Effectiveness of Conducted Electrical Weapons to Prevent Violence-Related Injuries in the Hospital

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CE Earn Up to 6.0 Hours. See page 313.

Contribution to Emergency Nursing Practice

- Violence-related injuries in health care—particularly in the emergency department—are of great concern. There is, therefore, a pressing need for evidence-based approaches to decrease rates of injury. High-risk workers lack information on the effectiveness of possible interventions that could reduce the risk of violence-related injuries. More hospitals are arming their security workers with tools of law enforcement to prevent violent injuries. This is the first study to examine whether the use of one of those tools—conducted electrical weapons—reduces the risk of injury.
- Emergency nurses need to be aware of the potential for security officers' tools to prevent serious injury.
- Although the study findings do not demonstrate a decrease in the overall rates of violence-related injuries to hospital staff after security officers began carrying conducted electrical weapons, the severity of violence-related injuries may have been reduced.

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Abstract

Introduction: Health care workers suffer higher rates of violence-related injuries than workers in other industries, with hospital security officers and ED personnel at particularly high risk for injury. Arming hospital security workers with conducted electrical weapons, such as tasers, has been suggested as an intervention to decrease violence-related injuries in the hospital.

Methods: A retrospective cohort of all security and ED nursing staff at an urban level 1 trauma center was identified from human resources data for the period 4 years before and 7 years after security workers were armed with conducted electrical weapons. A violence-related rate of injury was calculated as all violence-related injuries incurred by each employee for the numerator and the productive hours worked by each person during the study period as the denominator.

Results: The hospital employed approximately 30 security staff and 200 nursing staff at the time, with a total of 98 security officers and 468 nursing staff members over the 11 years of study. During the total nursing study period, 98 security officers contributed 452,901 hours; 265 registered nurses from the emergency department contributed 1,535,044 hours; and 203 health care assistants contributed 624,805 hours. Security officers' violence-related rate of injury was 13 times higher than that of the nursing staff. The risk ratio was 1.0 (95% confidence interval [CI] 0.7–1.4) between the 2 examination periods for security officers, with similar results for nurses. However, among security workers, the cost of the injuries decreased in the period after implementation.

Conclusion: Carrying conducted electrical weapons by hospital security staff appears to have limited capacity to decrease overall rates of violence-related injury but may decrease the severity of violence-related injuries. The latter could decease costs to health care organizations as well as morbidity of injured staff.

Key words: Workplace violence; Hospital safety; Conducted electrical weapons (CEWs); Occupational; Health care injuries; Injury prevention

Workers in health care had the highest incidence rate of workplace violence-related injuries involving days away from work compared with all other private industries in 2013.[1] The rate of violence-related injuries resulting in lost workdays per 10,000 workers in the health care and social assistance industry was 16.2, compared with 4.2 for the entire private industry. Within the health care sector, occupations vary greatly in their risk of workplace violence. Mental health workers and other ancillary staff in psychiatric health care are frequently documented as having higher rates of assault than other health care workers,[2,3] and the emergency department has long been recognized as a location in the hospital where nurses and medical doctors are at a higher risk for violent injury than in other areas of the hospital.[2,4,5]

Hospital safety and security workers are often overlooked in the health care violence-related injury literature. The relatively few studies that do include hospital security workers demonstrate that these workers have some of the highest rates of violence-related injuries within the hospital setting, with anywhere from 2 to 5 times as many injuries as nurses.[2,3,6,7] However, although there are many investigations of risk factors and interventions to decrease risk for violent injuries among health care staff,[4,8–17] almost no studies were conducted that specifically detail the risk and protective factors for violent injury to hospital security personnel.

One intervention that has been implemented and identified as potentially highly useful to decrease violence-related injuries is the arming of hospital security staff with conducted electrical weapons (CEWs), such as tasers.[18] Ho et al found that, among hospital security workers, staff injuries decreased from 31 in the year before implementation to 20 in the year after implementation. In addition, the severity of injuries apparently decreased; there were 18 days of lost employee time and 350 days of restricted work in the 12 preceding months, whereas there were 0 days of lost employee time and 16 days of restricted work in the first 12 months after introduction of CEWs. Some studies of the use of CEWs in criminal justice have found fewer injuries among both police officers and suspects following the implementation of CEWs,[19–21] although the risk for less severe injuries to suspects may increase with the use of CEWs.[22] In addition, field studies of the use of CEWs in law enforcement have not found risk of cardiac death or severe injury with deployment of CEWs against suspects.[23,24] However, a few deaths of suspects have occurred shortly after the use of CEWs, prompting some to suggest a causal association with CEWs,[25,26] although a common pathophysiologic cause is questionable.[27] As the relative safety of CEWs has been questioned, there is no doubt that the increased use of CEWs in the health care setting should be accompanied with research into the safety and effectiveness of such strategies.[28]

The goals of this study were to determine if the introduction of CEW carriage by hospital security officers affected the rates of injury among the security staff in the 7 years after their introduction and the rates of injury among the ED nursing staff in the 7 years after their introduction. A third goal of this study was to explore other factors related to injuries to security staff, including the severity of injury and demographic factors associated with violence-related injuries to security staff, as there have been no previous examinations of the risk factors for violence-related injuries among this population.

Methods

This investigation is a retrospective cohort study of two hospital employee populations: the hospital security staff and ED nursing staff in one urban hospital from January 1, 2004, to December 31, 2014. The hospital is a level 1 trauma center, located in the metropolitan core of a midwestern city. The hospital has 472 beds, 102 of which are designated for psychiatric patients. On average, 335 of all beds were occupied daily by patients in 2014. The emergency department, including urgent care, had 109,809

TABLE 1
Demographics of study personnel

Occupational Group	Total	Female n (%)	Male n (%)	Median Age (Quartiles 1 and 4)	Median Experience in Years (Quartiles 1 and 4)
Security Personnel	98	13 (13)	85 (87)	38 (21–31, 44–61)	7 (0–2, 14–33)
Registered Nurses	265	210 (79)	55 (21)	44 (23–36, 51–69)	7 (0–3, 13–34)
Health Care Assistants	203	121 (60)	82 (40)	30 (18–26, 40–64)	2 (0–1, 7–21)
Nursing Staff	468	331 (71)	137 (29)	40 (18–31, 49–69)	5 (0–2, 11–34)

TABLE 2
Full model results

Security Officers	Comparison	Rate Ratio	Mean 95% Confidence Limits		Chi-Square	Probability of Chi-Square Test Statistic
CEW Implementation	Post-CEW vs Pre-CEW	1.0	0.7	1.4	0.02	0.8995
Years of Experience at Observation	0-1 vs 14–33	1.4	0.6	3.0	0.68	0.4103
	2-6 vs 14–33	1.5	0.7	3.2	1.11	0.2923
	7-13 vs 14–33	1.1	0.6	2.0	0.08	0.7799
Age at Observation	21-30 vs 44–61	2.0	0.9	4.6	2.82	0.0932
	31-37 vs 44–61	1.3	0.6	2.7	0.40	0.5289
	38-43 vs 44–61	0.9	0.5	1.7	0.04	0.8338
Gender	M vs F	1.2	0.8	1.9	0.99	0.3207
Nursing Staff	**Comparison**	**Rate Ratio**	**Mean 95% Confidence Limits**		**Chi-Square**	**Probability of Chi-Square Test Statistic**
CEW Implementation	Post-CEW vs Pre-CEW	0.9	0.5	1.6	0.10	0.7515
Years of Experience at Observation	0–1 vs 11–34	2.0	0.9	4.2	3.09	0.0789
	2–4 vs 11–34	1.3	0.6	2.6	0.54	0.4632
	5–10 vs 11–34	0.8	0.4	1.7	0.34	0.5625
Age at Observation	18–30 vs 49–69	1.2	0.5	2.8	0.16	0.6894
	31–39 vs 49–69	1.2	0.6	2.5	0.25	0.6176
	40–48 vs 49–69	0.8	0.4	1.8	0.19	0.6652
Occupation	HCA vs RN	1.0	0.5	1.7	0.01	0.9095
Gender	M vs F	1.0	0.6	1.8	0.03	0.8604

CEW = conducted electrical weapons

visits that same year among its 62 ED beds and 10 urgent care beds.

The study is based on several hospital data sources: Demographic data and productive hours worked were obtained from the county's human resources departments, which—until 2007—had retained direct control over the hospital, and from the hospital's human resources department from 2007 forward. The specific date of initiation of carriage of CEWs—December 28, 2007—and annual CEW use and near use (in which a CEW was brandished but not deployed) were obtained from the security department. The hospital's workers' compensation administrator provided injury data and the costs of injuries to security workers, and hospital's occupational health department supplied the details of injuries. Violence-related injuries to security workers occurred throughout the facility, whereas injuries to the ED nursing staff occurred exclusively in the emergency department. From 2004 until March of 2007, the hours worked by each employee were available in a biweekly (pay period) format, whereas the hours worked from March 2007 until December 2014 were the hours contributed by each employee on a given day. The injury data received from the hospital's workers' compensation administrator did not include information as to whether a given injury was violence related. The occupational health record of each injury was reviewed by the author, J.G., and if the text of the narrative included language that the employee was bitten, hit, kicked, slapped, pushed, elbowed, scratched, spat upon, punched, and/or injured during the restraint process of a patient who was attacking the staff member, the injury was determined to be violence related. Finally, the workers' compensation administrator supplied data on the total cost (medical and indemnity) of each injury to the organization.

The research was approved by the institutional review boards at the study hospital and the researchers' university. Funding for this research was provided by the Midwest Center for Occupational Health and Safety-Education and Research

TABLE 3
Bivariate analyses of demographic variables among security workers

Years of Experience	Rate of Injuries per 100,000 Hours Worked	Rate Ratio Compared With 14–33 (Reference Category)	Mean 95% Confidence Limits		Chi-Square	Probability of Chi-Square Test Statistic
0–1	54.9	2.3	1.5	3.5	15.19	<0.0001
2–6	51.4	2.2	1.4	3.2	14.07	0.0002
7–13	29.2	1.2	0.8	2.0	0.73	0.3934
14–33	23.7	1	—	—	—	—
Age (Years)	**Rate of Injuries per 100,000 Hours Worked**	**Rate Ratio Compared With 44–61 (Reference Category)**	**Mean 95% Confidence Limits**		**Chi-Square**	**Probability of Chi-Square Test Statistic**
21–30	69.8	2.7	1.6	4.6	13.04	0.0003
31–37	40.1	1.5	0.9	2.5	2.78	0.0956
38–43	27.8	1.1	0.6	1.9	0.04	0.8338
44–61	26.1	1	—	—	—	—
Gender	**Rate of Injuries per 100,000 Hours Worked**	**Rate Ratio of Male to Female Staff**	**Mean 95% Confidence Limits**		**Chi-Square**	**Probability of Chi-Square Test Statistic**
Female	35.2	1.2	0.8	1.8	0.44	0.5063
Male	40.7	-	-	-	-	-

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STUDY POPULATION

There are approximately 30 full-time security officers employed at any one time at the hospital and more than 200 nursing staff members employed in the emergency department. Over the course of the 11-year study period, 98 security officers contributed 452,901 hours; 265 registered nurses from the emergency department contributed 1,535,044 hours; and 203 health care assistants contributed 624,805 hours. Among the emergency nurses and health care assistants, there were limited numbers of violence-related injuries in some years, and health care assistants and registered nurses are grouped together as nursing staff for the purposes of the analyses. Demographic information on the study participants is included in Table 1.

ANALYTIC APPROACH

Because there have been no previous investigations of the factors associated with rates of violence-related injuries among hospital security personnel, descriptive and bivariate analyses were completed with available demographic variables in addition to the hypotheses addressed by the multivariate models. To perform the analyses, a Poisson-like regression was used to compare rates of injuries associated with specific independent variables, the main independent variable under study being the carriage of CEW by security officers in the years after December 28, 2007, and lack thereof in the period before, with age, gender, and level of experience examined independently for security officers. The dependent variable is rate of injury, in which the numerator is violence-related injuries incurred by each employee, and the denominator is the productive hours worked by each person during the study period of each model. A structured correlation matrix was used to account for the correlated observations within subject. Use of this matrix assumes there is either constant variance within each subject, as with exchangeable or compound symmetry matrices, or that the variance increases as time progresses, as in an auto-regressive matrix.[29] Although an unstructured correlation matrix may be justified for any longitudinal logistic analysis that requires within-subject adjustment, each subject and covariate combination requires a new parameterization and greatly increases the error to the point of

making results unachievable. The robust variance (empirical) estimate was used, as this accounts for greater or smaller variance in the data than is assumed with Poisson modeling, in which the variance is the mean.[30,31] SAS 9.4 (SAS Institute, Cary, North Carolina) was used to run all statistical models using PROC GENMOD for comparative analyses.

As with bivariate analyses for security workers, Poisson-like logistic regression was used to analyze the data for differences in rates of injury for the 2 respective populations—security personnel and nursing personnel—before and after the implementation of carriage of CEWs by security personnel.

Results

There were a total of 279 violence-related injuries among security workers over the 11-year study period, with an annual range of injuries from a high of 41 in 2013, to 14 in 2008. Among ED nursing staff, there were 66 violence-related injuries in the 11 years, with an annual range of injuries from 9 in 2004, to 1 in 2010.

FULL MODEL RESULTS BY OCCUPATIONAL GROUP

From the start of the study period, January 1, 2004, until the implementation of CEW carriage by security officers (December 28, 2007), the rate of violence-related injuries among security officers was 39.9 injuries per 100,000 hours worked. In the period after implementation (December 29, 2007, to December 31, 2014), the rate of violence-related injuries was 40.2 injuries per 100,000 hours worked. The rate of violence-related injury for ED nursing staff before implementation of CEWs was 3.3 injuries per 100,000 hours worked, and the rate of injury in the 7 years of investigation when the security officers were armed with CEWs was 2.9 injuries per 100,000 hours worked. Results from the full models are shown in Table 2. When all results are adjusted for each other, as they are modeled and displayed in Table 2, none of the results was statistically significantly different: neither the variable of interest; CEW carriage by security officers; nor the demographic variables of age, gender, level of experience, or (for nursing staff) job category.

BIVARIATE ANALYSES OF DEMOGRAPHIC VARIABLES AMONG SECURITY WORKERS

Bivariate analyses of the demographic variables for the security workers demonstrate significantly correlated associations. Table 3 demonstrates that security staff members who have more years of experience have lower rates of violence-related injuries than staff members with fewer years of experience. Similarly, the youngest quartile of security staff is at a much higher risk of violence-related injury than older security staff. However, when comparing male and female security staff, no significant difference was found.

TRENDS OVER THE PERIOD OF STUDY AMONG SECURITY WORKERS

The numbers of security workers' injuries reported to the hospital's workers' compensation administrator varied widely between 2004 and 2014. The highest rate of injuries was 59.6 injuries per 100,000 hours worked in 2014, and the lowest rate was 21.5 injuries per 100,000 hours worked in 2008. The years when the highest numbers of injuries were reported were also years when the average level of experience among the security staff was relatively low, as demonstrated in Figure 1. In terms of use of CEWs, the number of times CEWs were used or nearly used remained flat for the first 3 years after implementation. The rate of injuries decreased in the year after implementation but returned to rates before implementation by 2009, without commensurate decreases in the number of times CEWs were used or nearly used. In fact, the first year in which there was a large drop in the use of CEWs (2011), there was the second lowest rate of injury experienced among security workers.

Although severity of injuries is not a part of the multivariate models in this study, as the information was not explicitly available, it is relevant to examine the injury-specific workers' compensation costs to the organization as a surrogate for severity. Based on costs adjusted to the last year under study—2014—Table 4 reveals a wide variation in the costs of workers' compensation claims (medical and indemnity) from year to year, with single injuries driving most of the costs in years when there were high costs.[32] For instance, in 2007, the most expensive year to the organization in terms of workers' compensation costs for violence-related injuries to security officers, 95% of the total costs were from 2 injuries, with 80% of the total cost to the organization coming from 1 injury. In addition, if the costliest injury in each year is eliminated, the average annual cost of the injuries in the 2004 to 2007 pre-CEW period was $11,345 per year and $12,625 per year in the post-CEW period.

Discussion

The study findings did not demonstrate a significant difference in the rates of violence-related injuries among either security officers or ED nursing staff in a comparison

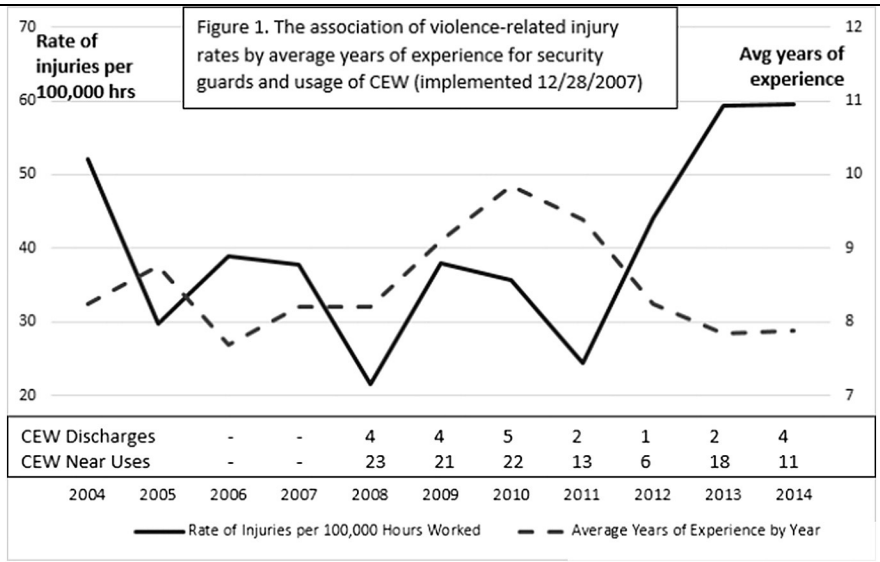

FIGURE 1

The association of violence-related injury rates by average years of experience for security guards and usage of CEW (implemented 12/28/2007).

of the periods before and after the security officers began to carry and use CEWs. Although there was a decrease in the year after implementation, from 38/100,000 hours worked in 2007 to 22/100,000 hours worked in 2008, the decrease was not sustained throughout the period when the security officers carried CEWs. The rate was essentially unchanged for both security officers and ED nursing staff. This was especially so for the security workers who had a rate in the first 4 years of the study of 39.9/100,000 hours worked, compared with 40.2/100,000 hours worked in the 7 years following implementation.

Although the rates of injury were not found to decrease with this study's populations, the burden of severe injury among security officers appears to decrease after officers began carrying CEWs, as indicated by the lack of high-cost injuries related to violence among security workers in the 7 years after deployment compared with the 4 years before. This was substantiated by the hospital's director of security,

TABLE 4

Workers' compensation costs by year: security injuries

Year	Number of Injuries	Workers' Compensation Costs	Adjusted to 2014 Dollars (32)	Costliest Injury (2014 Dollars)	Annual Costs Excluding Costliest Injury (2014 Dollars)
2004	31	$67,836.86	$85,015.49	$71,282.63	$13,732.86
2005	17	$3,911.16	$4,740.97	$961.10	$3,779.87
2006	24	$6,419.15	$7,537.92	$1,929.25	$5,608.67
2007	25	$98,766.14	$112,767.80	$90,508.21	$22,259.59
2008	14	$2,278.09	$2,504.87	$441.37	$2,063.50
2009	24	$8,964.71	$9,892.32	$2,574.96	$7,317.36
2010	22	$35,222.48	$38,239.85	$23,332.66	$14,907.19
2011	16	$4,724.57	$4,972.35	$623.30	$4,349.05
2012	30	$35,850.63	$36,965.84	$17,685.64	$19,280.20
2013	41	$30,204.70	$30,694.68	$6,428.70	$24,265.98
2014	34	$20,497.78	$20,497.78	$4,302.92	$16,194.86

who reported that the hospital security staff had not experienced the life-changing injuries that were experienced in the years before staff members carried CEWs. Using CEWs in a conflict situation may impede an aggressor from being able to harm security officers severely—and, potentially, other staff members—when major conflicts arise, although it may not impede the aggressive act from occurring in the first place. During the period under study (beginning in 2009 and through 2014), the hospital implemented a comprehensive de-escalation and violence safety program that was co-taught by nursing educators and security trainers. However, no appreciable difference in rates of violence-related injury could be found with attendance at the training.

As found in other studies of violence-related injuries in health care, this investigation demonstrates higher rates of injuries among hospital security staff compared with other hospital staff. However, the degree to which the security staff members are injured compared with ED nursing staff is startlingly high; security staff had a rate of violence-related injury approximately 13 times higher than the rate of violence-related injury for ED nursing staff in this study. The next highest difference found in the literature between nursing staff and security was approximately 5 times higher[7]; other investigations found security workers to have rates approximately 2 to 3 times higher.[2,3,6] It is unclear why the relative rates of violence-related injuries between security officers and ED nursing staff is greater in this study than in other studies. It may be that security officers are more likely to intervene early at the study hospital when hospital patients become aggressive compared with facilities in other investigations, and thus they incur more injuries but prevent injuries to other staff. Most studies of violence-related workplace injuries in health care are survey-based, and it is difficult to compare with this study's results. One study using similar data found the rate of violence-related injuries among ED staff to be 4.39/100 full-time equivalent (FTE) and 5.52/100 FTE among police/security[6]; our data reveal rates of 6.2/100 FTE and 80.2/100 FTE, respectively.

This is the first study analyzing the demographic features of hospital security workers associated with violence-related workplace injuries. As shown in studies with physicians, registered nurses, and ancillary health staff, younger and less experienced security officers have higher rates of violence-related injuries.[6,12,16] Bivariate analysis of these 2 variables—age and level of experience—demonstrate highly significant correlations with older age and increased experience and lower risk of violence-related injuries. Results of the multivariate analysis also show a 2-fold increase in risk for injury among the youngest age group security staff compared with the oldest age group, although the results failed to reach statistical significance at the $P < 0.05$ level.

One study that investigated situational risk factors for violent incidents involving hospital security officers found that 92% of all violent incidents that involved security occurred either in psychiatric departments or the emergency department, and 82% of these incidents occurred between 4 pm and 4 am.[33] In most cases, staff members with less experience are required to work shifts outside of the normal day shift hours. Because the current study did not include information on which shift each respective worker was working when injured, it is not possible to determine whether and how shift work relates to the apparent protective effects of level of experience among hospital security workers. Further research in this area is indicated.

Most studies that include an investigation into the gender of the recipients of violence-related injuries in health care find that men are more likely to experience these injuries than women.[2,4–6,12,15] This is not always the case, however, and others have found no difference in rates based on gender of the victims.[17] In this study, there was no significant difference in the rates of violence-related injuries among male security workers and female security workers. There was no difference among nursing staff; the rate of injuries for male nursing staff was 3.1 per 100,000 hours worked, whereas the rate for female nursing staff was 3.0 per 100,000 hours.

Limitations

One limitation of this study is that of omitted or unavailable variables. There may be differences in reporting of injuries based on omitted variables, such as cultural changes within the institution, as suggested by the director of the security department. Over time, there has been greater recognition of the problem of violence-related injuries in the hospital setting, with an accompanying understanding that violence directed at staff should not be tolerated. This may have increased staff reporting of injuries over time and thus artificially raised the rates of injury and also artificially increased or decreased the association between injuries and other key variables of interest. However, when the analyses were run without the last 2 years of data, the associations found in the full models remained. Access to the data in the electronic health records for the employee injuries was limited to 1 author, and thus an interrater reliability examination as to the determination of whether an injury was violence-related according to the established definition could not be accomplished. Comparing the period before

implementation of CEWs with the period after implementation of CEWs, one cannot identify whether any individual event is linked to their use. If an injury is avoided because of a CEW being used, or because the CEW is simply available, there is no record of this non-event. Similarly, there are no data available as to which person used the CEW and whether that person was injured in a CEW event. However, CEW use did not correspond with rates of injury in the first 3 years of implementation.

Another limitation is that this study was restricted to 1 institution and thus may not have the number of subjects needed to detect a difference in risk or have an external comparison group. Also, only one study using similar data to evaluate violence-related injuries among ED staff was identified by this author.[6] As discussed earlier, the basis for the difference in rates of injury for police/security by study is unclear. However, the advantage to investigating the topic at one institution is that the hours of work, and thus exposure, are available for each person at a level not easily obtained in a larger multisite study.

Implications for Emergency Nurses

Emergency department nursing leadership must seek to partner with hospital security leadership to identify methods to decrease the risk of violence-related injury, as these are 2 groups with some of the highest levels of violence-related injuries in any professional category. Undoubtedly, hospital security department staff members are able to prevent some serious injuries to ED nursing staff, and nurses should be aware of what tools those security officers have at their disposal to prevent aggressors from seriously harming others, as well as their effectiveness to do so. As they are the first and most constant hospital professionals to interact and care for potentially violent patients in the emergency department, emergency nurses are uniquely positioned to develop, test, and evaluate interventions to decrease the risk of violent injury. Interventions could include developing algorithms that help define when security should be involved, have violence-reduction interdisciplinary training implemented with nurses and security, and work together in meetings to develop violence-reduction plans in unison, as suggested by Gillespie et al.[34] Although it was not modeled statistically in this study, the use of CEWs appears to decrease the risk of severe injury among security staff; further examination should be undertaken to find whether there are decreases of severe injury among both security officers and nursing staff when security officers are armed with CEWs.

Conclusion

This is the first study to examine whether carrying conducted electrical weapons, such as tasers, affects the rates of violence-related injury among security workers and hospital staff in the emergency department. Comprehensive analysis of 11 years of data at an urban level 1 trauma center revealed no differences in rates of injury between the period before and after CEW were carried by the hospital's security staff. However, the severity of injuries may have decreased in that same period, based on workers' compensation claims.

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