


An Economic Model of Optimal Penalty for Health Care Workplace Violence

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Abstract

This article provides an economic model on the optimal penalty of health care workplace violence based on health care workplace classification and cost structure, aiming to deter potential offenders. By developing an EIP (externality, identifiability, and preventability) analytical method, we distinguish the characteristics of different workplaces and find that the health care workplace is the combination of externality, low identifiability, and low preventability. Besides the private cost to victims for ordinary workplace violence, the cost structure of health care workplace violence includes social costs like externality-related public safety cost, defensive medicine cost, and specific factors cost. When the optimal penalty corresponding to different levels of health care workplace violence increases, the threshold level of punishable violence decreases after incorporating the social costs into analysis. Our model shows that public safety costs are positively correlated with the importance of health care workplace in the service network, and a higher public safety cost should be matched with a greater optimal penalty.

Keywords

workplace violence, health care workers, optimal penalty, social cost, externality

What do we already know about this topic?

Prior studies focus mainly on the importance of health care workplace violence but ignore the incentive on potential perpetrators to curb violence.

How does your research contribute to the field?

This article develops an EIP (externality, identifiability, and preventability) method to classify the health care workplace with the ordinary workplace and provides an economic model on the optimal penalty of health care workplace violence.

What are your research's implications toward theory, practice, or policy?

Reform of the optimal penalty against health care workplace violence should be carried out to correct the cost–benefit analysis of the potential perpetrator when committing violence.

Introduction

Workplace violence against health care workers is a global problem that urges more action to be taken to prevent such attacks.^{1–3} Reducing the incidence and severity of health care workplace violence through legal means has become a consensus in many countries; however, traditional legislation on health care workplace violence treats health care facilities as ordinary workplaces and is implemented along the definition of the legal responsibility for crime prevention in the workplace. This policy assumes that among the parties involved in the criminal act, employers incur the lowest cost in reducing the probability of a crime occurring. Therefore, legislation should require employers to reduce the risk of health care workplace violence through training, accident reporting, and relief.^{4,5} However, employers' risk prevention and control

efforts are not enough to change perpetrators' incentives to engage in and incidences of health care workplace violence.^{6,7} The epidemic of violence against health care workers plagues hospitals in many countries, and the judicial system is also the

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target of complaints of doing little to prevent assaults against them.⁸

An important view of complementary rather than replacement is to design a direct incentive system using optimal penalties to adjust the cost–benefit analysis of the potential perpetrator when committing violence and in doing so, reduce the incidence and severity of health care workplace violence and protect health care workers from such violence.⁹ For moral reasons such as “to protect those who protect us,” some legislative efforts in recent years have witnessed an increase in penalties for perpetrators of health care workplace violence (Appendix Table A1). However, a theoretical answer is needed to explain why we do so and to what extent we should do. Prior studies discussed the types of workplace violence by perpetrator’s relationship with the workplace,² but the compulsory contracting characteristics of health care organizations makes this method not suitable for the analysis of health care workplace violence. This article provides a 3-dimension analytical method to evaluate the characteristics of different workplaces with respect to violence, and we emphasize the difference between health care facilities and general workplaces, and the cost structure of violence occurring at health care workplace through the lens of an economic theory. It aims to encourage lawmakers and the public to pay more attention to the social cost of health care workplace violence beyond victim costs and take a greater interest in the reform of the optimal penalty against health care workplace violence and the reallocation of judicial resources.

This article first provides a 3-dimension analytical method of EIP (externality, identifiability, and preventability) to classify different workplace and compare health care workplace with other workplaces. It then discusses the cost structure of health care workplace violence, which includes private cost of victims and social cost including externality-related public safety cost, defensive medicine cost, and specific factors cost. With ordinary violence crime without externality as the benchmark, an optimal penalty model is then developed to perform the comparative static and dynamic analysis.

Three Dimensions Evaluating Workplace Violence

The economics of criminal law assumes that under certain conditions a crime is determined by the cost–benefit analysis of the criminal act. The principle of the proportionality of crime and punishment reflects the scope and severity of the social harm that corresponds to different criminal behaviors, and the balance between the costs and benefits of crime control should be achieved through appropriate penalties. Although the voice in favor of 0 tolerance for health care workplace violence and strengthening legal protections is becoming increasingly louder, the significant differences in the scope and severity of social harm between health care workplace violence and violence in other workplaces have not been clearly distinguished in the existing legal and health

care literature on workplace violence, and appropriate policy ideas with sound theoretical bases have not yet been developed. Following Bentham’s¹⁰ ideas for determining the scope and extent of the harm caused by a crime, we evaluate and distinguish the violence that occurs in different workplaces and characterize the features of health care workplace violence using the 3 dimensions of externality, identifiability and preventability.

Externality Dimension

Bentham categorized crimes against others into private and public offenses. Private offenses refer to crimes against certain people, whereas public offenses refer to crimes against a certain part of society (semipublic offenses), all members of society, or an unspecified majority (public offenses).¹⁰ If a crime belongs to the category of public offenses, the scope of the harm is not limited to the violated and the victim’s private costs but goes beyond the violated individual to negatively affect the nonspecific majority of society, generating negative additional social costs, that is, negative externalities.¹¹ Workplaces with externalities (*EX*) often involve public safety and generally include the military, police, law enforcement agencies, health care worker, firefighters, and utilities. Employees in workplaces with public safety functions are generally prohibited from exercising the right to refuse to work when facing risk of violence. The rationale is that employees in these workplaces must assume their duties because the normal operation of these workplaces is associated with public safety. Therefore, any crime that obstructs or harms personnel in charge of public safety functions and makes it difficult for them to assume their duties could produce negative externalities that harm public safety and, thus, is categorized as a public offense as defined by Bentham—the scope of harm of such a crime is not limited to the victim alone but also to the direct legal interest violation against the unspecified individuals given that the victim’s public security responsibility cannot be performed.

According to the principle of the proportionality of crime and punishment, when a workplace lacks externality, the marginal benefits of preventing and controlling the criminal acts of violence in the workplace only occur to a specific individual with a low value, and the crime should be punished with a low-intensity penalty. When the externality is present in a workplace, the marginal benefits of preventing and controlling criminal acts of violence in the workplace are the sum of the costs of unspecified individuals with a high value, and the crime should be matched with a high-intensity penalty.

Identifiability Dimension

In general, the public can be made aware of the behavioral risk of a particular person or group based on personal experience, observation, and all available information, and can then adjust their behavior to avoid risk to the greatest extent.

Bentham noted that for offenses that depend on a particular position,

this circumstance tends, in general, to diminish the alarm by contracting its sphere . . . They create less alarm in proportion because the situation of the delinquent is more peculiar, the number of persons in similar situations is smaller, and the sphere of the offenses is more limited.¹⁰

Conversely, if the workplace is open to society or unspecified individuals—making it difficult to identify the offender who is hidden in public—the resulting panic is high. We define identifiability (C_i) as the possibility that an unspecified individual identifies potential personal injury risk. For example, when a police officer is on duty, his or her ability to identify perpetrators is very low as the latter blends in with the general public. However, when army soldiers are on battlefields, enemies are highly recognizable and easily identified. The reason that identifiability is important is that, when C_i is high, for particular individual with higher risk, employees with direct interest can easily identify the risk, and then take targeted measures to prevent and control the risk; other employees can realize that there is little risk of legal interests being infringed and they do not face prevention and control costs. Therefore, under the same personal injury conditions, situations with a high C_i should be in accordance with a low-intensity penalty.

However, when C_i is low, the social hazard significantly increases because it is difficult for the staff in the workplace to know from which of the perpetrator's identity the risk could originate, or the risk identification is restricted by regulations or professional provisions. When employees in the workplace also have a public safety function, violent crimes against them not only create fear among peers but also affect the unspecified public who may not be knowledgeable nor alarmed but have their legal interests substantially violated given the weakening of the available public security. Therefore, if workplace employers have difficulty paying a high cost for the risk and such a workplace is necessary for public security, legislators and the judiciary should formulate and apply a high-intensity penalty for workplace violence in the case of a low C_i .

Preventability Dimension

Preventability (C_p) is defined as the ability of an unspecified individual to adopt preventive measures to reduce the risk of bodily harm. Bentham recognized the importance of preventability in determining the severity of the harm from the criminal act, “the greater facility we see in repelling an offense, the less alarming it appears to us. The alarm cannot be very great when the offense cannot be perpetrated except with the consent of him who suffers by it.”¹⁰ If a workplace is not open to the public, the employer could invest on workplace safety and provide workplace violence risk information that

it owns and help reduce the incidence of violence. The information exchange among employees can also help achieve a higher C_p , which offers them the possibility of active prevention from being violated, giving rise to a high C_p . However, if the workplace is open to the public or a public place, the C_p could be significantly lowered. However, if employees of such a workplace receive legislative support and are given equipment and enforcement authority for evidence collection, admonition, and riot prevention based on rigorous selection and training, then the C_p of the workplace risk could be significantly enhanced. Conversely, if employees of a workplace lack enough aforementioned training, equipment, and law enforcement authority, and it is unable to restrict the admission of the unspecified public to their workplace, the C_p of risk is very low. Therefore, the violence with different C_p of workplaces should match different penalties.

Three-Dimension Analysis

The distinction between violence and aggression is not that clear. Existing literature has shown that aggression no longer engenders strong emotions that attract media attention, so that in our study violence and violent aggression should be used instead of aggression^{9,12}; other researchers also think violence can really only be appropriately considered as an extreme form of aggression.¹³ In this article, we adopt the definition of workplace violence by the National Institute for Occupational Safety and Health as “any physical assault, threatening behavior or verbal abuse occurring in the work setting.”¹⁴ All workplaces could be exposed to workplace violence for internal and/or external perpetrators. But workplace violence of internal perpetrators to coworkers is much more recognizable than that of external ones. This is because employers have access to information and risk recognition and management system and is able to filter out/eliminate potential perpetrators by employee hiring, training, record-keeping, and termination policies. These traditional practices that enable employers to keep workplace violence free for all employees is a low-cost law enforcement method for internal control.¹⁵ In this article, we define and discuss workplace violence in relation to perpetrators who are not members of the organization's workforce and their targets are employees of the organization in their workplace.

Based on the above 3-dimension EIP method, the workplace cases under different combinations of externality, identifiability, and preventability are shown in Table 1. In workplaces without externality (public safety), such as factories and commercial establishments that are not open to the public, identifiability and preventability are relatively high, and all employees can enjoy the benefits of risk prevention and control measures, such as access control, entry verification, and registration, among others. However, employees in a sector that serves the unspecified public, such as marketing workers and waiters, have a much lower risk identifiability. Comparatively, the rehabilitation staff and

Table 1. The Characteristics of Violence of Different Workplace.

Identifiability (C_i)	Preventability (C_p)		Externality (EX)
	High C_p	Low C_p	
High C_i	Factory workers	Rehabilitation staff	Without EX
Low C_i	Marketing workers/waiter	Security/entrance guard	
High C_i	Prison staff	Army soldiers	With EX
Low C_i	Police officers	Transportation/health care workers	

Source. The authors.

securities employed by different agencies also have low-risk preventability given their occupations, although the former has high-risk identifiability, and the latter has low-risk identifiability. Workplaces that are not associated with public safety can compensate their employees for the risk as a way to offset the low-risk preventability that they face because revenues from the workplaces are harvested and distributed solely by employers.

In workplaces associated with externality (public safety) but not open to the public, such as prisons and the army, employees already understand that the prisoners they face or the enemies on the battlefield pose a high risk to them, making risk identifiability rather high. However, although prison employees and soldiers in the army have been screened, trained, and adequately equipped, their preventability is very different: the former can legally use coercive means to monitor and prevent themselves from prisoners' violence and experience high C_p , while the latter must face enemies with an unknown level of violence, and the C_p is low. In workplaces with externality and open to the public, it is difficult, for example, for police officers, bus drivers, and health care workers to identify potential persons of violence hidden in the public, leading to very low identifiability. At the same time, these workplaces also have legislative restrictions that do not allow for the identification and prohibition of specific people from entering or leaving the workplaces. High-risk individuals still have the right to obtain goods or services in such workplaces because they are often necessary and inalienable for sustaining life, so the risks of them entering the space cannot be prevented and controlled by rejecting transactions. (In special cases for general/family practice, community health, and private practice, health care workers can identify and prohibit specific actors from entering their workplace, and in some circumstances can prevent actors leaving their workplace [eg, under mental health laws]. If this is the case, their identifiability and preventability is relatively high. We thank our anonymous referee for this comment.) However, similar to soldiers in the army, law enforcement's permission, equipment, and trainings given to police officers are sufficient to improve their ability to control perpetrators, or in other words, increase their risk preventability C_p . Yet, employees of workplaces with public functions such as public transportation, emergency services, and health care organizations rarely have legislated and coercive control over individuals. The lack of

risk prevention/control capabilities makes them extremely vulnerable when facing the risk of violence. Moreover, the income (if any) compensation paid to employees is insufficient to offset the damage to the unspecified public and public safety, and a different penalty intensity design is required to make the adjustment.

Cost Structure of Health Care Workplace Violence

Health care workers also face potential violence in the workplace originating both internally and externally. However, due to the higher identifiability and preventability, mechanisms discussed above that enable the employers to take lawful responsibilities to keep workplace safe, would greatly reduce internal violence against health care workers, and eventually converge to that of average rate across sectors. The particular part of health care workplace violence comes from its external perpetrators and we focus on this below.

From the perspective of economic theory, the design of the punishment intensity for a criminal act should achieve a balance between the costs and benefits of controlling crime and rights infringements under the constraints of limited judicial resources, so that potential offenders are incentivized to the maximum to avoid the social costs incurred by their acts. Regarding violent crimes committed in ordinary workplaces without externalities, additional social costs are generally not incurred. This is because only legal interests are infringed on victims. However, with violent crimes committed in health care workplaces, because of the presence of externalities that harm public safety, additional social costs are incurred on top of the victim's private cost. At the same time, the low identifiability and preventability of violence in health care workplaces, together with serious information asymmetry and specific factors in the health care service market, constitute the social cost structure of health care workplace violence different from that in other public places.

Victim Cost

Any given crime of violence could cause the victim to suffer physically and mentally and incur significant opportunity costs because of impaired working ability. The victim's private costs (C_0) include the following 3 aspects: (1) direct

losses other than property losses, which reflect the cost items of the victim's recovery of physical functions and the associated costs under current health care conditions, mainly including the costs of medical, mental health, and emergency response services, as well as insurance administration; (2) opportunity costs that mainly refer to productivity losses, including wages, fringe benefits, and housework, caused by the victim's inability to engage in paid work and unpaid household duties during the recovery of physical functions; and (3) nonmonetary losses such as the pain, suffering, and lost quality of life derived from the lack of a complete recovery of the victim's bodily functions.¹⁶ Health care workplace violent crimes are often manifested as assaults and assault attempts on health care workers and for which the victim's costs are identical to those of victims of violent crimes in other workplaces.^{15,17}

Public Safety Cost

The difference in violence between that in a health care workplace and in a general workplace, or a general crime of violence, arises from the externality of a health workplace being derived from its public safety responsibilities. Assaults against health care workers, whether or not they lead to seriously physiological and psychological injury or death, generate the risk of disrupting the availability of health care services, with the risk of losing emergency medical assistance services being the highest. Once the availability of health care services is disrupted or lost, all patients who are being treated or waiting to be treated are affected, exposing the unspecific public to risk. Although the public may not know and may not panic, their legal interests are already substantially infringed. Health care workplace violence can lead to a complete or partial disruption of service delivery, and even in the latter case, in an environment of panic in which health care workers are victimized or threatened by violence, the cost of the degradation in service quality and stability could inevitably be borne by patients and the public. In other words, violent attacks on health care worker in the hub of the service network have led to negative externalities that cause the short-term disintegration of the public health care service network and corresponding public safety costs (C_1). The negative externality caused by health care workplace violence is the main cost component that differentiates it from the violence that occurs in other general workplaces.

Defensive Medicine Cost

Given the broad presence of information asymmetry in health care services, defensive medicine is described as the behavior of doctors that includes evidence preservation and defending against rights infringement lawsuits, such as for improper treatment. This information asymmetry tends to increase medical costs and is difficult to completely eliminate.^{18,19} In transaction cost economics, to avoid transaction

risks, all parties concerned would design corresponding contractual safeguards in the contract and adopt targeted measures.²⁰ This ex ante cost is common in all workplaces open to the public. However, in the context of low-risk identifiability characteristics and health care workplace violence, it is difficult for health care organizations and health care workers—who are not allowed to identify high-risk persons and selectively provide services—to know from which persons the risk of violence exists. Therefore, health care workplace violence risks drive them to implement additional risk prevention and control measures for all patients. However, health care workers are different from the police and other law enforcers and do not have the necessary law enforcement permits, equipment, and skills to actively prevent and control the risk. Their passive risk aversion strategies include (1) expansion of the scope and extent of defensive medicine by overprescription and excessive examinations, which increase medical costs, to avoid potential health care workplace violence, claims, and legal liabilities; and (2) avoiding the provision of high-risk health care services or the transfer of service risks to other health care providers and the general public through unnecessary referrals.^{21,22} As a result, the defensive behaviors against the risks caused by health care workplace violence directly make all patients and the public as a whole to bear the cost of rising health care costs and declining service availability. We define this social cost, which is driven by health care workplace violence, exclusively present in health care workplaces and beyond information asymmetry, as a defensive medicine cost (C_2). As the incidence of health care workplace violence increases, the incentives for health care worker to implement defensive medicine will rise, and the defensive medicine cost C_2 would be higher correspondingly.

Specific Factors Cost

Health care human capital is a specific factor. That is, once this factor is formed, it can only be applied to health care facilities and is difficult to transfer to other markets.²³ From the perspective of the labor market, workplaces that provide services such as public transportation, law enforcement, and health care are also plagued by low-risk identifiability issues. However, the mobility of their employees varies widely: bus drivers have strong skill substitution into other transportation service markets, and the cost of acquiring the skill for new entrants is low. The skill-training period required by law enforcement is relatively short, whereas the training of qualified doctors usually takes more than 10 years. The formation of health care human capital means occupational lock-in and factor specialization. Specialization of factor constrains the cross-market mobility of incumbent health care personnel. But as the incidence of health care workplace violence is significantly higher than the average of that in other workplaces as the statistics showed,^{24,25} the negative impact of violence will be incorporated into the cost-benefit analysis for those

attending medical school and becoming a doctor, and the current decline in market-entry incentives would inevitably diminish the long-term stock of health care human capital,²⁶⁻²⁸ worsening the availability of health care services.

Depending on the presence and absence of price regulation, the specific factors cost (C_3) we defined can manifest in 2 forms. First, if the price of health care services is heavily regulated, a serious lack of market-entry incentive of health care workers could lead to service shortages (eg, longer waiting time) and declined service quality. Second, if the price of health care services is completely determined by the market, the service price would be driven up to offset high violence risk and incentive market entry of health care personnel, albeit at the expense of low-cost accessibility and the equitable attainability of health care services, which is another form of a specific factors cost.

Optimal Penalty of Health Care Workplace Violence

Despite various perceptions of what constitutes violence due to differential culture and social backgrounds and a lack of standard measurement on violence,^{26,29} different countries have developed mature legislative and judicial penalty designs on workplace violence regarding victims' legal interest infringements. In this section, we take such crime with no additional social costs as the benchmark and develop a comparative static analytical framework on the optimal penalty for health care workplace violent crimes. We include the externality feature of a health care workplace and the cost structure into the analysis. The core objective of the model is to deter potential criminal persons from their criminal acts, so as to achieve preventive protection for health care workers who perform public safety functions. Another function of the model is to allow the added social costs caused by the health care workplace violence being matched to the corresponding true cost as determined by the optimal penalty, which could help reallocate limited judicial resources.

The increase in the degree of violence could result in a gradual increase in the marginal cost; when the violence causes the death of the victim, the marginal cost is very high and tends to infinity. Therefore, the cost of violence increases gradually with the severity and quantity of violent crimes. In Figure 1, the horizontal axis represents the severity and quantity of violence, and the vertical axis represents the social cost and penalty. It can be seen that the violence (crime) cost curve is tilted to the upper right, with its slope, that is, the marginal cost, increasing. According to the principle of proportionality of crime and penalty, the cost of violence needs to be matched with the corresponding penalty. However, given limited judicial resources, when the severity of violence is lower than a threshold value, its penalty could be reduced to a very low level. Under such circumstances, a perpetrator of the crime is usually exempted from imprisonment, but could be subject to a warning, fine,

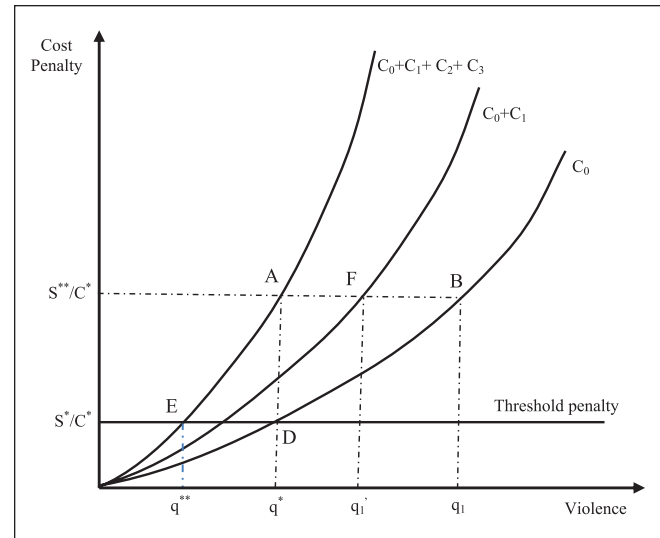


Figure 1. Optimal penalty model of health care workplace violence.

Source: The authors.

community service, and others. Let the starting penalty be S^* and its matching threshold level and corresponding cost be q^* and C^* , respectively. In the baseline case, only a victim's cost C_0 is present, its violence cost curve C_0 intersects with the starting-point (threshold) penalty $S = S^*$ at point D, where the optimal penalty S^* matches the level of violence q^* . For $q < q^*$, workplace violence exists, but not subject to criminal prosecution. As the severity of the violence increases, matched optimal penalty also increases along cost curve C_0 .

Comparative Static Analysis

Building on the baseline scenario introduced above, we now include the analysis of health care workplace violence-derived public safety cost (C_1), defensive medicine cost (C_2), and the specific factors cost (C_3). Figure 1 starts with the baseline violence cost curve C_0 for ordinary workplace from the right hand side. Adding the public safety cost C_1 makes the cost curve tilt upward to curve $(C_0 + C_1)$. Compared with the threshold-penalty intensity S^* and corresponding level of violence q^* for ordinary (workplace) violence, cost curve $(C_0 + C_1)$ intersects with $S = S^*$ at a level of q lower than q^* , indicating that the degree of violence corresponding to the starting (threshold) penalty intensity S^* should be lower than q^* . In other words, optimal penalty higher than S^* is needed to match the original level of violence q^* . For curve C_0 , only when the degree of violence q_1 causes serious injury to the victim is the penalty elevated to the penalty S^{**} corresponding to point B. However, after the public safety cost item is included, the cost curve $(C_0 + C_1)$ intersects with $S = S^{**}$ at equilibrium point F, where the corresponding level of violence must decrease from q_1 to q_1' .

If the defensive medicine cost (C_2) and specific factors cost (C_3) are further included, the violence cost curve is tilted further upward to $(C_0 + C_1 + C_2 + C_3)$ and intersect with original threshold violence degree $q = q^*$ at equilibrium point A with the optimal penalty increasing from S^* to S^{**} . Corresponding to social cost C^* and penalty intensity S^* of the threshold-penalty violence level q^* for ordinary (workplace) violence, now the level of violence must be decreased to q^{**} that is significantly lower than q^* , with the equilibrium changing from point D to E. Only below the level of violence corresponding to point E is the starting penalty not applicable in the context of health care workplace violence. Therefore, the degree of violence corresponding to the starting penalty in the context of health care workplace violence should be much lower than that in the context of ordinary violent crime. S^{**} to S^* reflects the situation in which, under the violence level of the starting penalty in the context of ordinary violent crime, an additional penalty is imposed on the perpetrator to offset the multiple social cost items to the public by health care workplace violent crime.

In the above analysis, we assume that different health care workplaces have the same cost structure and similar values. However, in most cases, different health care organizations in the service network exhibit differentiated systematic importance and violence incidence. In the graded diagnosis/treatment system used in most countries, the high-grade hospitals at the core of the network undoubtedly assume a more important position. There is evidence shown that these hospitals also experience higher violence incidence. For example, in China, the frequency of health care workplace violence in high-grade hospitals is much higher than that in low-grade hospitals²⁴; in United States, the incidence of health care workplace violence in health care organizations owned by state governments is far greater than that owned by private sectors and local governments.²⁵ Thus, the public safety cost generated by health care workplace violence is positively correlated with the importance of the health care facilities in which victims are assaulted. The public safety cost is greater when it is caused by violence at high-grade hospitals or health care organizations at the core of the service network, which means a larger magnitude of tilt of the cost curve ($C_0 + C_1$), a lower starting punishable level of violence, more serious social harm at a given level of violence, and the corresponding higher optimal penalty.

Another controversial factor related to health care violence is related to health care organizations themselves. When health care workers are not equipped with adequate training against potential perpetrators and/or their organizations are not supplied with suitable software and systems, it is difficult to prevent or reduce health care violence to a minimum. The implementation key is to observe whether an organization and its staff has satisfied the requirement set out by the relevant authorities and whether the organization has exert its legal responsibilities to keep the workplace safe. Organizations that have not reached the standard must subsequently fall into

various degrees of organizational culpability. These organizations must then accept subsequent punishment incurred both to themselves and their staff, and must improve to satisfy the legally acceptable requirements. The emphasis of law enforcement in the literature is where the controversy lies.^{9,15} However unprepared organizations and employees do not affect our discussions on the optimal penalty on health care workplace violence.

Optimal Penalty Dynamics

Violence cost and the optimal penalty dynamics is associated with the defensive medicine cost C_2 and the specific factors cost C_3 . Compared with the current effect of public safety costs, a lag effect emerges when considering C_2 and C_3 . After the current term when health care workplace violence happened, the cumulative violence and incidence change will alter the expectations of health care personnel and labor market participants: driving the former to change the diagnosis and treatment behaviors, and the services price would be pushed up; motivating the latter to reevaluate their health care market-entry decision, resulting a supply shortage (eg, longer waiting time, or congestion), or a quality decline in health care services (higher dissatisfaction) in long term and imposing a cost margin to the public.^{27,28} Besides, increasing congestion and dissatisfaction usually amplify negative motion of patients and trigger a vicious circle with health care workplace violence and further cost increase.^{29,30} Such dynamics would drive violence cost curve ($C_0 + C_1 + C_2 + C_3$) upward. The upward tilt of the violence cost curve calls for an increase for the optimal penalty to intervene until the increasing trend of incidence of health care workplace violence is reversed. If the incidence of health care workplace violence can be gradually reduced to a level close to that of ordinary workplaces, then the 2 costs of C_2 and C_3 would decline and tend to disappear. Thus, the violence cost curve would tilt downward, and the optimal penalty should be dynamically adjusted to cover victim's private cost and the public safety cost ($C_0 + C_1$).

Conclusion

This article develops an economic model aiming at generating a direct incentive system using optimal penalties to deter external perpetrators at health care workplace violence. We provide a 3-dimension analytical method, that is, externality, identifiability, and preventability, to distinguish the characteristics of health care workplaces from ordinary workplaces: (1) as an important component of the social emergency service system, health care workplace (worker) undertakes a public security obligation, making any violence in health care workplace a significant negative externality; and (2) the nature of compulsory contracting characteristics of health care organizations leads to low identifiability and preventability of external violence to health care workers. The

matching of differentiated legislative punishment and workplace characteristics is the key to materialize protection for victims and the related public interest to the greatest extent. Besides the private cost of victims as ordinary workplace violence shows, our cost structure analysis emphasized the social cost of health care workplace violence, which includes the externality-related public safety cost, and 2 cost items specific to health care context: the defensive medicine cost and specific factors cost. To allocate the scarce judicial resources more efficiently, it is needed for legislators to take into account the cost structure of health care workplace violence to balance the cost and benefit of the criminal act on health care workers and realize the proportionality of crime and punishment.

We also construct a simple optimal penalty model on health care workplace violence with ordinary violent crime without externality as the benchmark. The comparative static analysis reveals that the upward tilting of the violence cost curve significantly increases the optimal penalty corresponding to different levels of violence and decreases the threshold level of punishable violence to offset the social cost caused by health care workplace violence. The public safety cost is positively correlated with the importance of 1 health care workplace in the service network, and the higher the public safety cost is, the greater the optimal penalty should be. The resulting additional punishment for the perpetrator is aiming at the protection for the public interest attached to health care workers as the natural person. Implementing the law is never cost-free, and the antiviolence policy goal is not to

completely eliminate violence but, instead, to establish an incentive system that directly targets perpetrators to maximally inhibit the incidence of and harm from violence, to at least largely reduce and even eliminate defensive medicine cost and specific factors cost while fully compensating public safety cost. Changes could be expected if greater efforts are taken to persuade the legislators and the public into accepting the optimized penalty design, rather than sticking to the top-to-bottom cultural assumption that violence is part of the job of health care workers.

Nevertheless, we recognize that further work is needed to expand this study. First, EIP method developed in this study has a focus on optimal penalty in characteristics of workplace, level of violence, and their appropriate penalties, but not on types of violence. It should be noted that physical violence and verbal violence are different and there may be discrepancies in optimal penalties between the two. Second, in cost analysis on crime against health care staff, victim cost estimation on physical violence is established, but the cost on verbal violence needs different studies, the estimation of other costs requires further research, for example, evidence from case studies and/or empirical work. Finally, the justification of violence could be marginally effective in preventing health care workplace violence from the perpetrators' perspective, but it should be viewed as an important part of comprehensive solutions, which may include health care financing, training and education, regulation, and employers' duties, and the empirical evidence of their marginal effect could be explored.

Appendix

Table A1. Recent Law Revision for Nonfatal Health Care Workplace Violence in Selected Countries.

Countries	Victim	Present crime	Present penalty	Former crime	Former penalty	Year of law revision
Connecticut, USA	Health care workers	Felony class C	≤10 years imprisonment ≤\$10 000 fine	Misdemeanor class A	≤1 year imprisonment ≤\$2000 fine	2011
Illinois, USA	Nurses	Felony class C	2-5 years imprisonment	Misdemeanor class A	≤1 year imprisonment ≤\$2500 fine	2013
Texas, USA	Emergency workers	Felony class C	2-10 years imprisonment ≤\$10 000 fine	Misdemeanor class B (Unintentional)	≤180 days imprisonment ≤\$2000 fine	2013
				Misdemeanor class A (Intentional)	≤1 year imprisonment ≤\$4000 fine	2013
New York, USA	Nurses	Felony class D	≤7 years imprisonment	Misdemeanor class A	≤1 year imprisonment	2010
Vitoria, Australia	Emergency workers	—	Baseline 6 months imprisonment	NA	≤3 months imprisonment	2014
South Korea	Health care workers	—	≤5 years imprisonment ≤Won 20 million fine	NA	NA	2016

Source. The authors' collection.

Note. NA = not applicable.

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