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Saving lives and saving money: Hospital-based violence intervention is cost-effective

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BACKGROUND: Victims of violence are at significant risk for injury recidivism, including fatality. We previously demonstrated that our hospital-based violence intervention program (VIP) resulted in a fourfold reduction in injury recidivism, avoiding trauma care costs of $41,000 per injury. Given limited trauma center resources, assessing cost-effectiveness of interventions is fundamental to inform use of these programs in other institutions. This study examines the cost-effectiveness of hospital-based VIP.

METHODS: We used a decision tree and Markov disease state modeling to analyze cost utility for a hypothetical cohort of violently injured subjects, comparing VIP versus no VIP at a trauma center. Quality-adjusted life-years (QALYs) were calculated using differences in mortality and published health state utilities. Costs of trauma care and VIP were obtained from institutional data, and risk of recidivism with and without VIP were obtained from our trial. Outcomes were QALYs gained and net costs over a 5-year horizon. Sensitivity analyses examined the impact of uncertainty in input values on results.

RESULTS: VIP results in an estimated 25.58 QALYs and net costs (program plus trauma care) of $5,892 per patient. Without VIP, these values are 25.34 and $5,923, respectively, suggesting that VIP yields substantial health benefits (24 QALYs) and savings ($4,100) if implemented for 100 individuals. In the sensitivity analysis, net QALYs gained with VIP nearly triple when the injury recidivism rate without VIP is highest. Cost-effectiveness remained robust over a range of values; $6,000 net cost savings occur when 5-year recidivism rate without VIP is at 7%.

CONCLUSION: VIP costs less than having no VIP with significant gains in QALYs especially at anticipated program scale. Across a range of plausible values at which VIP would be less cost-effective (lower injury recidivism, cost of injury, and program effectiveness), VIP still results in acceptable cost per health outcome gained. VIP is effective and cost-effective and should be considered in any trauma center that takes care of violently injured patients. Our analyses can be used to estimate VIP costs and results in different settings. (*J Trauma Acute Care Surg*. 2015;78: 252–258. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Economic and value-based evaluation, level 2.

KEY WORDS: Violence; cost-effectiveness; injury prevention; violence intervention.

Although there has been a recent downward trend in violent death in the United States, homicide remains the most common cause of death in African Americans aged 15 years to 34 years.[1] For every homicide recorded in 2011, there were 42 documented nonfatal injuries.[2] The nonfatal effects of injury include disability, decreased quality of life, and economic consequences, for both the individual and the society.[3] In 2005, unrelated violent injuries by those aged 10 years to 24 years are estimated to have cost the United States $12.7 billion.[4]

The strongest risk factor for violent injury is a history of previous violent injury,[5,6] with the chances of reinjury as high as 45%,[7,8] and future death from violent injury twice as likely.[9] Given the mortality, morbidity, and societal consequences of injury, many hospitals have instituted hospital-based violence intervention programs (VIPs) to take advantage of a "teachable moment," intended to reduce violent injury recidivism. Historically, violence intervention programs have focused on preinjury interventions, but there is growing evidence that the cycle of violence can be influenced by intervention immediately after the initial violent injury.[8,10–13] These hospital-based VIPs target the highest-risk individuals to prevent both injury recidivism and future interaction with the criminal justice system.

At San Francisco General Hospital (SFGH), the Wraparound Program (WAP) has served as the hospital-based VIP since 2005. After initial stabilization, all patients who are victims of violent injury between the ages of 10 years and 30 years are screened by culturally competent case managers for inclusion.[12,14] Victims assessed to be high risk for recidivism are offered participation in WAP, where they receive intensive, individualized case management services and are guided to risk reduction resources. Since its inception, WAP has been associated with a fourfold decrease in injury recidivism compared with previous recidivism rates at SFGH.[11]

While the evidence for the potential efficacy of VIPs is growing, the cost-effectiveness of programs at the hospital level remains unclear. Cost-effectiveness of intervention and treatment programs is fundamental to the feasibility of their implementation, given increasing financial pressures in the face of rising health care costs. Some reports evaluating the cost of incarceration or hospitalization associated with injury describe potential cost savings associated with VIP[8,12]; however,

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information on in-depthcost-effectiveness analysis of VIP is lacking. In addition, even if VIP is shown to be cost-effective in one context, the question of whether this model is also cost-effective in another environment that may have differing baseline characteristics in terms of health care costs, population served, and program effectiveness remains unanswered.

The purpose of this study was to assess the cost-effectiveness of the SFGH VIP using a decision tree and Markov disease state model. We assessed the cost-effectiveness of VIP over a range of plausible contexts to facilitate decision making for program implementation at other institutions with differing baseline characteristics.

PATIENTS AND METHODS

Study Setting

The study context is SFGH, the city's only Level I trauma center, which treats 97% of all trauma victims in the city. Any patient between the ages of 10 years and 30 years who was intentionally injured by another person as defined by the Center for Disease Control was included; victims domestic violence, sexual assault, and child abuse were excluded because other programs exist for these entities that are more germane to their risk factors.[15] The WAP is a hospital-based VIP based at SFGH that was started in 2005. After initial stabilization of the violently injured patient, this prospective client is approached by a WAP case manager. If the client enrolls in WAP, he or she is then provided with intense and culturally sensitive one-on-one case management, including mental health services, employment opportunities, and guidance to other resources based on initial risk assessment (including education resources, court advocacy, housing opportunities, and tattoo removal).

Model Construction and Analysis

This study is a cost-effectiveness analysis using a state-transition (Markov) decision model to determine health and economic outcomes over a 5-year period with WAP, a hospital-based VIP. A decision tree was created to represent the possible stages after violent injury, with the decision node being enrollment in WAP VIP versus no enrollment in WAP VIP (Fig. 1). A patient not enrolled in WAP VIP received standard treatment available to all patients at SFGH, including social work resources. Following the decision node, a Markov node represents each successive potential transition to a new health state: death, reinjury during that period, no reinjury during that period, or injury free for the remaining cycles. Death and injury-free states are final in the model, but reinjury and no reinjury states have further nodes with potential health transitions. For example, the "no reinjury" state can progress to reinjury or remain injury free for the next cycle. Each cycle lasts for 1 year, and the model has a total of six cycles, one for each year of follow-up and a sixth cycle to capture survival after 5 years. The decision model was constructed and analyzed using decision software TreeAge.[16] Cost and quality-adjusted life-years (QALYs) were assigned to each cycle over the 5-year horizon.

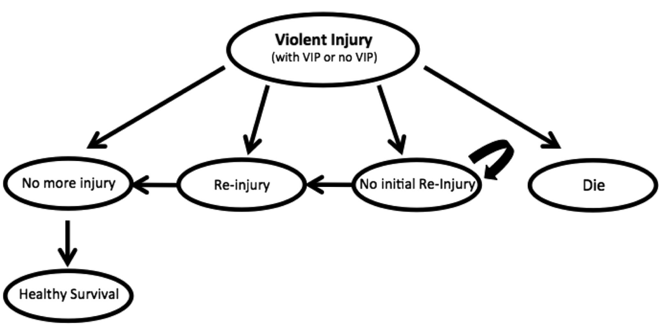

Figure 1. Markov decision tree for violently injured patients at SFGH.

Transition Probabilities

The probability of injury recidivism was drawn from previous work at SFGH, where the violent injury recidivism rate associated with participation in VIP was 4.5% over 5 years, resulting in an average 0.9% VIP-associated annual recidivism rate.[11] The historical 5-year recidivism rate for patients who did not have the opportunity to participate in VIP at SFGH was 16%,[11] correspondingly converted to an annual recidivism rate of 3.2% for the purposes of the Markov model, which uses 1-year cycles. The case-fatality rate for violent injury was determined using SFGH trauma registry data spanning from 2000 to 2010, estimated at 8.8%.

Costs

SFGH patient financial records were used to estimate cost (not charges) associated with injury, including the direct cost of initial trauma care and follow-up visit costs. Costs were generated from facility and professional fees by converting charges to costs using the SFGH cost-to-charges ratio for 2011, yielding an estimated trauma care cost of $41,757 per patient. Costs associated with VIP were based on the operational budget of the WAP. These included supplies and materials, transportation costs, evaluation costs, and salaries/benefits of all individuals who worked for the program, including case managers, support staff, and administrative staff. The 2011 annual cost was divided by the annual enrollment in the program, resulting in a VIP-associated cost of $4,150 per patient. All costs are reported in 2011 US dollars and are discounted at a rate of 3% per year.

Utilities

Health outcomes associated with each state were expressed in QALYs based on previously published values. A "health utility" of 0.7, reported by MacKenzie et al.,[17] was used to represent the health state of patients in the first year after injury. Patients who died were assigned a health utility of 0 and gained no additional QALYs for the remainder of the model. After the first year after the injury, the health state of an individual returned to 0.84, assumed to be the baseline value for a healthy individual aged 20 years to 29 years in the United States.[18] Health states for the 1-year cycles were summed for the 5-year horizon; in the final cycle, all surviving patients in the model were given additional QALYs based on a life expectancy to 77 years old.

TABLE 1. Summary of Variables Used in Markov Model Analysis

Variable	Base Case Value	Analysis Range	Source
VIP cost (per patient), US dollars	4,150	3,574–5,058	Primary* data (WAP)
Cost of trauma care (per patient), US dollars	41,757	230–897,117	Primary* data (SFGH)
Annual injury recidivism (VIP), %	0.9	0.10–1.7	Smith et al.,[11] 2013
Annual injury recidivism (no VIP), %	3.2	2.4–7.0	Primary* data (SFGH)
Injury case-fatality rate, %	8.8	5.8–11.9	Primary* data (SFGH)
Utility** after injury	0.7	0.68–0.82	MacKenzie et al.,[17] 2010
Utility** if healthy	0.84	0.82–1.00	Hanmer et al.,[18] 2006
QALYs after 5-y analysis frame	21.47	12.56–41.49	

*Primary data: retrospective review of patients' financial data and medical records at SFGH and WAP's annual budget.
**Utility: a quantitative measurement of the strength of a patient's preference for a particular state of health outcome.

Sensitivity Analysis

Sensitivity analyses were performed to examine the effects of uncertainty in inputs and modeling assumptions on cost and health utilities. A one-way sensitivity analysis was performed for each parameter of the model (transition probabilities, costs, and utilities) over a plausible range of values intended to cover a broad spectrum of contexts (Table 1). Several combinations of the variables found to be the most sensitive in the one-way analysis were included in two-way sensitivity analyses. We used a three-way sensitivity analysis to explore the combined effect of the three variables with the highest impact on cost-per-QALY ratio by varying injury recidivism rate with and without VIP as well as cost of trauma. Probabilistic sensitivity analyses determined uncertainty in model results, specifically incremental QALY and costs. Multivariate Monte Carlos simulations were performed to portray the impact of aggregate variation in key inputs (Crystal Ball, version 7.2, Decisioneering). In a 100,000-trial simulation, all model inputs were varied simultaneously.

Studies associated with the WAP exist under a certificate of confidentiality from the National Institutes of Health. This study was approved by the University of California-San Francisco's Committee on Human Research.

RESULTS

Cost-effectiveness Analysis

The total discounted cost per patient for the VIP arm starting after initial injury was $5,892 for the VIP group versus $5,923 for the standard risk reduction resources group. Based on the model, the total QALYs expected for the VIP group was 25.58 versus 25.34 for the non-VIP group. An incremental cost-effective ratio (ICER) was not calculated because VIP was both less expensive and more effective than the comparison strategy of no VIP (i.e., "dominant"), rendering an ICER uninterpretable. When scaled to a typical program size of 100 individuals, the expected gain in QALYs is 24 with net savings of $4,100.

One-Way Sensitivity Analysis

Sensitivity analyses were performed on the main probabilities and cost assumptions to test the robustness of the cost-effectiveness results over a range of plausible inputs (Table 2). VIP was superior with regard to QALYs gained for every circumstance. Although VIP was dominant over no VIP in most cases, ICERs were calculated for those cases in which it was not; ICERs ranged between $3,627 and $17,079 per QALY gained. Varying reinjury rate with and without VIP had a significant effect on both net cost and net QALYs. The factor with the greatest effect on net QALYs was the reinjury rate in a context without VIP; net QALYs nearly tripled (0.59) when annual reinjury rate with no VIP was at its maximum input value of 7%. Reducing the annual reinjury with VIP to the lowest value in the range of inputs (0.1%) also increases net QALYs gained to 0.33. Factors with large effect on net cost alone were the cost of injury and cost of VIP. Net cost decreases from −$31 to −$6,147 when cost of injury is at its highest,

TABLE 2. One-Way Sensitivity Analyses for Transition Probabilities, Cost, and Utilities

Variable	Range	Net Cost (VIP; No VIP)	Net QALYs (VIP; No VIP)	ICER* (VIP vs. No VIP)
Base case	n/a	−$31	0.24	VIP dominant
Recidivism rate with no VIP (annual)	0.024–0.070	$1,379; −$6,147	0.16; 0.59	$8,609; VIP dominant
Recidivism rate with VIP (annual)	0.001–0.017	−$1,577; $1,466	0.33; 0.16	VIP dominant; $9,454
Cost of injury (per patient)	$230–$897,117	$4,127; −$85,691	0.24; 0.24	$17,079; VIP dominant
Cost of VIP (per patient)	$2,000–$5,058	−$2,182; $876	0.24; 0.24	VIP dominant; $3,627
Injury case-fatality rate (annual)	0.058–0.119	−$31; −$31	0.17; 0.33	VIP dominant; VIP dominant
Utility if healthy (per patient)	0.82–1.00	−$31; −$31	0.24; 0.26	VIP dominant; VIP dominant
Utility after injury (per patient)	0.68–0.82	−$31; −$31	0.24; 0.23	VIP dominant; VIP dominant
QALYs if survive	12.56–41.49	−$31; −$31	0.16; 0.43	VIP dominant; VIP dominant

*ICER not calculated when one option is dominant (interpretable). "Dominant" means that the intervention (VIP) is both less expensive and better than alternative. n/a, not applicable.

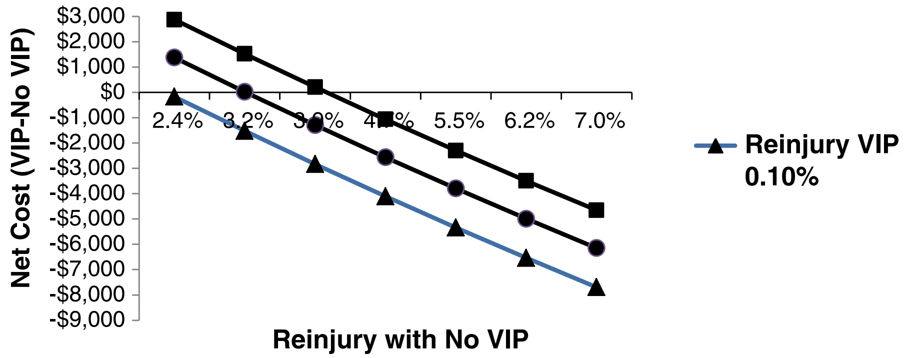

Figure 2. Two-way sensitivity analyses: net cost by reinjury rate with no VIP.

meaning that the no VIP arm is more expensive when cost of injury is high. At the lowest input value for cost of injury, net cost increased from −$31 to $4,127, that is, the VIP strategy costs more. Net QALYs was not sensitive to the cost of injury.

Two-Way Sensitivity Analysis

When evaluated over a range of plausible recidivism rates associated with no VIP, net cost (VIP − no VIP) is consistently $1,546 higher at a higher hypothetical VIP-associated recidivism rate of 1.7% compared with the SFGH VIP-associated rate of 0.9% (Fig. 2). The highest net savings ($7,693) is achieved when the reinjury rate with VIP is lowest (0.1%) and the reinjury rate with no VIP is highest (7%). The highest net cost is when there is a high reinjury rate with VIP (1.7%) and low reinjury rate with no VIP (2.4%). Another two-way sensitivity analysis assessed the effect of varying recidivism rate with and without VIP on QALYs (Fig. 3). As reinjury rate with no VIP increased and VIP injury recidivism decreased, there is an increase in QALYs gained. Maximum QALYs gained (0.684) is achieved when injury recidivism with no VIP is at the highest value (7%) and VIP recidivism is at the lowest value (0.1%).

Three-Way Sensitivity Analysis

The effect on outcomes when varying three key inputs (reinjury rate with no VIP, reinjury rate with VIP, and cost of injury) was also assessed. The highest ICER ($58,857 per QALY gained) results when recidivism rate with no VIP is low (12% over 5 years), cost of injury is low ($1,000 per injury), and reinjury rate with VIP is high (8.5% over 5 years). The most cost-effective outcome (net savings of $166,000 and a gain of 0.68 QALYs) is achieved when reinjury rate with no VIP is high (35%), cost of injury increases to $600,000, and VIP reinjury rate is low.

DISCUSSION

VIPs have been associated with reduced injury recidivism in several contexts.[10–12] At SFGH, WAP was associated with a decrease in violent injury recidivism from 16% over a 5-year period before initiation of WAP to 4.5% over the 5-year period after WAP was instituted.[11] Culturally competent, intensive case management; adequate mental health treatment; and securing employment seem to be an integral component of a successful VIP in this setting, perhaps explaining the program's effectiveness. While reduction in injury recidivism is the ultimate outcome, in the current economic climate, even successful programs may not continue to receive funding if they are not shown to be cost-effective.

Previous work has used metrics such as hospital cost and cost of incarceration in treatment groups versus control groups as a measure of cost associated with each group.[12] Assuming the average annual cost of incarceration was US $25,000 for one person, Cooper et al. found that their VIP group of 56

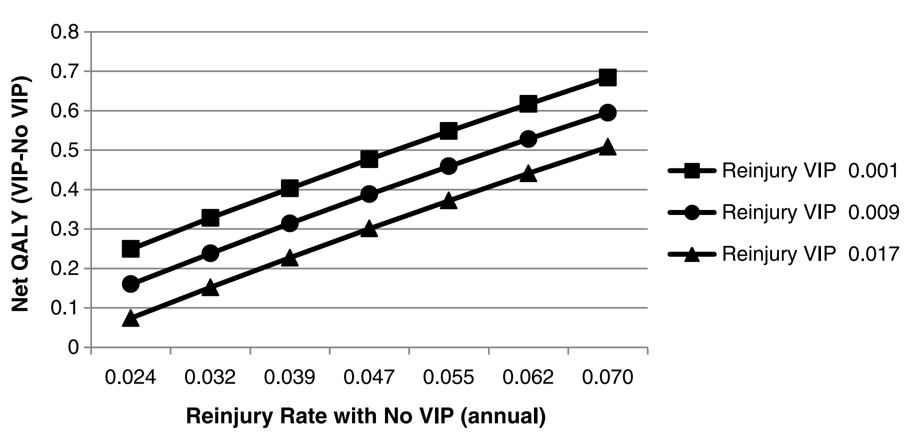

Figure 3. Two-way sensitivity analyses: net QALY by reinjury rate with no VIP.

patients had a reduction in cost of incarceration of US $3.15 million, versus a reduction of US $550,000 for the 44 patients in the control group. Similarly, the cost associated with hospitalization for the 3 injury recidivists in the VIP group was $138,000, compared with $736,000 for the 16 reinjured patients in the control group. In our context, previous exploration of cost-effectiveness for WAP presumed an average cost of hospital treatment for reinjured patients of $49,000 in the context of WAP budget of $138,000 that same year. With the use of these data, it was projected that prevention of 3.5 recidivist injuries annually would render the program cost neutral; hence, at its current effectiveness, the program should save the hospital approximately half a million dollars per year.[11]

While these numbers are encouraging, these examples are analyses limited to a comparison of costs between treatment groups and nontreated groups, without relating the cost against a metric of effectiveness, a necessary component of cost-effectiveness analysis. In our model, the effectiveness of WAP was not limited to injury recidivism but the effects of recidivism as measured by QALYs. VIP was associated with 24 QALYs saved per 100 patients, comparable with the 30 QALYs estimated to represent a normal lifespan. In our one-way sensitivity analysis, VIP was usually both more effective and less costly than no VIP, thus usually “dominant” using Markov terminology. Even in cases where VIP was not dominant and the plausible scenario was the least favorable, the ICER range generated ($5,685 to $7,724 per QALY gained) was well below the $100,000 to $150,000 per QALY considered to be a reasonable cost-effectiveness threshold.[19,20] By using this cost-effectiveness model, the ratio of cost to effectiveness can still be measured when the VIP is not less expensive, giving us an estimate of the cost in US dollars for each incremental gain in QALYs supplied by the program.

The benefits of using a Markov analysis to do this are multiple. Because it is an iterative, probabilistic model, a Markov analysis of cost-effectiveness can use existing data to incorporate benefits and costs beyond the time horizon of the existing data; that is, rather than wait until the data are available far in the future, after much time and expense lost, probabilistic modeling based on existing cost data, recidivism rates, and probabilities allows us to predict outcomes in terms of effectiveness and costs in a complex system using hypothetical subjects. In addition, a Markov analysis incorporates all relevant possibilities, based on the probability of them happening (i.e., Markov modeling accounts for the variable response to the intervention and uses the evidence-based probability of success to predict cost-effectiveness). This methodology also allows us to incorporate data from multiple sources and integrate these into one model to predict cost-effectiveness; therefore, in a situation where equipoise prevents us from randomizing patients to treatment (WAP) versus no treatment (standard care), the Markov model allows us to compare these interventions directly. Including one-way, two-way, and three-way sensitivity analyses of the findings of the model allows for a variety of inputs, so cost-effectiveness can be predicted in other contexts where injury recidivism, program effectiveness, and other inputs into the model may be different from our context. This aspect of the analysis increases the generalizability of the model’s findings, allowing health care decision makers at other institutions to estimate whether VIP would be cost-effective in their population, given their input metrics.

Despite these advantages, there are several limitations to the methods described in this report. The estimates used for recidivism rates for WAP and standard treatment in our context are limited to ecologic data, as the study team felt that randomization of subjects to a study arm that would not provide these services was unethical; therefore, the influence of other factors on injury recidivism in the city over time is not known. Our cost data are limited to program costs and costs associated with hospitalization; the hospital registry would not have captured incarceration or death at the scene, so these outcomes of injury recidivism are not included in the injury rate estimates. Given the evidence in other contexts that an intensive, culturally competent case management approach reduces incarceration,[12] the model in our study likely underestimates the true cost-effectiveness of WAP. Similarly, costs represented in this model do not include indirect costs of injury, such as jobs lost, wage reduction, or effects on family members’ productivity. Again, this exemption likely contributes to an underestimation of the true cost associated with violent injury.

As the evidence continues to grow supporting the effectiveness of VIP, trauma centers will be increasingly likely to assess whether implementing a VIP in their context is both feasible and affordable. Our findings demonstrate that WAP both reduces lost QALYs and hospital cost associated with violent injury recidivism when compared with not having VIP, while accounting for the known costs associated with implementing the program. Even if other trauma centers have differing injury recidivism rates, program effectiveness, or costs associated with injury, VIP should at least be considered as a potentially cost-effective measure, given the robustness of our model as demonstrated by the sensitivity analyses. VIPs may be discouraged by hospital leadership because of misperceptions regarding program cost and ability to prevent violent injury, but this report adds to an increasing body of evidence that VIPs are a fiscally sound investment that reduces injury recidivism and saves lives.

AUTHORSHIP

R.A.D. and J.G.K. designed this study. R.S. and R.A.D. acquired the data. R.S., N.A., A.G., and J.G.K. contributed to the analysis. C.J., R.S., N.A., A.G., and J.G.K. interpreted the data. C.J. prepared the manuscript and coordinated its revision. C.J., R.S., N.A., J.G.K., and R.A.D. contributed to the manuscript review.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. *Leading Causes of Death Reports 2011*. Available at: http://www.cdc.gov/injury/wisqars/leading_causes_death.html. Accessed August 16, 2014.
2. Center for Disease Control, Injury Prevention and Control. *Data and Statistics (WHISQARS)*. Available at: http://www.cdc.gov/injury/WISQARS/. Accessed August 17, 2014.
3. Hoffman K, Cole E, Playford ED, Grill E, Soberg HL, Brohi K. Health outcome after major trauma: what are we measuring? *PLoS One*. 2014;9(7):e103082.

4. Center for Disease Control IPaC. *Data and Statistics (WHISQARS): Cost of Injury Reports*. Available at: http://wisqars.cdc.gov:8080/costT/. Accessed August 19, 2014.
5. McCoy AM, Como JJ, Greene G, Laskey SL, Claridge JA. A novel prospective approach to evaluate trauma recidivism: the concept of the past trauma history. *J Trauma Acute Care Surg*. 2013;75(1):116–121.
6. Cheng TL, Schwarz D, Brenner RA, Wright JL, Fields CB, O'Donnell R, Rhee P, Scheidt PC. Adolescent assault injury: risk and protective factors and locations of contact for intervention. *Pediatrics*. 2003;112(4):931–938.
7. Goins WA, Thompson J, Simpkins C. Recurrent intentional injury. *J Natl Med Assoc*. 1992;84(5):431–435.
8. 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):684–689.
9. Griffin RL, Davis GG, Levitan EB, MacLennan PA, Redden DT, McGwin G Jr. The effect of previous traumatic injury on homicide risk. *J Forensic Sci*. 2014;59(4):986–990.
10. Zun LS, Downey L, Rosen J. The effectiveness of an ED-based violence prevention program. *Am J Emerg Med*. 2006;24(1):8–13.
11. 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):976–980; discussion 980–982.
12. Cooper C, Eslinger DM, Stolley PD. Hospital-based violence intervention programs work. *J Trauma*. 2006;61(3):534–537; discussion 537–540.
13. Becker MG, Hall JS, Ursic CM, Jain S, Calhoun D. Caught in the crossfire: the effects of a peer-based intervention program for violently injured youth. *J Adolesc Health*. 2004;34(3):177–183.
14. Dicker RA, Jaeger S, Knudson MM, Mackersie RC, Morabito DJ, Antezana J, Texada M. Where do we go from here? Interim analysis to forge ahead in violence prevention. *J Trauma*. 2009;67(6):1169–1175.
15. Center for Disease Control IPaC. *Definition for WISQARS.* Available at: http://www.cdc.gov/ncipc/wisqars/nonfatal/definitions.htm. Accessed August 19, 2014.
16. TreeAge Software. *TreeAge Pro 2013*. Williamstown, MA: TreeAge Software, Inc.; 2013.
17. MacKenzie EJ, Weir S, Rivara FP, Jurkovich GJ, Nathens AB, Wang W, Scharfstein DO, Salkever DS. The value of trauma center care. *J Trauma*. 2010;69(1):1–10.
18. Hanmer J, Lawrence WF, Anderson JP, Kaplan RM, Fryback DG. Report of nationally representative values for the noninstitutionalized US adult population for 7 health-related quality-of-life scores. *Med Decis Making*. 2006;26(4):391–400.
19. Barie PS, Ho VP. The value of critical care. *Surg Clin North Am*. 2012;92(6):1445–1462.
20. Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB. Recommendations of the panel on cost-effectiveness in health and medicine. *JAMA*. 1996;276(15):1253–1258.

DISCUSSION

Dr. Carnell Cooper (Baltimore, Maryland): The hold that violence has on our patients and our society is well documented.

What is equally concerning is the growing body of data that shows that 36% of our violence-injured patients will return to our nation's trauma centers with another violent injury. And when they return with these violent injuries their risk of dying is increased, as high as ten-fold in some cities.

Hospital-based violence prevention programs like the one our authors describe have been shown to be effective in reducing violent recidivism. However, the cost-effectiveness of these intervention and treatment programs remain unclear.

The financial pressure facing our health care facilities make it imperative that programs like this are cost-effective or we will not be able to achieve widespread permutation.

The authors attempt to determine the cost-effectiveness of a violent, of a hospital-based violence prevention program using a cost-facility analysis. They use MARKOV analysis. They calculated quality-adjusted life years and performed system analysis. Cost of care, cost of their hospital-based violence prevention program, and risk of recidivism with and without their program was calculated. I must say I had to go through several pots of coffee to get through all of that.

The authors concluded that having their hospital-based violence prevention program cost less than not having their program, with significant improvements in quality-adjusted life years.

This is a well-executed study with complex analysis that still has my head spinning. I have a few questions for the authors:

1. Can you elaborate on quality-adjusted life years? Specifically, what is acceptable payment for QALYs and how does your program compare?

2. How is what you have demonstrated here going to help to create and sustain violence prevention programs all over the country?

3. I noticed that the cost you are including in your model are direct costs. Are there other costs that are not being accounted for? And if so, how does it affect your model?

4. This is a complex analysis that you have done. Can you tell me, is there a point at which violence prevention programs would not be cost-effective?

And, finally, there is a new buzzword in health care that is driving the way we practice medicine and giving clinicians like myself headaches. It is called "population health." It is defined as organization and management of the health care delivery system in a manner that makes it more clinically-effective, more cost-effective, and safer.

I think that what Dr. Smith and her colleagues are achieving with their hospital-based violence prevention programs is population health. I congratulate them on their work and I thank you for the privilege of the floor.

Dr. Charles Yowler (Cleveland, Ohio): I also work at a county public facility. I think you have effectively shown the cost-effectiveness of this approach just as alcohol interventions have been shown to be effective, too. I have two questions.

What is the total cost for your hospital? You broke it down per patient but at San Francisco General what is the cost of this program per year in real dollars?

And does the hospital pay for it? Are you funded by a grant? Does an outside government agency pay for this program? How is it funded?

Dr. Peter Rhee (Tucson, Arizona): I applaud you for your efforts on this. I think that my hospital does alcohol intervention and now drug intervention. And violence intervention is not something that we currently do. and I want to go back and try to see if there is a way I can implement this. Even though you did a great analysis that it is cost effective, I don't know what the appropriate cost is for a life.

Dr. Randi Smith (San Francisco, California): Thank you, Dr. Cooper, and thank you for the other questions.

To answer your question about quality-adjusted life years, there is a known cost that is considered acceptable in the U.S. health care for payment to save a quality-adjusted life year. This number is $100,000.

So it is valued to be worthwhile to save one quality-adjusted life year. And our numbers are very comparable to other areas in health care like mammography where this is considered extremely tremendously acceptable in the U.S. health care system. The question of sustainability has come up a couple of times and it really is hard to get funding from programs such as violence intervention programs.

Our funding comes from multiple sources currently. We've been funded by grants in the past. We actually have a line item in the mayor's budget. Our case managers are employees of the hospital so there are some hospital dollars that also provide funding for this program.

But, really, what I would like to do in terms of sustainability is take this project and all of our other studies to the funders and say, "hey, look." We actually *are* proving that the hospital-based violence intervention programs work. And we know that they cost money but they cost less than actually treating someone who has been injured and re-injured and re-injured. Because we definitely see those in our patient population.

Additionally, in California there have been a couple of bills passed that are trying to get our case managers funding from the state, like domestic violence workers. They actually get funding for the work that they do.

We are trying to push bills that say the case managers are just as important as the domestic violence workers, as well, and trying to push these bills forward so that we can get more funding and more sustainability coming from our government.

In terms of other costs, we did use direct costs for our hospital dollars that we mentioned here. And that was really based off of our hospital billing data. However, we can account for things such as lost wages.

And my impression is that we largely underestimate the costs of injury and re-injury and if we were able to put all of these parameters into the cost we would see that our violence intervention program was tremendously cost-effective and that differential was greater; so it actually would benefit us if we knew how to put those numbers in.

And in terms of this program ever not being beneficial, we do the sensitivity analysis so that we can look over a broad range of injury recidivism rates, of cost, and say with certainty that our violence intervention program works.

But it is true. There may be a small trauma center across the nation that doesn't have this same burden of injury or burden of injury recidivism and maybe a violence intervention program may not be as beneficial for them. However, that is not what we found in our study.And that is still to be determined.

So I hope that I answered all your questions. I thank you, again, for the privilege of the podium.