Cost–Benefit Analysis Simulation of a Hospital-Based Violence Intervention Program

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Background: Violent injury is a major cause of disability, premature mortality, and health disparities worldwide. Hospital-based violence intervention programs (HVIPs) show promise in preventing violent injury. Little is known, however, about how the impact of HVIPs may translate into monetary figures.

Purpose: To conduct a cost–benefit analysis simulation to estimate the savings an HVIP might produce in healthcare, criminal justice, and lost productivity costs over 5 years in a hypothetical population of 180 violently injured patients, 90 of whom received HVIP intervention and 90 of whom did not.

Methods: Primary data from 2012, analyzed in 2013, on annual HVIP costs/number of clients served and secondary data sources were used to estimate the cost, number, and type of violent reinjury incidents (fatal/nonfatal, resulting in hospitalization/not resulting in hospitalization) and violent perpetration incidents (aggravated assault/homicide) that this population might experience over 5 years. Four different models were constructed and three different estimates of HVIP effect size (20%, 25%, and 30%) were used to calculate a range of estimates for HVIP net savings and cost–benefit ratios from different payer perspectives. All benefits were discounted at 5% to adjust for their net present value.

Results: Estimates of HVIP cost savings at the base effect estimate of 25% ranged from $82,765 (narrowest model) to $4,055,873 (broadest model).

Conclusions: HVIPs are likely to produce cost savings. This study provides a systematic framework for the economic evaluation of HVIPs and estimates of HVIP cost savings and cost–benefit ratios that may be useful in informing public policy decisions.
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Introduction

The public health imperative to prevent interpersonal violence is clear—it is a major cause of disability and premature mortality around the world.[1–4] Although numerous program models have demonstrated effectiveness in preventing violence,[5] their sustainability hinges on their cost-effectiveness.[6] Hospital-based violence intervention programs (HVIPs) are one promising strategy to prevent interpersonal violence.

HVIPs provide brief intervention in the hospital, needs assessment, and therapeutic case-management services to connect violently injured patients with resources that reduce risk of violent reinjury and perpetration.[7,8] HVIP services are provided by case workers who understand the life experiences of violently injured patients. HVIPs are grounded in empirical data about the recurrent nature of violent injury[9–26] and the theory that hospitals offer a unique opportunity for intervention.[7,8]

HVIPs have shown effectiveness in preventing violent reinjury and perpetration; in improving employment, education, and healthcare utilization; and in reducing aggressive behaviors.[14,27–32] More than 20 HVIPs operate across the U.S. under the National Network of Hospital-Based Violence Intervention Programs (NNHVIP)[33] and well-established HVIPs have begun to be replicated.[34] The U.S. Department of Justice (DOJ) has acknowledged the value of HVIPs, recommending that "Hospital-based

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counseling and prevention programs should be established in all hospital emergency departments (EDs)—especially those that provide services to victims of violence" (p. 13).[35] Several cities participating in DOJ's National Forum on Youth Violence Prevention are integrating HVIPs into their strategic plans.[36]

HVIPs are proliferating across the U.S. and research is documenting their effectiveness. Little is known, however, about their economic impacts. Understanding HVIPs' costs and benefits and distribution across different sectors is important because it will impact HVIP sustainability. The primary aim of this study is to develop a cost–benefit analysis (CBA) framework for HVIPs. Secondary aims are to conduct a CBA simulation of an HVIP, produce preliminary estimates of HVIP cost–benefits, and identify priorities for future HVIP effectiveness and violence prevention research.

Methods

The best secondary data sources available as of 2013 were used to simulate the violent reinjury and perpetration outcomes likely to be experienced by a hypothetical population of 180 violently injured patients, 90 of whom received HVIP intervention and 90 of whom did not, in the 5 years after a violent injury resulting in hospital care. Estimates of the outcomes in these two groups were compared and the monetary costs associated with each were summed to estimate the cost savings that an HVIP would produce over 5 years, assuming different HVIP effect sizes. Ninety was the number chosen for each group because it is the approximate number of clients an HVIP serves in 1 year.[37] Although most HVIP services are provided in the first year after injury, 5 years was selected as the time frame for the simulation because HVIPs connect patients with resources (e.g., education and employment) that have enduring risk-reduction benefits.[1,38]

Two major cost–benefit pathways were identified through which an HVIP could produce cost savings—preventing violent reinjury and preventing violent perpetration (Figure 1).

Cost Estimates

Four categories of costs were included in the CBA simulation (Table 1). Average annual HVIP operating costs were estimated from a 2012 survey of directors of NNHVIP member programs.[37] Cost inputs included three full-time HVIP case workers, one full-time administrative/research staff member, one part-time emergency physician/trauma surgeon, staff benefits, case management database, and overhead.

Estimates reported by Corso et al.[39] of lifetime healthcare and lost productivity costs associated with nonfatal and fatal injuries were used and adjusted for 2011 healthcare dollars.[40] For fatal injuries, the lost productivity estimates for boys and men aged 15–24 years were used because HVIPs predominantly serve this demographic group. Estimates reported by DeLisi and colleagues[41] of costs associated with cases of violent perpetration were used and adjusted for 2011 U.S. dollars.[42] This previous analysis estimated the criminal justice costs associated with cases of homicide and aggravated assault resulting in conviction

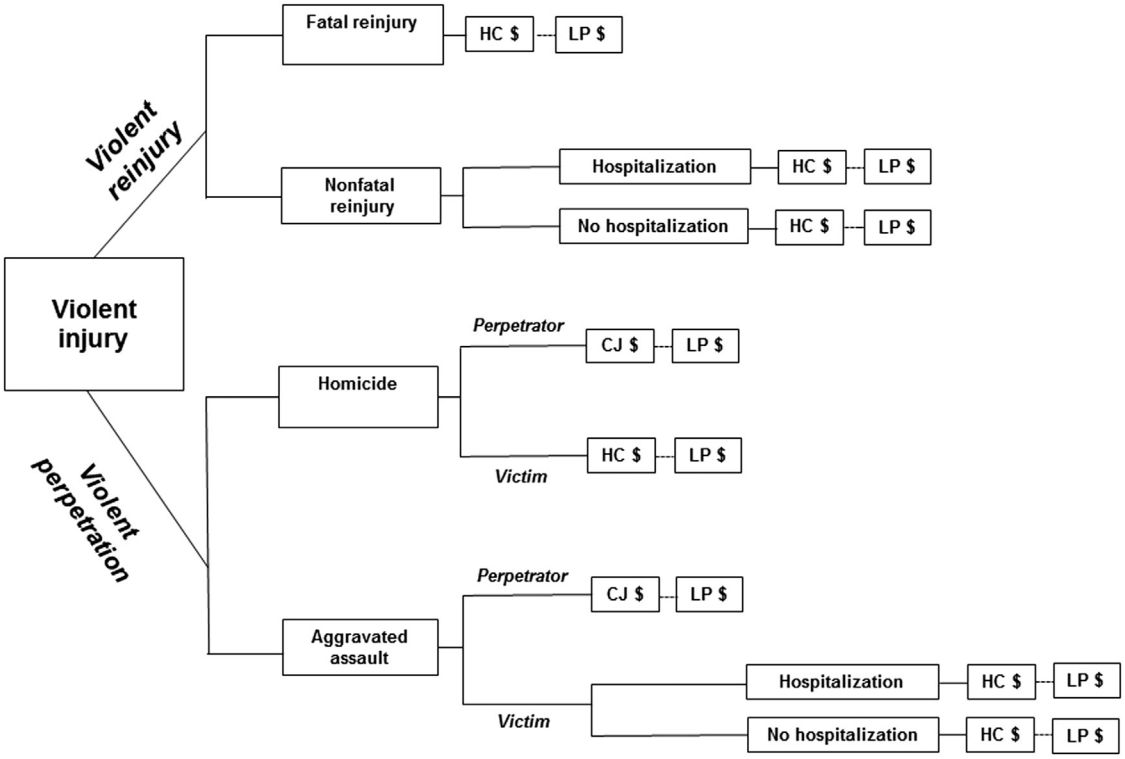

Figure 1. HVIP pathways to potential cost savings.
CJ, criminal justice costs; HC, healthcare costs, HVIP, hospital-based violence intervention program; LP, lost productivity costs.

Table 1. Summary of Cost Estimates[a]

HVIP intervention costs	
Annual cost to serve 90 clients	$350,000
Healthcare costs	
Nonfatal violent reinjury resulting in hospitalization	$37,260
Nonfatal violent reinjury not resulting in hospitalization	$1,533
Fatal violent reinjury resulting in medical care	$7,251
Criminal justice costs	
Homicide conviction	$321,111
Aggravated assault conviction	$14,450
Lost productivity costs	
Nonfatal violent reinjury resulting in hospitalization[b]	$74,730
Nonfatal violent reinjury not resulting in hospitalization[b]	$3,686
Fatal violent reinjury[c]	$2,189,698
Homicide conviction[b]	$149,851
Aggravated assault conviction[b]	$6,850

[a]2011 U.S. dollars.
[b]All age groups.
[c]Men and boys ages 15–24 years.
HVIP, hospital-based violence intervention program.

by summing the costs of investigation, legal defense, incarceration, probation, and parole. The corresponding productivity losses reported were also used.

Outcome Estimates

Searches were conducted in PubMed for *violent reinjury* and *violent injury recidivism*; the references of these publications were reviewed, and Google Scholar was used to locate articles citing these publications to identify studies conducted in the U.S. that reported data on the 5-year incidence of violent reinjury when the initial violent injury and violent reinjury both resulted in hospital care. This type of reinjury was the focus because hospital-treated violent injury is an inclusion criterion for receiving HVIP services and because of the CBA's emphasis on healthcare costs associated with violent reinjury. Six studies were identified (Appendix Table 1; available online).[9–14] The reinjury rate ranged from 2.9% to 44%. Methodologic differences between the studies (e.g., method of assessing initial injury and reinjury and number of hospitals included in the study) prohibited pooling of results. It was estimated that 4.5% of violently injured patients sustained a fatal violent reinjury within 5 years, translating into four incidents in the hypothetical control population ($90\times0.045=4.05$), and that 30% of patients sustained an average of 1.38 nonfatal violent reinjuries resulting in hospitalization, translating into 37 incidents ($[\{90\times0.3\}\times1.38]=37.26$). The estimate of 1.38 was generated by calculating the weighted mean of the average number of reinjuries reported in the identified studies.[9,11,12]

Injury surveillance data were used to estimate the number of violent injuries not resulting in hospitalization that occur for every one that does. According to U.S. CDC data,[43] among boys and men aged 15–24 years, an estimated 376,653 incidents of nonfatal violent injury were treated in hospitals in 2011, and 40,148 of those resulted in hospitalization or critical care transfer (a ratio of 8.38:1.0). Therefore, the estimate of the number of nonfatal violent reinjuries resulting in hospitalization was multiplied by 8.38 to produce an estimate of the number resulting in hospitalization ($37.26\times8.38=312.2$).

When an incident of violent perpetration occurs, the perpetrator incurs criminal justice and lost productivity costs only if the incident results in police involvement. The victim of violent perpetration, however, incurs healthcare and lost productivity costs regardless of whether the incident is reported to police. Therefore, the costs incurred by the perpetrator and the victim (Figure 1) were considered separately.

One study was identified that documented the 5-year incidence of homicide conviction after hospital-treated violent injury. Sims et al.[9] found that 1.14% of violently injured patients were convicted of homicide within 5 years, translating into 1 homicide conviction ($90\times0.0114=1.026$). No studies were located that assessed the 5-year incidence of aggravated assault conviction after hospital treatment for violent injury. To address this issue, criminal justice data were used to estimate the number of assault convictions that occur for every one homicide conviction. A DOJ report[44] provided data on outcomes of state court felony proceedings in large urban counties in the U.S. between 1990 and 2002. In this period, there were 12,950 aggravated assault convictions and 1,077 homicide convictions, for a ratio of 12.02:1.0. Therefore, the estimate of the number of homicide convictions was multiplied by 12.02 to estimate the number of aggravated assault convictions, translating to 12 aggravated assault convictions ($1.026\times12.02=12.33$).

Only 64.8% of homicides/manslaughters and 56.9% of aggravated assaults reported to the police were cleared by arrest in 2011.[45] Assuming that all of these arrests result in conviction, the estimate of the number of homicide convictions was multiplied by 1.54 ($1.0\div0.648=1.54$) and the estimate of the number of aggravated assault convictions was multiplied by 1.76 ($1.0\div0.569=1.76$) to estimate the number of homicides ($1.026\times1.54=1.58$) and aggravated assaults ($12.33\times1.76=21.70$) that would occur. The ratio of nonfatal violent injuries not resulting in hospitalization to those resulting in hospitalization presented here (8.38:1.0) was used to estimate the proportion of nonfatal aggravated assaults resulting in hospitalization, translating to three resulting in hospitalization ($21.70\div8.38=2.58$) and 19 not resulting in hospitalization ($21.70-2.58=19.12$).

Studies evaluating HVIP effectiveness were identified through a systematic review of youth-focused HVIPs,[46] narrative reviews of HVIPs,[7,8] review of the references of these publications, and use of Google Scholar to identify articles citing these publications. Five studies that documented the incidence of violent reinjury and violent perpetration with HVIP intervention were identified (Appendix Table 2; available online).[14,27–30] Methodologic differences between HVIP evaluations prohibited pooling of results. The review of HVIPs suggested that they are effective in preventing violent reinjury. Based on the empirical evidence of HVIPs,[14,27–29] it was estimated that HVIPs reduce the 5-year incidence of violent reinjury by 25%. Therefore, each reinjury outcome estimate for the population without HVIP intervention was multiplied by 0.75 to

produce estimates of outcomes with HVIP intervention (e.g., 37.26×0.75=28.0 for nonfatal violent reinjury resulting in hospitalization).

No studies were identified that assessed the effect of HVIPs on preventing homicide or aggravated assault perpetration. Two studies, however, provided data that allowed generation of estimates. In an RCT, Cooper et al.[27] found that the HVIP group was four times less likely to be convicted of violent crime than the control group (13% vs 55%). In a quasi-experimental evaluation, Shibru and colleagues[29] found that the incidence of violent crime perpetration was significantly lower among subjects in the HVIP group than the control group (9% vs 16%). Zun et al.,[28] however, found no difference in rates of arrest (7.5% vs 7.4%) between the HVIP and control groups in an RCT. Working within the limitations of the published literature, it was estimated that HVIPs reduce the 5-year incidence of violence perpetration by 25%. Accordingly, each violence perpetration outcome estimate for the population without HVIP intervention was multiplied by 0.75 to produce estimates of outcomes with HVIP intervention (e.g., 12.33×0.75=9.25 for aggravated assault conviction).

Analyses

A sensitivity analysis was conducted to produce a range of estimates for all outcomes according to varying assumptions of HVIP effect size. Estimates of the number and type of violent reinjury and violent perpetration outcomes were calculated according to HVIP effect estimates 5 percentage points below (i.e., 20%) and 5 percentages points above (i.e., 30%) the base HVIP effect estimate of 25%.

Four different models were constructed to estimate the range of HVIP cost–benefits from different payer perspectives (Table 2). All future HVIP benefits were discounted at a conservative rate of 5%.[47] All HVIP intervention costs were assumed to be expended in Year 1 and benefits were assumed to be produced uniformly over 5 years. All costs and benefits were standardized in 2011 U.S. dollars.

All calculations were performed in Excel (Microsoft Corporation, Redmond WA; results available upon request). For each model and assumption of HVIP effect size, estimates of the number of violent injury and perpetration outcomes were multiplied by their corresponding costs to produce a total sum of costs. This was done separately for the group receiving HVIP intervention and the group not receiving HVIP intervention. Intervention costs ($350,000) were added to the total sum of costs for the group receiving HVIP intervention. The total sum of costs for the group receiving HVIP intervention was then subtracted from the sum of costs for the group not receiving HVIP intervention to produce an estimate of the net benefit produced over 5 years. It was assumed that these benefits were produced uniformly over 5 years and future benefits were discounted at a rate of 5% annually, adjusting estimates of cost savings for their net present value. Net benefits were divided by intervention costs ($350,000) to produce cost–benefit ratios.

Table 2. Model Variations

Model	Costs included	Perspective
1	Reinjury healthcare costs	Healthcare
2	Reinjury healthcare costs + perpetration victim healthcare costs	Healthcare
3	Reinjury healthcare costs + perpetration victim healthcare costs + perpetration criminal justice costs	Public sector
4	Reinjury healthcare costs + perpetration victim healthcare costs + perpetration criminal justice costs + lost productivity costs	Societal

Results

The HVIP produced cost savings over 5 years in all models according to most assumptions of HVIP effect size (Table 3). At the base effect estimate of 25%, HVIP cost savings ranged from $82,765 (Model 1) to $4,055,873 (Model 4), and 83 incidents of nonfatal violent reinjury not resulting in hospitalization, 10 resulting in hospitalization, 1 fatal violent injury, and 3 cases of aggravated assault conviction prevented (Table 4).

Discussion

Secondary data were used to estimate the potential costs and benefits of an HVIP over 5 years from different payer perspectives. The results indicate that HVIPs are likely to produce cost–benefits from healthcare, public sector, and societal perspectives. The amounts of cost-savings estimates produced by this analysis are modest compared with those of other economic evaluations of HVIPs. Cooper et al.[27] calculated the monetary value of outcomes observed in an RCT and concluded that the HVIP saved approximately $1.25 million in criminal justice costs and $598,000 in healthcare costs over 2 years. Smith and colleagues[30] found that healthcare costs savings would render an HVIP cost-neutral if it prevented 3.5 injuries per year. The relatively modest results reported in the present study are partially explained by the fact that Cooper et al. ($46,000) and Smith et al. ($49,000) used higher cost estimates for violent injury resulting in hospitalization and observed effect sizes that exceeded estimates used in the current study.

This study focused on cases of violent reinjury in which the initial violent injury and subsequent violent injury both resulted in hospital care. Thus, the study did not account for violent reinjuries not resulting in medical care and should be considered within the broader context of violent reinjury research. Gallagher[25] found that only 19% of people reporting violent injuries sought hospital care and that people not seeking care were at higher risk for violent reinjury than those who did seek care (13% vs 6%). A survey of youth presenting to an emergency department (ED), regardless of chief complaint, found that 9.6% reported sustaining a violent injury resulting in medical treatment in the past year.[48] A similar study of

Table 3. Estimates of HVIP Cost–Benefits[a]

	Model 1 Healthcare perspective			Model 2 Healthcare perspective			Model 3 Public sector perspective			Model 4 Societal perspective		
HVIP effect estimate (%)	20	25	30	20	25	30	20	25	30	20	25	30
Cost savings ($)	(3,788)	82,765	169,319	21,270	114,008	206,810	113,887	229,858	345,830	3,174,698	4,055,873	4,937,047
Cost–benefit ratio	0.99	1.24	1.48	1.06	1.33	1.59	1.33	1.66	1.99	10.07	12.59	15.11

[a]Over 5 years, net present value discounted at 5%, 2011 U.S. dollars.
HVIP, hospital-based violence intervention program.

adults found that 11.0% reported being assaulted in the past year[49] and a study using Monitoring the Future survey data found a 1-year violent reinjury rate of 8.8% among high school students,[26] but the proportion of injuries resulting in hospital care was not reported in either study. Furthermore, this study focused on violent reinjury at 5-year follow-up and should be considered within the context of research that has assessed violent reinjury at different follow-up periods.[18–24] The present study highlights the need for a systematic review of the violent reinjury literature.

The analysis reported here is based on numerous assumptions and has several limitations. The estimates of the incidence of violent reinjury are likely low because most studies assessed reinjury at a single hospital and a previous or subsequent violent injury could have been treated at a different hospital. Kennedy et al.[12] found that only 42% of violently reinjured patients received treatment for their initial injury in the same hospital where their reinjury was treated. Because HVIPs prevent violent reinjuries and their associated costs, underestimating the incidence of violent reinjury would also underestimate the cost–benefits of HVIPs. Future research linking injury records across hospitals would enhance the rigor of economic evaluations of HVIPs.

Relatively short follow-up periods (i.e., 1–2 years) in most HVIP outcome evaluations limited the precision of the 5-year HVIP effect estimates reported here. Some evidence, however, suggests that the 5-year base effect estimate of 25% is an underestimate. For 6 years, Smith and colleagues[30] prospectively collected data on incidents of violent reinjury among HVIP clients and found that 6% experienced violent reinjury, compared with a 5-year reinjury rate of 15% that Tellez et al.[11] documented at the same hospital before the intervention—a 60% reduction. Future evaluations of HVIPs should document outcomes over extended time periods. Publically available data sources, such as death certificates and criminal justice records, provide a means to track long-term violent reinjury and perpetration outcomes.

The extrapolation of ecologic data limits the precision of outcome estimates. The ratio of violent injuries not resulting in hospitalization to violent injuries resulting in hospitalization and the ratio of aggravated assault convictions to homicide convictions may not be generalizable to a population that experiences violent reinjury and is unlikely uniform across all regions in the U.S. The cost estimates used are also not generalizable to all regions in the U.S. The criminal justice cost estimates of DeLisi and colleagues[41] were generated from only 8 states and although the healthcare cost estimates of Corso et al.[39] were nationally representative, the cost of health care varies substantially between regions.[50]

Table 4. Estimates of Outcomes 5 Years After a Violent Injury

	Without HVIP intervention (n=90)		With HVIP intervention (n=90)								
	No. of incidents	Incidence rate per 100 person-years at risk	No. of incidents			Incidence rate per 100 person-years at risk			No. of incidents prevented		
HVIP effect estimate (%)	NA	NA	20	25	30	20	25	30	20	25	30
Violent reinjury pathway											
Nonfatal violent reinjury resulting in hospitalization	37	8.3	30	28	26	6.6	6.2	5.8	7	9	11
Nonfatal violent reinjury not resulting in hospitalization	312	69.4	250	234	219	55.5	52.0	48.6	62	78	94
Fatal violent reinjury resulting in medical care	4	0.90	3.2	3.0	2.8	0.72	0.68	0.63	0.8	1.0	1.2
Violent perpetration pathway											
Nonfatal violent injury resulting in hospitalization	3	0.57	2.1	1.9	1.8	0.46	0.43	0.40	0.5	0.6	0.8
Nonfatal violent injury not resulting in hospitalization	19	4.25	15.3	14.3	13.4	3.40	3.19	2.97	3.8	4.8	5.7
Fatal violent injury resulting in medical care	2	0.35	1.3	1.2	1.1	0.28	0.26	0.25	0.32	0.40	0.47
Homicide conviction	1	0.23	0.08	0.08	0.07	0.18	0.17	0.16	0.21	0.26	0.31
Aggravated assault conviction	12	2.7	9.9	9.2	8.6	2.2	2.1	1.9	2.5	3.1	3.7

HVIP, hospital-based violence intervention program; NA, not applicable.

The analysis reported here assumes that HVIPs had a homogeneous effect over 5 years because the existing research was insufficient to support estimates of risk and HVIP effect at different time points. Some studies, however, suggest that risks are highest, and that HVIPs are most effective in the first year after violent injury. Madden et al.[17] found that 30% of patients receiving ED care for a violent injury had received care for a violent injury within 1 year. The risks of violent perpetration may also be highest in the period immediately after violent injury, as some patients seek retaliation against their perpetrator(s).[51] Because the present study discounted future benefits at an annual rate of 5%, assumptions of when HVIPs produce outcomes have implications for the estimates of HVIP cost savings. If HVIPs have heterogeneous effects over 5 years and produce more outcomes (i.e., prevent reinjury and perpetration) earlier rather later, the assumption of a homogeneous effect would lead to underestimation of cost−benefits.

Assuming that 10% of violently injured patients in the hypothetical control population sustain a violent reinjury resulting in hospitalization at 1-year follow-up without intervention ($90\times0.10=9$), and a 1-year HVIP effect estimate of 25% ($9\times0.75=6.75$), an HVIP would prevent two violent injuries resulting in hospitalization ($9-6.75=2.25$), translating to \$74,520 (\$37,260×2.0) in healthcare cost savings. Thus, all additional HVIP benefits (e.g., preventing nonfatal violent reinjuries not resulting in hospitalization, fatal violent reinjuries, violent perpetration) would be produced at a willingness to pay (WTP) of \$275,480 (\$350,000−\$74,520) or \$3060 per HVIP client (\$275,480÷90). In addition to the high likelihood of these costs being offset by healthcare and criminal justice savings, Cohen et al.[52] estimated a societal WTP of \$11.8 million for preventing one murder and \$85,000 for

preventing one aggravated assault. The results of this CBA simulation should be considered within the context of evidence about society's desire to prevent violence for reasons beyond healthcare and criminal justice costs.

Conclusions

This CBA simulation provides preliminary support for the conclusion that HVIPs produce cost savings. Although the CBA framework constructed in this study should be tested through future research, the results reveal a possible financial incentive for state Medicaid and Victims of Crime Assistance agencies to explore reimbursement mechanisms that aid HVIP sustainability.

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References

1. Krug EG, Mercy JA, Dahlberg LL, Zwi AB. The world report on violence and health. Lancet 2002;360(9339):1083–8.
2. CDC. Violence-related firearm deaths among residents of metropolitan areas and cities—United States, 2006—2007. MMWR Morb Mortal Wkly Rep 2011;60(18):573–8.
3. CDC. Injury prevention & control: data & statistics (WISQARS™). Leading causes of death. 2014. www.cdc.gov/injury/wisqars/leading_causes_death.html.
4. CDC. Injury prevention & control: data & statistics (WISQARS™). Nonfatal injury data. 2014. www.cdc.gov/injury/wisqars/nonfatal.html.
5. Hockenhull JC, Whittington R, Leitner M, et al. A systematic review of prevention and intervention strategies for populations at high risk of engaging in violent behaviour: update 2002—8. Health Technol Assess 2012;16(3):1–152.
6. Sharp A, Prosser L, Walton M, et al. Cost analysis of youth violence prevention. Pediatrics 2014;133(3):448–53.
7. Purtle J, Dicker R, Cooper C, et al. Hospital-based violence intervention programs save lives and money. J Trauma Acute Care Surg 2013;75(2):331–3.
8. Cunningham R, Knox L, Fein J, et al. Before and after the trauma bay: the prevention of violent injury among youth. Ann Emerg Med 2009;53(4):490–500.
9. Sims DW, Bivins BA, Obeid FN, Horst HM, Sorensen VJ, Fath JJ. Urban trauma: a chronic recurrent disease. J Trauma 1989;29:940–6; discussion 946—7.
10. Morrissey TB, Byrds CR, Deitch EA. The incidence of recurrent penetrating trauma in an urban trauma center. J Trauma 1991;31(11):1536–8.
11. Tellez MG, Mackersie RC, Morabito D, Shagoury C, Heye C. Risks, costs, and the expected complication of re-injury. Am J Surg 1995;170(6):660–3; discussion 664.
12. Kennedy F, Brown JR, Brown K, Fleming AW. Geographic and temporal patterns of recurrent intentional injury in south-central Los Angeles. J Natl Med Assoc 1996;88(9):570–2.
13. Worrell SS, Koepsell TD, Sabath DR, Gentilello LM, Mock CN, Nathens AB. The risk of reinjury in relation to time since first injury: a retrospective population-based study. J Trauma 2006;60(2):379–84.
14. Gomez G, Simons C, St John W, et al. Project Prescription for Hope (RxH): trauma surgeons and community aligned to reduce injury recidivism caused by violence. Am Surg 2012;78(9):1000–4.
15. Haider AH, Young JH, Kisat M, et al. Association between intentional injury and long-term survival after trauma. Ann Surg 2014;259(5):985–92.
16. Griffin RL, Davis GG, Levitan EB, MacLennan PA, Redden DT, McGwin G. The effect of previous traumatic injury on homicide risk. J Forensic Sci 2014;59(4):986–90.
17. Madden C, Garrett JM, Cole TB, Runge JW, Porter CQ. The urban epidemiology of recurrent injury: beyond age, race, and gender stereotypes. Acad Emerg Med 1997;4(8):772–5.
18. Crandall CS, Jost PF, Broidy LM, Daday G, Sklar DP. Previous emergency department use among homicide victims and offenders: a case-control study. Ann Emerg Med 2004;44(6):646–55.
19. Moscovitz H, Degutis L, Bruno GR, Schriver J. Emergency department patients with assault injuries: previous injury and assault convictions. Ann Emerg Med 1997;29(6):770–5.
20. Buss TF, Abdu R. Repeat victims of violence in an urban trauma center. Violence Vict 1995;10(3):183–94.
21. Cooper C, Eslinger D, Nash D, al-Zawahri J, Stolley P. Repeat victims of violence: report of a large concurrent case-control study. Arch Surg 2000;135(7):837–43.
22. Caputo ND, Shields CP, Ochoa C, et al. Violent and fatal youth trauma: is there a missed opportunity? West J Emerg Med 2012;13(2):146–50.
23. Livingston DH, Lavery RF, Lopreiato MC, Lavery DF, Passannante MR. Unrelenting violence: an analysis of 6,322 gunshot wound patients at a Level I trauma center. J Trauma Acute Care Surg 2014;76(1):2–9.
24. Dowd MD, Langley J, Koepsell T, Soderberg R, Rivara FP. Hospitalizations for injury in New Zealand: prior injury as a risk factor for assaultive injury. Am J Public Health 1996;86(7):929–34.
25. Gallagher CA. Injury recurrence among untreated and medically treated victims of violence in the USA. Soc Sci Med 2005;60(3):627–35.
26. Chang JJ, Chen JJ, Brownson RC. The role of repeat victimization in adolescent delinquent behaviors and recidivism. J Adolesc Health 2003;32(4):272–80.
27. Cooper C, Eslinger DM, Stolley PD. Hospital-based violence intervention programs work. J Trauma 2006;61(3):534–7.
28. Zun LS, Downey L, Rosen J. The effectiveness of an ED-based violence prevention program. Am J Emerg Med 2006;24(1):8–13.
29. Shibru D, Zahnd E, Becker M, Bekaert N, Calhoun D, Victorino GP. Benefits of a hospital-based peer intervention program for violently injured youth. J Am Coll Surg 2007;205(5):684–9.
30. Smith R, Dobbins S, Evans A, Balhotra K, Dicker RA. Hospital-based violence intervention: risk reduction resources that are essential for success. J Trauma Acute Care Surg 2013;74(4):976–82.
31. Aboutanos MB, Jordan A, Cohen R, et al. Brief violence interventions with community case management services are effective for high-risk trauma patients. J Trauma 2011;71(1):228–36.
32. Cheng TL, Haynie D, Brenner R, Wright JL, Chung SE, Simons-Morton B. Effectiveness of a mentor-implemented, violence prevention intervention for assault-injured youths presenting to the emergency department: results of a randomized trial. Pediatrics 2008;122(5):938–46.
33. National Network of Hospital-Based Violence Intervention Programs. Mission: the emergence of a network. nnhvip.org/mission/.
34. Smith R, Evans A, Adams C, Cocanour C, Dicker R. Passing the torch: evaluating exportability of a violence intervention program. Am J Surg 2013;206(2):223–8.
35. U.S. Department of Justice. Report of the Attorney General's National Task Force on Children Exposed to Violence. 2012. www.justice.gov/defendingchildhood/cev-rpt-full.pdf.
36. U.S. Department of Justice, Office of Justice Programs. News Center. National Forum on Youth Violence Prevention. ojp.gov/newsroom/youthviolenceforum.htm.

37. Purtle J, Topp D. HVIP sustainability strategies. Presented at the National Conference of Hospital-Based Violence Intervention Programs Annual Conference; 2013, September 27. Philadelphia PA. nnhvip.org/wp-content/uploads/2013/10/Jonathan-Purtle-Sustainability.pdf.
38. Dahlberg LL. Youth violence in the United States. Major trends, risk factors, and prevention approaches. Am J Prev Med 1998;14(4):259–72.
39. Corso PS, Mercy JA, Simon TR, Finkelstein EA, Miller TR. Medical costs and productivity losses due to interpersonal and self-directed violence in the United States. Am J Prev Med 2007;32(6):474–82.
40. U.S. Department of Labor, Bureau of Labor Statistics. 2011 Consumer Price Index detailed report tables. 2014. Consumer Price Index for All Urban Consumers (CPI-U): U.S. city average, by expenditure category and commodity and service group. Table 1 A. www.bls.gov/cpi/cpid11av.pdf.
41. DeLisi M, Kosloski A, Sween M, Hachmeister E, Moore M, Drury A. Murder by numbers: monetary costs imposed by a sample of homicide offenders. J Forensic Psychiatry Psychol 2010;21(4):501–13.
42. U.S. Department of Labor, Bureau of Labor Statistics. CPI inflation calculator. data.bls.gov/cgi-bin/cpicalc.pl.
43. CDC. WISQARS™. Nonfatal injury reports, 2001–2012. 2013. webappa.cdc.gov/sasweb/ncipc/nfirates2001.html.
44. Reaves BA. State court processing statistics, 1990–2002: violent felons in large urban counties. Bureau of Justice Statistics Special Report. Washington DC: U.S. Department of Justice, 2006. http://www.bjs.gov/content/pub/pdf/vfluc.pdf.
45. U.S. Department of Justice, Federal Bureau of Investigation. Crime in the United States. Percent of offenses cleared by arrest or exceptional means by population group, 2010 Table 25. www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/tables/10tbl25.xls.
46. Snider C, Lee J. Youth violence secondary prevention initiatives in emergency departments: a systematic review. CJEM 2009;11(2):161–8.
47. Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.
48. Cunningham RM, Walton MA, Roahen Harrison, S, et al. Past-year intentional and unintentional injury among teens treated in an inner-city emergency department. J Emerg Med 11;41(4):418—26.
49. Cunningham RM, Murray R, Walton MA, et al. Prevalence of past year assault among inner-city emergency department patients. Ann Emerg Med 2009;53(6):814–23.
50. U.S. Department of Labor, Bureau of Labor Statistics. Consumer Price Index for All Urban Consumers (CPI-U): Selected areas, by expenditure category and commodity and service group. Table 16. http://www.bls.gov/cpi/cpid1401.pdf.
51. Copeland-Linder N, Johnson SB, Haynie DL, Chung SE, Cheng TL. Retaliatory attitudes and violent behaviors among assault-injured youth. J Adolesc Health 2012;50(3):215–20.
52. Cohen MA, Piquero AR, Jennings WG. Studying the costs of crime across offender trajectories. Criminol Public Policy 2010;9(2):279–305.

Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2014.08.030.