in 2008. An additional 2.35 million individuals sustained injury. Pedestrians represented 4,378 of these fatalities and 69,000 of the injured.[1–3] These statistics are gathered from police reports. Our group previously published data suggesting that the police reports may actually underestimate pedestrian injury.[4] The national pedestrian fatality rate is 1.4 per 100,000. The city of San Francisco, with a population of 808,976 (>1 million when counting workday commuters), ranks first in California's 13 most populous cities in pedestrian injury.[5] Both the Centers for Disease Control and Healthy People 2010 consider road traffic safety a high priority area to target as a public health issue.[6,7]

Vehicle–pedestrian countermeasures refer to a wide variety of strategies designed to improve pedestrian safety. Urban design, engineering efforts, and law enforcement all contribute to countermeasure implementation. Speed control, separation of vehicles from pedestrians, and measures that increase pedestrian visibility are broad categories of countermeasures. A number of countermeasures have demonstrated effectiveness in reducing pedestrian injury, but they all come with a price tag. To engage city, state, and federal lawmakers in dialogue about the importance of implementing countermeasures, understanding the details of the cost of not addressing the issue by looking at the detailed cost of injury is of great importance.

Several previous studies have documented the magnitude and severity of pedestrian injury; however, there are very little data looking at the detailed cost of pedestrian injury.[8–11] The purpose of our study was to conduct a detailed analysis of the direct hospital cost of pedestrian injury and its relationship to location of injury occurrence in our city. We looked at each supervisorial district in an effort to find pedestrian "hotspots" in San Francisco, because these regions may represent prime areas to pilot countermeasures. Our hypothesis is that pedestrian injury creates a tremendous public funding burden and that hotspot sites can be mapped based on corresponding hospital costs.

## MATERIALS AND METHODS

### Study Design and Population

We conducted a 5-year retrospective cohort study of all pedestrians struck by a motor vehicle (n = 3,598) treated at an urban Level I trauma center between January 2004 and December 2008. San Francisco General Hospital is the only trauma center for the City and County of San Francisco and receives >98% of injured individuals. People injured outside of the County of San Francisco were excluded from the sample (n = 20). Pedestrians intentionally assaulted with a motor vehicle were also excluded (n = 5). Permission to conduct this research was obtained by the University of California, San Francisco's Institutional Review Board.

## Data Sources

All study variables were collected from five separate data sources. The hospital's trauma registry was used to identify auto versus pedestrian (AVP) injuries. The San Francisco Department of Public Health (SFDPH) Billing Information System (BIS) was used to obtain total hospital charges, professional fee charges, and professional fee payments.

For the spatial analysis of cost, the intersection where the collision occurred for admitted pedestrians transported by ambulance was obtained from the paper, Emergency Medical Response record, kept in the medical record. For any pedestrian missing an Emergency Medical Response record, the Statewide Integrated Traffic Records System (SWITRS) database was used to find the collision intersection.[12] Since SWITRS does not provide personal identifiers, locations were found by linking the trauma registry to SWITRS using date and time of collision occurrence. This methodology is similar to that described by Sciortino et al.[4] The San Francisco Geographic Information System was used to recode collision intersections to supervisorial district.[13]

## Definitions of Categories and Variables

Nonadmitted patients were defined as those who are discharged within 24 hours of an Emergency Department visit, whereas admitted patients were those kept for observation or further treatment for a period of >24 hours. Nonadmitted pedestrians had fewer variables than those who were admitted. Specifically, method of arrival, length of stay, intensive care unit (ICU) days, ventilator days, and disposition were not available for nonadmitted cases.

Charges were conceptually defined as "the amount asked for a service by a healthcare [institution]."[14] Hospital charges were inclusive of all goods used to care for individual patients, including room fees, medications, medical supplies and devices, nursing and allied health care, nonspecialty medical care, administrative services, and overhead. Professional fee charges consisted of additional charges for specialty services such as trauma and orthopedic surgical procedures, not included in general hospital charges. However, costs were defined as "the amount the provider incurs in furnishing the service."[14] In the healthcare literature, the cost-to-charge ratio (CCR) for each fiscal year is multiplied by the hospital charge to obtain hospital cost. CCR is generally calculated as the total hospital operating expenses minus the total operating revenues divided by the gross patient revenue multiplied by 100. In this study, professional costs were defined as actual payments received for professional fee charges. Ambulance fees were defined as the cost of transporting a patient in San Francisco via ambulance on an Advanced Life Support Protocol. Payer was defined as the funding source to which charges for medical care were billed. Payer information was derived from the financial code, which was determined at the time of the hospital visit. Supervisorial district was defined as the geographic area assigned to a City Supervisor who is "elected on a nonpartisan basis from a district where he or she lives."[15]

## Procedures

### Calculating Direct Medical Cost

Direct medical cost of pedestrian injury was calculated by taking the sum of three major components—hospital costs, professional fee costs, and ambulance fee costs. To derive the data for these three components, the following steps were taken: First, AVP cases were identified using the trauma registry by ICD-9 Ecode (814.7; World Health Organization, 1977). Second, hospital charge information was collected using the SFDPH BIS. Third, CCRs for each fiscal year were obtained from the hospital's Chief Financial Officer and were multiplied by hospital charges to derive hospital costs. Fourth, professional fee charges and payments were collected from the SFDPH BIS. Fifth, we estimated the ambulance cost by using 2008 ambulance charges within the City and County of San Francisco. Sixth, hospital costs and professional fee costs were converted to 2008 dollars using Consumer Price Indices and Conversion Factors published by the U.S. Bureau of Labor Statistics.[16] Finally, the sum of hospital costs, professional fee costs, and ambulance fees was used to compute total cost expressed in 2008 dollars.

### Geocoding and Spatial Analysis

We identified the geographic locations of collisions for admitted pedestrians and recoded the data by supervisorial district. This allowed us to place "price tags" on each of 11 supervisorial districts in San Francisco. Nonadmitted patients were excluded from this portion of the analysis. They accounted for the majority of AVP cases although the cost to treat them accounted for a small percentage of the total cost. Hence, only the collisions pertaining to the admitted, more costly cases were mapped.

## Statistical Analyses

For collisions that occurred within San Francisco, we compared the samples of admitted (N = 931) and nonadmitted (N = 2,667) individuals by demographic characteristics (age, gender, and race) and the collision year using *t* tests and $\chi^2$ statistics.

For all individuals (admitted and nonadmitted), we modeled cost as a function of admission status using an overdispersed Poisson model and natural log transformations of cost. In this model, the dispersion parameter was given by the square root of Pearson's $\chi^2$ statistic divided by its degrees of freedom. All confidence intervals (CIs) and the test of likelihood ratio homogeneity were adjusted accordingly. We report both the absolute mean (95% CI) costs on the natural scale, using year 2008 as the reference.

For the sample of admitted patients, we summarized collision frequency by supervisorial district and discharge disposition. For those individuals whose collision location was known (77% of 931 patients), we modeled cost as a function of collision district using an analogous model. We report the absolute mean (95% CI) cost using district with the most collisions as the reference.

A regression analysis using the entire method was conducted to determine the significant predictors of cost of admission. The dependent variable was the log-transformed cost for all years and the independent variables were hospital days, ICU days, ventilator days, and age. Finally, we report total cost for all years. Analyses were conducted using SPSS version 16.0 and SAS version 9.1.[17]

## RESULTS

### Demographics

Of 3,598 pedestrians included in the study, 931 (26%) were admitted and 2,667 were nonadmitted (74%). Age ranged from 0 year to 94 years. Children between the ages of 0 year and 19 years accounted for 14%, whereas adults (20–64 years) and elderly patients (older than 65 years) accounted for 72% and 13%, respectively. More than 50% of the sample consisted of Caucasians and Asians (33 and 25%, respectively). Ninety-eight percent lived in California at the time of the injury, whereas 74% lived in the City of San Francisco. Only 0.6% of all pedestrians in the sample were visiting San Francisco from a foreign country at the time of injury. Homeless people accounted for 7% of the sample.

### Comparing Admitted With Nonadmitted Patients

Admitted patients were older (mean age, 48 years; 95% CI, 47–50 years) than nonadmitted patients (mean age, 38 years; 95% CI, 38–39 years). For both groups, fewer than half were women (44%). The relationship between gender and admission was insignificant. There was a significant association between ethnicity and admission, such that higher proportions of Caucasians and Asians were admitted versus nonadmitted (39% vs. 32% and 31% vs. 23%, respectively). Lower proportions of African Americans and Hispanics were admitted versus nonadmitted (12% vs. 15% and 15% vs. 19%, respectively).

Over the 5-year study period, the proportion of pedestrians admitted decreased from 29.7% of 673 individuals in 2004 to 22.1% of 730 in 2008 ($p = 0.01$; Table 1). This suggests that the frequency of admission for a pedestrian struck by a motor vehicle is decreasing.

**TABLE 1.** Admissions and Nonadmissions by Year

| Year | Admitted, n (%) | Nonadmitted, n (%) |
|---|---|---|
| 2004 | 200 (29.7) | 473 (70.3) |
| 2005 | 194 (27.6) | 507 (72.4) |
| 2006 | 181 (24.3) | 561 (75.7) |
| 2007 | 195 (25.9) | 557 (74.1) |
| 2008 | 161 (22.1) | 569 (77.9) |

$\chi^2$ (1, N = 3,595) = 12.77, $p = 0.01$.

### Patient Outcomes

The case-fatality rate for all patients, regardless of admission status, was between 2% and 3% each year. People older than 40 years were 4.39 times more likely to die than people younger than 40 years after AVP collision ($\chi^2$ [1, N = 3,595] = 33.02; $p < 0.000$).

Over the 5-year period, admitted pedestrians (n = 931) spent an average of 11.6 days in the hospital (95% CI, 10.1–13.4 days). Of them, 30% (n = 328) required the ICU with a mean stay of 2.8 days (95% CI, 2.2–3.5 days). Of the patients who stayed in the ICU, 56% (n = 184) required mechanical ventilation for an average of 2.1 days (95% CI, 1.7–2.8 days). Patients spent a total of 10,845 days in the hospital; including 2,623 days in the ICU and 2,001 days on a ventilator. The length of stay increased by year, with a significant difference between 2004 (7.9; 95% CI, 5.9–9.9) and 2006 (13.3; 95% CI, 10.1–16.6). The mean days in the ICU and on a ventilator also increased through 2007 but these differences were insignificant (Table 2). During the time period of 2004 to 2009, the Injury Severity Score (ISS) of our admitted patients increased. In fact, this trend continues today. For example, in 2005, patients with an ISS of 1 to 9 made up 43% of admitted patients, whereas in 2009, that number was down to 36%. In addition, patients with ISS >25 made up 15% of our admitted population in 2005, whereas in 2009, they accounted for 19%. Although the overall number of our trauma activations has remained essentially the same, it takes a greater injury severity to be admitted. This has in turn increased the overall hospital days because those with less severe injuries are no longer contributing to the overall average length of stay. In addition, we have had a few mentally ill, severely injured patients who are extremely difficult to place post acute care.

Approximately 55% (n = 510) of all admitted patients were discharged home, 7% (n = 62) were discharged to acute rehabilitation, 19% (n = 174) were discharged to a skilled nursing facility, and 9% (n = 82) died. The years of potential life lost for those who died before reaching the age of 75 years (n = 65) was ~1,700.

### Cost of Pedestrian Injury in the City and County of San Francisco

After adjusting for economic inflation, the total charges for the 3,598 pedestrians in the study during the 5-year period amounted to $171 million (expressed in the value of 2008 dollars). Total cost, or the actual amount paid for medical

**TABLE 2.** Mean Hospital Days, ICU Days, and Ventilator Days for Admitted Patients by Year

| | | Hospital Days | | ICU Days | | Ventilator Days | |
|---|---|---|---|---|---|---|---|
| Year | N | Mean | 95% CI | Mean | 95% CI | Mean | 95% CI |
| 2004 | 200 | 7.9 | 5.9–9.9 | 2.0 | 1.0–3.0 | 1.6 | 0.7–2.4 |
| 2005 | 194 | 9.1 | 7.3–11.0 | 1.9 | 1.0–2.7 | 1.5 | 0.7–2.2 |
| 2006 | 181 | 13.3 | 10.1–16.6 | 3.5 | 2.1–4.8 | 2.6 | 1.5–3.7 |
| 2007 | 195 | 13.8 | 9.2–18.4 | 4.2 | 2.0–6.5 | 3.5 | 1.4–5.6 |
| 2007 | 161 | 14.8 | 9.1–20.6 | 2.5 | 1.3–3.7 | 1.6 | 0.7–2.5 |

**TABLE 3.** Cost of Pedestrian Injury per Capita per Year (N = 3,598)

| Collision Year | Total Cost (The Value of 2008 Dollars) | Population | Cost per Capita |
|---|---|---|---|
| 2004 | $11257143.03 | 724,538 | $15.54 |
| 2005 | $13480653.08 | 719,077 | $18.74 |
| 2006 | $16574112.85 | 744,041 | $22.27 |
| 2007 | $17673296.91 | 812,241 | $21.75 |
| 2008 | $15358023.35 | 824,525 | $18.62 |
| All years | $74343229.22 | | |

care, was $74.3 million. Total cost increased by year, from $11.2 million in 2004 to $17.7 million in 2007, and then decreased to $15.7 million in 2008. The cost to treat pediatric patients for all years was $6.4 million, whereas the cost for adults and older adults was $52.7 million and $14.3 million, respectively. Only 24% ($17.6 million) of the total cost was charged to private insurance and the rest was charged to public funds such as Medi-Cal (28%), Medicare (17%), and to patients themselves (16%). The minimum amount billed directly to patients (uninsured) was $5,143 and the maximum was $505,952. Per capita cost is detailed in Table 3.

Although admitted patients accounted for only 25% of all AVP collisions, the cost of their medical care accounted for 82% of the total. The mean cost per pedestrian per year for admitted and nonadmitted patients is presented in Table 4. It ranged from $47,303 to $77,679 for admitted patients and $3,798 to $6,405 for nonadmitted patients, suggesting that an admission was at least 1,200% as expensive as a nonadmission each year. The maximum cost for a single admitted patient was $1.9 million.

## Predictors of Cost of Admission

The regression was a rather poor fit ($R^2$ adj = 48%), but the overall relationship was significant ($F_{(4,926)} = 220.435$; $p = 0.000$). With other variables held constant, cost was positively related to hospital days, ICU days, and age. The strongest positive predictor was number of ICU days ($\beta = 0.92$; $t(926) = 7.72$; $p = 0.000$) followed by hospital days ($\beta = 0.44$; $t(926) = 13.79$; $p = 0.000$) and age ($\beta = 0.07$; $t(926) = 2.83$; $p = 0.000$). Number of ventilator days, on the other hand, was a strong but negative predictor of cost ($\beta = -0.634$; $t(926) = -5.5$; $p = 0.000$).

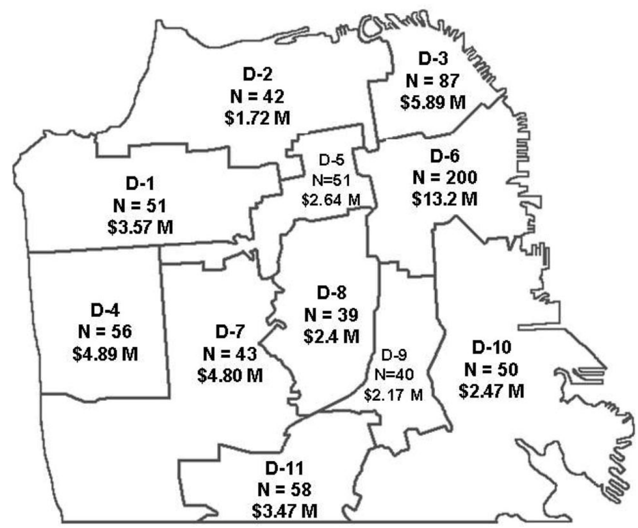


**Figure 1.** Total medical cost per supervisorial district for patients admitted between 2004 and 2008. D, district; N, number of pedestrians struck; M, million.

## Spatial Analysis of Admitted Patients

### Cost

Approximately 77% of admitted patients had collision location available. Collision locations were collated into San Francisco supervisorial district (Fig. 1). For admitted patients with collision locations, the total cost per year was $8.1 million for 2004, $7.4 million for 2005, $10.6 million for 2006, $10.4 million for 2007, and $7.9 million for 2008. The minimum and maximum costs per year by district for these patients are presented in Table 5.

The total cost was the highest in district 6 during the 5-year period ($12.8 million) and accounted for 17% of the total cost for all years. Conversely, the total cost was the lowest in district 2 during the 5-year period ($1.6 million) and accounted for 2.1% of the total cost for all years. Districts 3 ($5.7 million), 4 ($4.8 million), and 6 ($12.9 million) made up 52% of the total cost for admitted patients with collision locations.

The highest absolute mean cost per pedestrian was $86,997 for collisions occurring in district 7, whereas the lowest absolute mean cost per pedestrian was $40,001 in district 2 ($p = 0.35$). The district with the highest number of

**TABLE 4.** Mean Cost per Pedestrian per Year for Admitted and Nonadmitted Patients

| | Admitted | | | Nonadmitted | | |
|---|---|---|---|---|---|---|
| Year | Mean | 95% CI | Frequency | Mean | 95% CI | Frequency |
| 2004 | $47,303 | $38,739–$57,760 | 200 | $3,798 | $2,401–$6,006 | 473 |
| 2005 | $55,989 | $46,467–$67,461 | 194 | $5,165 | $3,533–$7,550 | 507 |
| 2006 | $76,440 | $64,803–$90,168 | 181 | $4,881 | $3,367–$7,075 | 561 |
| 2007 | $77,679 | $66,336–$90,961 | 195 | $4,534 | $3,081–$6,674 | 557 |
| 2008 | $72,754 | $60,799–$87,058 | 161 | $6,405 | $4,643–$8,837 | 569 |

 

**TABLE 5.** Highest and Lowest Total Costs by Year for Admitted Patients With Collision Locations

| | Highest Cost | | | Lowest Cost | | |
|---|---|---|---|---|---|---|
| Year | District | Cost | Percent of Yearly Total Cost* | District | Cost | Percent of Yearly Total Cost* |
| 2004 | 6 | $2.1 million | 25 | 2 | $260,000 | 3.2 |
| 2005 | 6 | $1.3 million | 19 | 2 | $140,000 | 1.5 |
| 2006 | 6 | $4.4 million | 41 | 11 | $264,000 | 2.4 |
| 2007 | 6 | $2.9 million | 28 | 8 | $307,000 | 2.9 |
| 2008 | 6 | $2.1 million | 26 | 9 | $91,000 | 1.1 |

* Refers to total cost of admitted patients with collision locations.

**TABLE 6.** Absolute Mean Cost of Admission by District for All Years

| District | Mean | 95% CI | Frequency |
|---|---|---|---|
| 1 | $65,432 | $42,463–$100,824 | 51 |
| 2 | $40,001 | $21,748–$73,571 | 42 |
| 3 | $66,277 | $47,699–$92,089 | 87 |
| 4 | $85,194 | $59,342–$122,307 | 56 |
| 5 | $51,264 | $31,454–$83,551 | 51 |
| 6 | $64,681 | $51,929–$80,565 | 200 |
| 7 | $86,997 | $57,830–$130,874 | 43 |
| 8 | $59,597 | $35,501–$100,051 | 39 |
| 9 | $43,520 | $23,917–$79,189 | 40 |
| 10 | $47,702 | $28,604–$79,550 | 50 |
| 11 | $58,127 | $37.806–$89,370 | 58 |

collisions leading to admission (district 6) had an absolute mean cost of $64,681 (Table 6).

## Residence

The majority of mapped admitted patients (68%) were involved in an AVP collision in a district different from their home district. However, women were 1.34 times as likely as men to be involved in a collision in the district where they lived ($\chi^2$ [1, N = 711] = 8.64; $p$ = 0.003).

## DISCUSSION

Pedestrian injury remains a compelling public health issue on a local, statewide, and federal level. Understanding the magnitude of the issue is the first step in planning appropriate and effective prevention strategies. Federally, the National Highway Traffic Safety Administration has created a warehouse of pedestrian injury statistics. This information allows for an understanding of general hotspots in our nation and states that are particularly associated with high rates of injury.[18]

Congress recently passed the Safe, Accountable, Flexible, Efficient Transportation Equity Act that requires the Department of Transportation to produce comprehensive reports on magnitude of injury and pedestrian safety. In 2008, the report acknowledged that a number of promising pedestrian countermeasures were at various stages of research and development. They directly recommended that "further research be conducted to determine the most appropriate locations where each type of technology should be deployed to maximize each technology's potential for improving pedestrian safety." They went on to recommend that "… localities need this information to assure the greatest safety impact in the most cost-efficient manner."[19] Our study focused on answering the call for more research on determining appropriate locations to pilot promising countermeasures.

Pedestrian safety countermeasures under the umbrella of traffic calming or enhancement of pedestrian visibility have demonstrated positive results. These include roundabouts, multi-way stop sign control, and flashing crosswalks.[20] Many of these countermeasures require a commitment on the part of the local and perhaps state government to budget for a change in the built environment. Enhanced law enforcement, particularly in an effort to reduce speeding, has also been effective.[21] Increasing enforcement also comes with a commitment to finance it. With the United States in a recession, our cities and states have significant budget shortfalls. The state of California has an estimated budget deficit of $42 billion in 2010[22] and the City of San Francisco has a shortfall of about $522 million. With that backdrop, compelling arguments must be put forth to policymakers to invest in changes to enhance pedestrian safety. Pedestrian injury carries the intangible price tag of human life and the tangible price tag of healthcare expenditures. Providing not only an account of where collisions occur but also the monetary cost of the injuries incurred at those sites gives credence to instituting life-saving and cost-saving measures targeting specific locations and specific road traffic issues.

A previous surveillance study in San Francisco systematically looked at the SWITRS (from police collision reports) and the San Francisco General Hospital trauma registry to create a map of pedestrian injury using Arc Geographic Information System mapping version 8.2.[4] Although police reports were found to underestimate collisions, between the trauma registry and the SWITRS database, the vast majority of collisions were recorded citywide. This was a first step in understanding where injury is most prevalent in the city.

Prior studies have documented hospital charges of pedestrian injury.[23] In this study, we mapped collisions by supervisorial district and put a price tag, by detailing injury cost, on each district. We found that over time, district 6 is the most costly in terms of pedestrian injury, keeping in mind that pedestrian injury in our hospital is publicly funded ~76% of the time. This district is a center of city commerce with high-density and potentially poor pedestrian visibility. This may be a prime location to pilot countermeasures designed to enhance visibility. By contrast, district 2 had some of the lowest costs. District 2 is characterized by significant parkland and separation between high motor vehicle traffic areas and pedestrians. During the 5-year study period, districts 3, 4, and 6 made up over half of the overall cost of pedestrian injury. District 3 is the "Financial District" and similar to district 6 it has very high density but relatively low speed. However, district 4 has a mixture of high speeds with a corridor to a major highway, and pedestrians from a large university and shopping center nearby. Ramping up enforcement of speed limits may be the appropriate countermeasure in this district.

The biggest limitation of our study is that we did not map pedestrian versus motor vehicle collisions for individuals not admitted to the hospital. Although the nonadmitted population is much larger than the admitted population, 82% of the cost was generated by admitted pedestrians. Piloting countermeasures in areas that have more severe and more costly injuries, corresponding to admitted pedestrians, seem most effective and economical at this time.

We plan to present our findings to the city Supervisors through our group's seat on the San Francisco Pedestrian Safety Advisory Committee. It is charged with making official recommendations regarding development of built environment and countermeasures relevant to pedestrian safety in the City of San Francisco. In a resource-constrained environment, mapping out injury hotspots can be helpful to city planners and policy makers. Detailing districts that are particularly collision prone and costly can serve to create a strategy for the right countermeasure fit and provide impetus to supervisors and community advocates affected to champion the cause.

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