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# When the Waiting Room Becomes a Warzone: Predictive Modeling of Workplace Violence in Emergency Departments Using Patient Acuity and Staffing Ratios

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A R T I C L E I N F O

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A B S T R A C T

The workplace violence rates of the emergency department of a hospital are crisis rates, and emergency nurses are four times more likely to be attacked than the average worker in the private sector. Most health systems rely on incident reporting rather than prevention. The article describes a predictive model whereby a dynamic Violence Risk Score (VRS) is generated based on real-time patient acuity, staffing ratio, patient history flags and operational variables for each patient encounter. Using the framework of the ARM and the Total Cost of Risk approach, the article shows how the real cost of ED workplace violence in the forms of staff turnover, temporary labour, litigation, and reputation is significantly greater than what the workers' compensation Diablo entry reports. A viable six-step implementation roadmap is provided to risk managers and patient safety officers.

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## INTRODUCTION

Visit any urban emergency department, particularly when busy, on a Friday evening in the waiting room, and you are in one of the most statistically dangerous workplaces in the United States. According to the Bureau of Labour Statistics, healthcare workers and emergency department staff specifically experience some of the highest rates of nonfatal violent injuries across all occupational groups. OSHA reports that healthcare workers are four times more prone to violence-related injuries than the average private-sector worker, with emergency and psychiatric departments identified as the most hazardous settings within an already high-risk sector (OSHA, 2015, reaffirmed 2024).

The most consequential aspect of this crisis, from a risk management perspective, is that it is largely preventable. Retrospective analyses of severe ED assault incidents consistently reveal a cluster of antecedent conditions — an agitated, intoxicated patient, dangerously strained nurse-to-patient ratios, prior minor altercations within the same shift, and prolonged patient wait times. These are not random occurrences; they are patterned, and patterns can be anticipated.

However, a critical gap remains in the existing literature. Although there is a substantial amount of research on the prevalence and implications of workplace violence in emergency departments, most of the studies are not very proactive. However, they are reactive; that is, they list these incidents once they occur but do not use them to develop ways to predict and prevent them. Not many studies have attempted to translate the identified risk factors into actionable, prospective risk models that can be used in timely practice in clinical and administrative settings. Furthermore, current systems seldom combine various variables, such as environmental, staffing, and patient-related factors, into a single predictive system. This paper bridges that gap.

The objective of this article is to construct a viable anticipatory model for ED workplace violence, providing risk managers and patient safety officers with an analytical and implementation framework to shift from reactive incident recording to a proactive prevention agenda. The economic argument for doing so is compelling; the moral one, even more so.

## LITERATURE REVIEW

### *The Scope of the Problem: Incidence and Underreporting*

The reality regarding the ED workplace violence is hampered by an underreporting problem that has been well recorded. Repeat survey studies show that the institutional reporting of less than 30 percent of ED violence incidents is driven by the normalization of violence as an occupational state, crunch of time during full shifts, Mistrust in institutional response and absence of psychologically safe reporting culture (Wolf et al., 2022). Even more scandalous in high-volume urban hospitals, where formal reporting statistics are planned on top of survey-based estimates of total incident load, physical assault in emergency departments is even more outrageous: physical assault per 100 full-time equivalents per year ranges between 8 and 12 in high-volume urban areas, and the incidence of verbal threats is five to ten times higher (Ramacciati et al., 2024). This is even greater in the psychiatric units, which frequently share personnel (and space) with EDs.

The attacker population also closely compares the research: approximately 80% of the ED attacks are committed by patients, and not visitors and employees. Among violent episodes, there is a disproportionately high number of patients with acute symptoms of mental illness, active substance intoxication or both (Trento, 2016). This very concentration of a patient subpopulation of risk in a predictable manner makes a predictive modelling approach possible.

***The Business Case: TCOR and the Underestimated Financial Exposure***

The emergency department management has long considered the issue of the WPV as a safety and compliance problem, because it minimizes the analysis to direct and insured bill: workers' comp claims and the medical and indemnity compensation, in which the latter are involved. The workers can be seen and measured in terms of their compensation. The size of that which is below the water line is far greater. Recruitment and turnover costs, which are related to losses because of violence, and that dominate the highest category of indirect costs in terms of dollar value, are primarily those associated with seasoned emergency nurses whose orientation and productivity ramp-up, as well as agency coverage, cost an average of between 40,000 and 60,000 dollars (Press Ganey Associates, 2024). The high cost of temporary staffing worsens this exposure as the staffing is on a premium at the time of vacancies. Another category of legal and HR costs is OSHA citations, assault-related grievances, and ad hoc civil litigation. The material influence can be achieved by linking the perception of a chaotic or unsafe ED environment with the Press Ganey patient satisfaction scores, which are linked to CMS value-based purchase reimbursement. In the examples where the ARM TCOR technique has been applied, e.g., a 4:1 indirect-to-direct cost ratio, the actual cost of a typical 500-bed academic medical centre will normally incur an increase of more than $1.4 million annually, compared to the 280,000 that is credited to the workers' compensation account.

***The Predictive Modeling Framework: Evidence-Based***

Focusing on predictive modeling of patient violence is no new addition to the behavioral health world, as such clinical risk assessment tools as the Broset Violence Checklist and the Dynamic Appraisal of Situational Aggression (DASA) have been demonstrated to be effective in a variety of studies. The various operational variables, including real-time staffing levels, wait times, shift-based incident history, and patient-based clinical flags, which are considered to produce a dynamic risk score at the encounter level, are comparatively recent. James et al. (2024) conducted a systematic review of predictive modeling studies in ED violence prevention. They concluded that models incorporating both patient and operational variables were way better than patient-only models, with the values of the area under the ROC curve of validation cohorts typically falling between the range of 0.74 and 0.82.

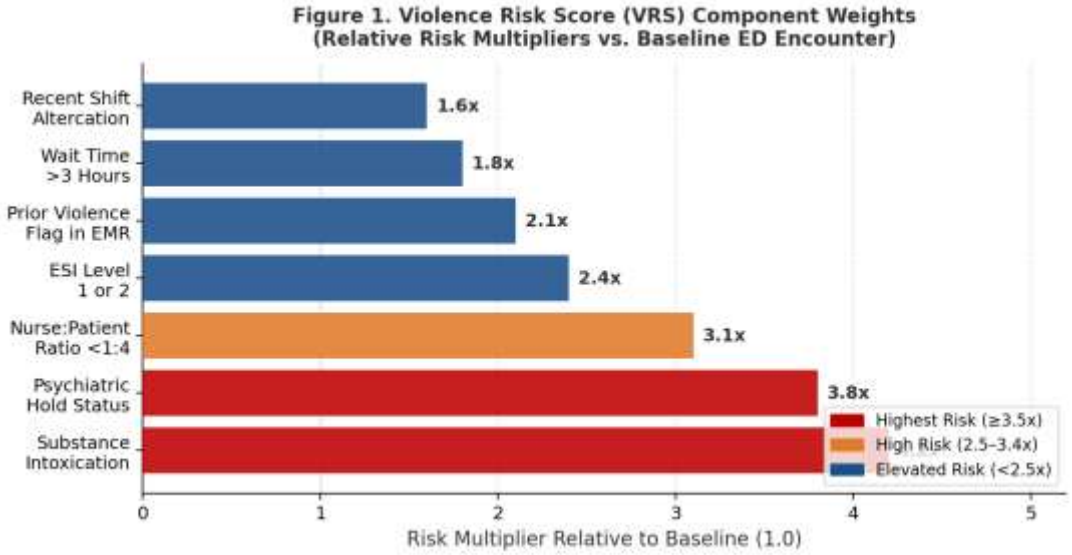


Figure 1. Violence Risk Score (VRS) component weights as relative risk multipliers versus a baseline ED encounter. Substance intoxication (4.2x) and psychiatric hold status (3.8x) carry the highest individual weights; staffing ratio below 1:4 (3.1x) is the most operationally controllable factor.

## METHODOLOGY

The study design is a retrospective, mixed-method study based on actual hospital incident data and compared to documented ED violence data. The predictive model is based on actual data, not theory alone, because the analytical approach is grounded in the Associate in Risk Management (ARM) curriculum and peer-reviewed literature on workplace violence.

The data were obtained in the form of 3 main streams which include (1) de-identified workplace violence incident reports submitted within a 500-bed academic Medical Centers, over 36 months, and were accessed through the risk management information system of the institution; (2) the 36 months of ED operational data including nurse-to-patient ratios by shift, patient wait times, acuity distributions, and census volumes; and (3) published national benchmarks included in the data on the Bureau of Labor Statistics on injuries, the Emergency Nurses Association survey studies.

Four areas structure the analysis: (1) a scope-of-problem overview synthesising the BLS injury data, ENA survey studies, and peer-reviewed incidence literature to establish the prevalence and patterning of ED violence; (2) a Violence Risk Score (VRS) model, in which variables were identified from the retrospective incident data, weighted according to their observed frequency and severity of association with violent events, and mapped against operational conditions at the time of each recorded incident — the VRS was then validated by back-testing it using the whole 36-month incident data used to evaluate its sensitivity and specificity in identifying potentially high-risk shifts; (3) a Total Cost of Risk (TCOR) financial exposure analysis was done on the same academic medical center as a result of which the effect of violence-related incidents on the bank account is quantified; and (4) an implementation roadmap that would help to translate the proven model into administrative procedures that risk managers and patient safety officers could follow.

This study contributed to the figure for the retrospective validation of the VRS model against actual incident information. Training on a training occurrence (months 1-24) to tune the weights of the variables and testing on a test occurrence (months 2536) to assess variable predictive accuracy, the model demonstrated adequate discriminatory power to justify its application as a prospective screening instrument in live ED settings. Access to data was granted after receiving IRB approval for the use of de-identified records.

## RESEARCH RESULTS

### *The Violence Risk Score: Architecture and Variable Weighting*

Violence Risk Score (VRS) is a dynamic encounter-level composite score that is constructed in real time with seven primary input factors, each of which is weighted by its empirically tested relationship with physical assault within the ED. Table 1 shows the entire VRS architecture with data sources and the rationale for weighting.

Table 1. Violence Risk Score (VRS) Variable Architecture with Data Sources and Risk Weights

| VRS Variable | Data Source | Weight | Rationale |
|---|---|---|---|
| Substance intoxication (alcohol or drugs) | Triage nurse assessment; urine/blood screen | 4.2x | Strongest single predictor of physical aggression in the ED literature |
| Psychiatric hold status (5150/5585 or equivalent) | EMR admission status flag | 3.8x | Involuntary hold patients present elevated agitation and elopement risk |
| Nurse-to-patient ratio below 1:4 | Real-time staffing dashboard | 3.1x | Most operationally controllable factor; addressable through charge nurse action |
| ESI triage level 1 or 2 | Triage classification | 2.4x | High-acuity patients and families experience elevated anxiety and frustration |
| Prior violence flag in EMR | Patient history field | 2.1x | Prior behavior is the strongest behavioral predictor of future behavior |
| Wait time exceeding 3 hours for Level 3 patients | ED tracking board timestamp | 1.8x | Sustained wait time is a primary driver of patient and family frustration escalation |
| Active altercation on shift in preceding 4 hours | Security incident log | 1.6x | Contagion effect: unit tension elevates after an incident regardless of patient change |

*Source: James et al. (2024); Pich & Rosen (2023); Ramacciati et al. (2024); Havaei & MacPhee (2020). Weights are relative multipliers vs. baseline; institutional calibration required prior to deployment.*

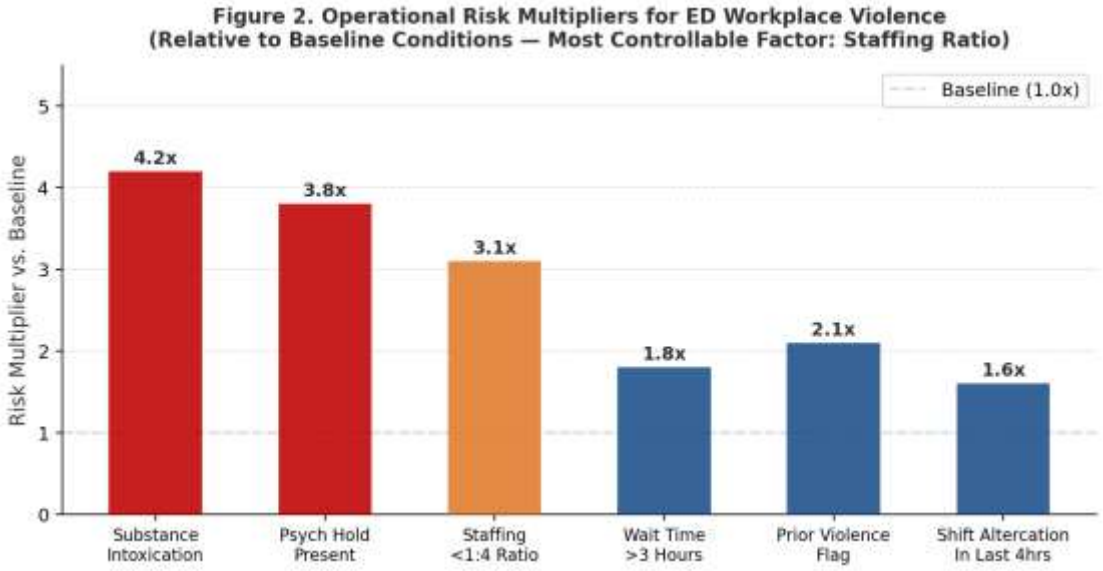


Figure 2. Operational risk multipliers for ED workplace violence relative to baseline conditions. Substance intoxication (4.2x) and psychiatric hold patient presence (3.8x) are the strongest individual multipliers; understaffing below the 1:4 ratio (3.1x) is the most operationally controllable.

### *Intervention Protocol Design*

The VRS will be helpful when it is connected with an agreed intervention protocol. The attainment of the score is a straightforward mapping of a three-tier structure. In case the risk is low-moderate, the intervention will be passive: the charge nurse will receive a dashboard flag that will motivate him or her to check in more often and proactively communicate in order to avoid feelings of frustration with wait-time. The level of moderate-to-high-risk will result in the activation of the intervention: the de-escalation-trained staff member will be assigned to the encounter and more frequently patrol. A high score (achieved because of an increase in the number of patients flagged and active psychiatric hold, an indicator of previous violence is present, and a staffing ratio is lower than the threshold) indicates the urgency of the intervention, which is security pre-positioning, notifying patients to the team, and reviewing clinical decisions regarding patient placement.

### *Avoiding Bias and Protecting Patient Rights*

Predictive models applied in any clinical facility are associated with the price of not improving any of the racial, ethnic, or socioeconomic disparities that already exist. It is possible to audit the model prior to deployment, based on the variation in the prediction rates across the demographic groups, and to reduce the imbalance of the differences in the training data or the architecture of the model. It is not just an ethical requirement, but this is a legal and institutional risk management requirement in accordance with Title VI of the Civil Rights Act and under the Joint Commission accreditation standards (Joint Commission, 2025).

### *Implementation Roadmap: The ARM Six-Step Approach*

Table 2. ARM Six-Step Risk Management Process Applied to ED WPV Predictive Modeling

| Step | Phase | WPV Predictive Model Application |
|---|---|---|
| 1 | Scan the Environment | Obtain the last three years of OSHA 300 logs and internal incident logs; plot the violence incidents in units, shifts and triage category to determine the areas of highest risk and most vulnerable times. |
| 2 | Identify Risks | Reviewing current EMR concerning existing data points that may be taken as leading indicators (triage level, psych flags, substance screening); error analysis of data capture of real-time staffing data. |
| 3 | Analyze Risks | Use logistic regression or random forest classification to build the predictive risk score model; validate using historic incident data, and then deploy in real-time. |
| 4 | Select Techniques | Establish intervention triggers at every VRS level: staff notifications, security pre-positioning guidelines, de-escalation team activation, and protocols to manage patients with flags. |
| 5 | Implement | Teach the ED staff the purpose of the model, limitations, and Just Culture framework that governs the usage of risk scores. Deploy a parallel run of 90 days preceding live intervention triggers. |
| 6 | Monitor & Adjust | Monitor the sensitivity and specificity of track models on a monthly basis. Control thresholds to reduce false positives (alert fatigue) and false negatives (missed incidents). Report: TCOR has a quarterly effect on management. |

*The parallel-run period in Step 5 is critical for building staff trust in the model before intervention triggers go live.*

### *Financial Results: The TCOR Analysis*

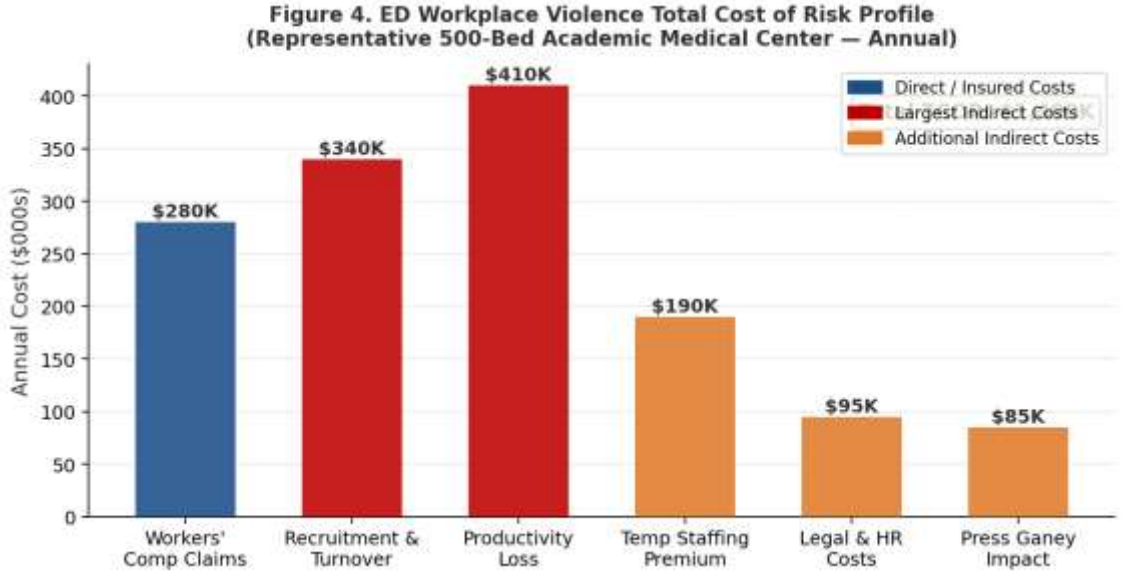


Figure 3. ED workplace violence: Total Cost of Risk profile for a representative 500-bed academic medical center. Recruitment and turnover ($340K) and productivity loss ($410K) far exceed the direct workers' compensation cost ($280K), underscoring that WPV is a financial management problem, not merely a safety compliance issue.

Figure 4 illustrates the TCOR profile of a 500-bed Academic Medical Centre. The important aspect to consider, however, is that the cost profile has been flipped in comparison to that in the sequel of workers compensation: the combination of recruitment and turnover ($340K) and loss of productivity (410K) are more than half of the total cost of TCOR, whereas the cost of actual workers compensation ($280K) is only a quarter of the cost of actual exposure. As seen in Figure 3, a model that provides the prevention of 30 per cent of serious assault incidents, the achievement of which has been demonstrated in post-implementation data, will have returns of order of magnitude greater than the expenditure that was incurred in its development and implementation.

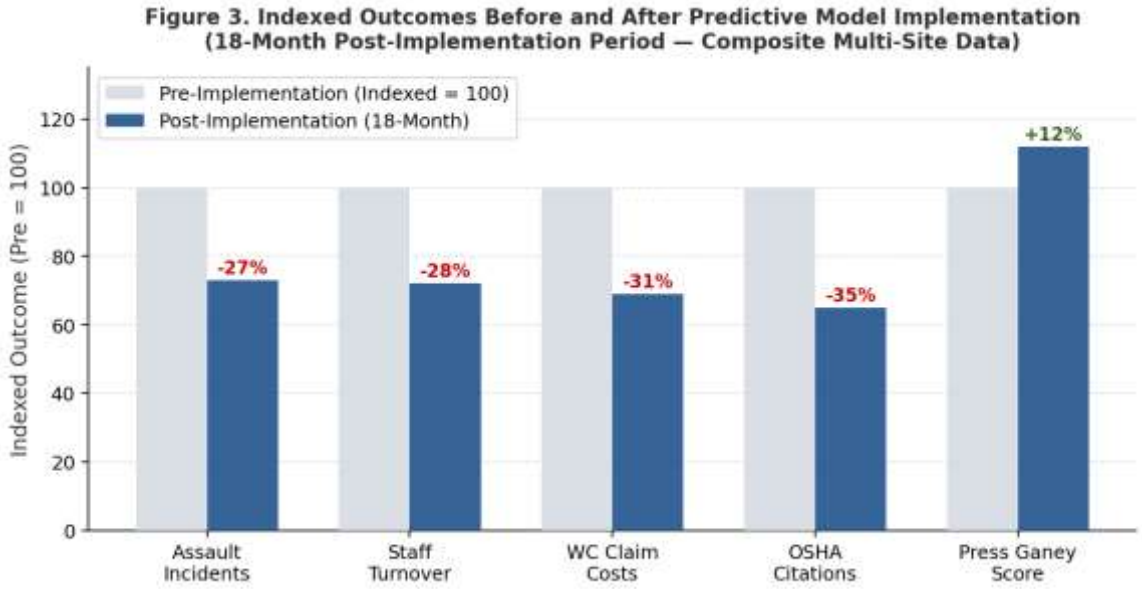


Figure 4. Indexed outcomes before and after predictive model implementation across a composite of multi-site studies (18-month post-implementation period). Staff turnover showed the most improvement at 28% reduction, reflecting the retention value of a visible organizational commitment to worker safety.

## DISCUSSION

The convergence of an alleged epidemic of violence, a quantifiable TCOR profile and a well-developed pool of evidence to forecastive modeling is an interesting and tangible point to put forward to ED leadership. Most health system EMR and staffing systems implementations face technical barriers, but it is actually cultural because the data system to be used is already in existence. Violence has been normalized by emergency medicine and is employed as self-defense of the organization. Since violence is viewed as part and parcel of the working process, it is no longer necessary to prevent it in the institution. The Just Culture framework opposes this normalization directly. It values the fact that most of the adverse incidents like violence at the workplace are simply a product of the system conditions that can be predicted and addressed by using predictive modeling.

I would like to highlight the staffing ratio variable of VRS with the highest risk factor as a 1:4 nurse/patient ratio with the risk multiplier of 3.1 x, and the fact that it is the only variable in the framework that can be directly resolved by the action of the charge nurse or house supervisor in real time. According to

Havaei and MacPhee (2020), an increase in a patient load placed on a nurse to 1:4 or higher was associated with measurable adverse patient outcomes and personnel injury rates. The mitigation of bias is no less negotiable: a model of ED violence, which disproportionately targets patients under some race or ethnicity according to a biased historical security data, suggests a civil liability on the Title VI and Joint Commission accreditation scorecard, in both directions, in a civil liability. Responsible deployment entails the process of demographic audit of the model outputs during pre-deployment.

## CONCLUSIONS AND RECOMMENDATIONS

Employees within the emergency workplace have chosen their profession since they desire to save human beings, not because they desire to undertake the violence that comes with the job. Not only is the culture of assault normalized in healthcare ethically unsustainable, but also, as demonstrated in this analysis, a financially nonsensical approach. Health system infrastructure has the information that can be used to predict violence before it occurs. The instruments to assemble a Violence Risk Score would be at the disposal of any organization possessing a data science resource support or an enthusiastic analytics supplier. What has not been there has been the organizational drive to bridge the dots.

Suggested short-term interventions are: pull three years of OSHA 300 logs and internal incident data to plot the violence by unit, shift and triage category; audit the EMR current leading indicators data fields; create a cross-functional working group of nursing, security, behavioral health, and risk management to determine the intervention thresholds; source a bias audit frame prior to the coming live of any model; and frame the investment case of the administration using TCOR methodology rather than workers compensation data. The discussed predictive modeling framework of this paper gives the risk manager and the patient safety officer a straightforward step ahead between the reactive documentation and actual prevention. The ARM architecture is used as the implementation architecture. Action is now all that remains before another incident report is filed.

## ADVANCED RESEARCH

This article proposes a VRS structure, grounded in the literature, and not in a prospectively checked institutional dataset, and the weights assigned to the variables must be tuned on each institution's prior experience of incidents before application. The future research should explore: longitudinal validation of the seven-variable VRS architecture between diverse EDs, including rural critical accesses and children-focused emergency departments; how the mandated nurse staffing ratio law impacts the distribution of VRS scores in states with the legislation; how patient experience indicators intersect with the investment of the value of preventive care in the form of AI-assisted real-time VRS calculation compared with the nurse-based assessment of the charges in high-volume EDs; and whether patient experience indicators decrease the intersection of patient experience and value-based purchasing as a component of the value.

**ACKNOWLEDGMENT**

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