
Testing the Reliability and Validity of a Measure of Safety Climate

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adherence programs
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The lack of compliance with universal precautions (UP) is well documented across a wide variety of healthcare professions and has been reported both before and after the enactment of the Occupational Safety and Health Administration's Bloodborne Pathogens Standard. Gershon, Karkashian, and Felknor (1994) found that several factors correlated significantly with healthcare workers' lack of compliance with UP, including a measure of organizational safety climate (e.g., the employees' perception of their organizational culture and practices regarding safety). We conducted a secondary analysis using data from a cross-sectional survey of a convenience sample of 1,746 healthcare workers at risk of occupational exposure to bloodborne pathogens to assess the validity and reliability of Gershon's measure of safety climate. Findings revealed no relationship between safety climate and employees' gender, age, education, tenure in position, profession, hours worked per day, perceived risk, attitude toward risk, and training. An association was demonstrated between safety climate and (1) healthcare worker compliance with UP and (2) the availability of personal protective equipment, providing support for the construct validity of this measure of safety climate. These findings could be used by occupational health professionals to assess employees' perceptions of the safety culture and practices in the workplace and to guide the institution's risk management efforts in association with UP.

The risk of bloodborne pathogens to healthcare workers is well known. There are approximately 5.5 million healthcare workers in this country with either patient or patient-specimen contact (*Federal Register* 56, 1991). Despite development and dissemination of regulations by the Centers for Disease Control and Prevention (CDC) and the Occupational Safety and Health Administration (OSHA), the problem of healthcare worker compliance with "universal precautions" (UP) is widely documented (Gershon et al., 1995). Quality improvement (QI) monitoring of UPs can be used as an effective tool to determine

underlying issues of noncompliance. Recent studies have attempted to investigate behavioral factors predicting compliance. According to Gershon et al. (1995), a key predictor is organizational safety climate. However, previous studies have shown that safety climate is a diffuse, poorly understood construct (Brown & Holmes, 1986; Coyle, Sleeman, & Adams, 1995; De-dobbeleer & Beland, 1991; Zohar, 1980). The purpose of this study was to assess the validity and reliability of Gershon's measure of organizational safety climate in order to understand its relevance to the greater body of literature on safety climate. This information can be used by safety professionals to monitor the quality of their organization's safety culture.

Review of UP Compliance Literature

In an effort to minimize healthcare worker exposure to HIV and other bloodborne pathogens, the CDC formulated the concept of UP, in which an effort is made to prevent healthcare worker exposure to blood and body fluids of all patients (Henry, Campbell, Collier, & O'Boyle-Williams, 1994). According to these guidelines, patients' blood and other body fluids (semen, vaginal secretions, and cerebrospinal, synovial, pericardial, and amniotic fluid) are considered potentially infectious for HIV, hepatitis B virus (HBV), and other bloodborne pathogens. To guard against exposure to these potentially fatal secretions, barrier precautions (i.e., gloves, gowns, eye protection, leg coverings) are to be used appropriately when dealing with every patient, thus the term UP (Ronk & Girard, 1994). In 1996 the term UP was changed to standard precautions (Garner, 1996). However, the term UP is used in this paper.

OSHA's bloodborne pathogen standard implies that engineering controls, not merely worker compliance with regulations, are optimal methods for achieving this goal. The OSHA compliance directive instructs OSHA compliance officers how to enforce the new standard, making it clear that it is "the employer's responsibility to ... review the feasibility of instituting more advanced engineering controls," such as needleless IV (intravenous) connectors and self-sheathing needles (*Federal Register* 54, 1989).

A review of the literature indicates that lack of compliance with UP is widespread, documented across a wide variety of healthcare worker occupations, and frequently reported both before and after the enactment of the OSHA bloodborne pathogens standard. Lack of compliance with UP increases healthcare workers' occupational blood exposures and the potential for transmission of bloodborne pathogen disease. Lack of compliance

encompasses a wide variety of behaviors. Gershon, Karkashian, and Felknor (1994) cited factors significantly correlated with lack of compliance, including the following: (a) gender (i.e., men reported lower levels of compliance), (b) perceived patients' needs (i.e., healthcare workers perceived that the patients' needs were so pressing that the worker could not adhere to UP), (c) risk-taking personality (i.e., workers who scored high on a well-defined risk-taking personality scale were much less likely to comply with UP than those workers with average or low scores), and (d) safety climate (i.e., workers who perceived management to have a low level of commitment to workplace safety were less compliant). Factors that were also noted to be significantly associated with compliance included high levels of knowledge of the actual risk of HIV infection and the routes of transmission in the healthcare setting, tolerant attitudes towards HIV/AIDS patients, low levels of work stress, and belief in the efficacy of the preventive compliance behaviors.

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Review of Safety Climate Literature

Safety climate is described by Coyle et al. (1995) to be a subset of organizational climate, or the social and organizational circumstances in which employees work, defined primarily in terms of employees' perceptions. Safety climate includes work practices, work style, operator training, and industrial hygiene.

A study by Zohar (1980) is the first published paper we identified that attempted to measure safety climate. Zohar proposed that safety climate was not a single dimension (like height or weight) but could best be understood as a set of independent (unrelated) components. This study used factor analysis to describe the patterns of correlations observed among different measures related to safety climate.

Zohar (1980) identified eight components of safety climate as perceived by workers, including the importance of safety training programs, management attitudes toward safety, the effects of safe conduct on promotion, the level of environmental risk, the effects of required work pace on safety, the status of the safety officer, the effects of safe conduct on social status, and the status of the safety committee. Zohar found that the organizational safety climate is positively correlated with safety program effectiveness, as judged by safety inspectors, and concluded that an analysis of safety climate can identify areas in which organizational safety can be improved. The two dimensions of highest importance in determining safety climate were workers' perceptions of management attitudes about safety and workers' perceptions of the relevance of safety in general production processes.

Very little research has addressed the impact of safety climate on healthcare worker compliance with UP with the exception of a study by Gershon et al. (1995), which revealed that healthcare worker compliance rates were higher for workers who perceived that the hospital had a strong commitment to safety than

for those who did not perceive a strong safety commitment. The purpose of this paper is to evaluate the reliability and validity of a measure of safety climate in association with healthcare worker compliance with UP.

Theoretical Background

The construct validity of a test is the extent to which the test may be said to measure a theoretical construct or trait. Criterion validity is a second type of validity. In this type of validity there is usually a pragmatic, objective criterion with which to compare a measure (e.g., if we were using employee reports to measure workplace policy, a good criterion validity measure would be to compare employees' self-report of policy to the organization's written policies). In criterion-related validity the key issue is often whether the instrument is a useful predictor of subsequent behaviors, experiences, or conditions (e.g., do Scholastic Aptitude Test scores predict college performance?). The more abstract the concept, the less suitable it is to validate a measure by the criterion-related approach. Construct and criterion-related validity share an empirical component, but in construct validity the instrument designer is concerned with the questions: What is this measuring device really measuring? Is the abstract concept under investigation being adequately measured with this instrument? Construct validity is more concerned with the underlying attribute than with the scores that the instrument produces (Polit & Hungler, 1995).

Safety climate should be measured using construct validity given its abstract nature. All the safety climate articles reviewed (Brown & Holmes, 1986; Coyle, Sleeman, & Adams, 1995; De-dobbeleer & Beland, 1991; Zohar, 1980) had validity testing as a primary objective. All investigators agree on the existence of a theoretical concept of safety climate as perceived by employees, but there is no consensus on the structure of measure (i.e., number and names of factors), although there is a similarity in the nature of items (worker training, organizational policies, availability of appropriate equipment, etc.) across factors. Investigators typically use factor analysis or a related multivariate analytic method to establish a reliable and valid measure for their population of interest.

Methods

This report is based on a reanalysis of data collected by Gershon et al. (1995) to assess levels of compliance with UP among hospital-based personnel.

Data Collection: The data were taken from a cross-sectional study performed at three large, geographically distinct, acute-care hospitals. The Mid-Atlantic, Southwestern, and Midwestern hospitals had high, medium, and low prevalence rates of bloodborne infection, respectively. A convenience sample of volunteers at each hospital completed questionnaires on their knowledge, attitudes, and behaviors related to HIV/AIDS and compliance with UP in 1992.

The study population included personnel expected to be in direct patient care or having specimen contact, for example,

critical care, emergency, laboratory, surgery, and phlebotomy personnel. A sample of 3,000 employees was identified by selected departments and job classifications from hospital personnel records and sent a confidential, self-administered 210-item questionnaire designed by Gershon et al. (1995). The response rate for healthcare workers was 57%.

Sample Characteristics: The sample consisted of 79% females and 21% males ($N = 1,746$). The mean age was 36 years. The majority of the participants (50%) were college graduates, and 31% had postgraduate education. The largest group in the sample was nurses (52.4%), followed by physicians (18.7%), laboratory technicians (16.6%), and miscellaneous workers (12.4%), including dentists, emergency medical staff, embalmers, orderlies, and clinical and management personnel. On average, healthcare workers had worked 5.9 years in their present position. Most respondents (81%) were employed full-time, while 13.6% were employed part-time, and the remaining 5.5% were on-call staff, volunteers, or float-pool staff. The plurality of respondents were from Maryland (45.5%); another 34.7% were from Minnesota; and 19.8% were from Texas.

Survey Instrument: The survey developed by Gershon et al. (1995) took item content from UP guidelines issued by the CDC and OSHA. For the most part scales and questionnaire items were selected from established, well-defined instruments. Additional input from healthcare workers was obtained through focus groups.

The final questionnaire addressed three major conceptual areas, all of which were hypothesized to function as factors influencing compliance behaviors: (a) sociodemographic and individual factors, (b) psychosocial factors, and (c) organizational factors (Gershon et al., 1995).

Safety Climate: The items used to measure safety climate are described in **Table 1**. Each item was scored on a 4-point Likert-type scale ranging from strongly agree to strongly disagree. Each item's score was added, and then a mean for the entire scale was computed; the range of scores was from 1 to 4. The higher the score, the stronger the safety climate was perceived to be by the healthcare worker.

Analysis

Internal consistency reliability was assessed using a statistical test called Chronbach's alpha, which is a statistic that assesses the reliability of a measure. It estimates the correlations between all possible pairs of questionnaire items to evaluate the internal consistency of a measure (e.g., safety climate). While higher item intercorrelations generally indicate a measure is more internally consistent and reliable, if the score is too high there may be redundancy in measurement (McDowell & Newell, 1996). Convergent evidence regarding validity is drawn from a variety of statistical tests. Each test is based on a hypothesis about the nature of the safety climate. Specific variables, hypotheses, and statistical tests are summarized in **Table 2**. A positive association between the independent variable and safety climate is denoted by +, and no relationship, by \emptyset .

Table 1. Measure of Organizational Safety Climate

Please answer the following questions about your workplace by indicating if you strongly agree, agree, disagree, or strongly disagree

Employees, supervisors, and managers work together to ensure the safest possible working conditions.

There are no significant compromises taken when worker protection from infectious diseases is at stake.

The protection of workers from occupational exposure to HIV is a high priority with the management where I work.

All reasonable steps are taken to minimize hazardous job tasks or procedures.

Unsafe work practices are corrected by supervisors.

Top-level management gets personally involved in safety matters.

Unsafe practices are corrected by coworkers.

There is a safety committee where I work.

I feel free to report safety violations where I work.

To establish construct validity, hypotheses were generated about both the presence and absence of expected relationships among variables. There is reason to believe that education and profession would have an effect on employees' perception of safety climate. It is expected that educated individuals will have a greater understanding of safety climate than less educated individuals and will score relatively higher on safety climate. Physicians, nurses, and laboratory technicians would each perceive safety climate differently. Physicians may have the lowest scores on safety climate because they have admitting privileges at a variety of institutions and may be less aware of any one institution's safety practices. Laboratory technicians stay at one institution and therefore may score higher on safety climate. Although nurses also stay at one institution, they may have greater variability in job tasks and functions, which may make awareness of or adherence to institutional safety climate less than that observed for laboratory technicians.

Perceived risk and attitude toward risk are positively related to safety climate. People who are risk averse may be more acutely aware and sensitive to safety climate than individuals who are risk tolerant. Availability of personal protective equipment (PPE) and training in UP/PPE would have a positive relationship on safety climate because it would reflect how great a priority management places on the safety of its employees. Healthcare workers who practice compliance with UP may also score higher on safety climate because they would tend to perceive management as having a strong commitment to safety. In contrast to the above expected relationships, there is no reason to believe that gender, age, tenure in a position, or hours worked

Table 2. The Hypothesized and Observed Relationships Between the Independent Variables and Safety Climate for Healthcare Workers (N = 1,746)

Independent Variable	Hypothesized Relationships	Observed Relationships	Meaningfulness	Statistical Test
Education (levels ranged from no high school to postgraduate education)	+	∅	∅	Spearman correlation
Profession (MDs, RNs, laboratory technicians, miscellaneous workers)	+	+	∅	ANOVA
Perceived risk (self-rated risk of HIV infection through work)	+	+	∅	Pearson correlation
Attitude toward risk (mean response to 6 items)	+	+	∅	Pearson correlation
Availability of PPE (5 items assessing access to PPE)	+	+	+	Spearman correlation
Training in UP (who had training/who did not)	+	∅	∅	z-test
Training in PPE (who had training/who did not)	+	∅	∅	z-test
Compliance (self-rating on 11 compliance behaviors)	+	+	+	Pearson correlation
Gender (0 = male, 1 = female)	∅	∅	∅	z-test
Age (actual age in years)	∅	+	∅	Pearson correlation
Tenure in position (number of years worked in current position)	∅	∅	∅	Pearson correlation
Hours worked/day	∅	∅	∅	Pearson correlation

Note. MD = medical doctor, RN = registered nurse, PPE = personal protective equipment, UP = universal precautions, ANOVA = analysis of variance, + = positive association between independent variable and safety climate, ∅ = no relationship between independent variable and safety climate.

in a day would have an effect on employees' perception of safety climate. These hypothesized relationships are summarized in Table 2.

Limitations

The study findings are limited to bivariate associations for purposes of assessing validity of the measure of safety climate. Thus no causal inferences can be made. However, the analysis is a necessary step in constructing valid and reliable questions for use in program evaluations for purposes of quality improvement.

Results

Reliability: Chronbach's alpha for the 8-item safety climate scale was 0.85, indicating a high degree of internal consistency reliability. The items were also used in a principal components analysis, which is a method of factor analysis that refers to a variety of statistical techniques whose common ob-

jective is to represent a set of observed variables in terms of a smaller number of hypothetical variables (Kim & Mueller, 1978). This analysis showed a single factor that correlated highly with all items. The high reliability score and single factor solution indicate that safety climate is a unidimensional construct.

Validity: Statistical tests indicate the probability that the relationships seen in our data could have occurred by chance alone. If this probability is less than 5% ($p < .05$), the relationship is considered "statistically significant," or meaningful. The total sample size for this study was $N = 1,746$. With extremely large sample sizes, average differences too small to be meaningful may actually be statistically significant. Therefore, for each result reported below, we indicate the outcome of the appropriate statistical test and our interpretation of its meaningfulness. Table 2 depicts the hypothesized and actual relationship between the independent variable and the measure

of safety climate. Only those results that are both empirically significant and important for practice are described.

Availability of PPE: Respondents were asked to what extent their employers provided access to PPE. Five items (strongly agree, agree, disagree, strongly disagree, and not applicable) were scored on a 5-point Likert scale. Item content addressed employees' perception of (a) whether or not the facility provides necessary equipment and devices to protect the healthcare worker from HIV exposure, (b) whether or not the necessary equipment and devices to help avoid contact with HIV were readily available, (c) whether or not sharps containers were readily available at the facility, (d) whether or not medical waste was properly disposed of, and (e) whether medical waste containers and bags were readily available. The mean of these items measured availability of PPE. Higher scores indicated greater availability of PPE. The Pearson correlation between safety climate and PPE availability was 0.48 with 1,720 degrees of freedom, $p < .0001$, indicating a statistically significant relationship. A 2-point increase in PPE availability is associated with an approximately 1-point increase in safety climate score. This is a meaningful relationship.

People who are risk averse may be more acutely aware and sensitive to safety climate than individuals who are risk tolerant.

Compliance: Respondents were asked how frequently they performed each of 11 compliance behaviors (disposal of sharps in a sharps container; wearing gloves; washing hands after removal of gloves; wearing fluid resistant gowns, protective eye shields, and disposable face masks whenever splashes are anticipated; disposal of contaminated materials in a red bag; prompt wiping up of spills with a disinfectant; following UP with all patients regardless of diagnosis; no food items where there is a possibility of contamination with blood or body fluids; and wearing gloves when drawing a patient's blood). Frequency was measured on a 5-point Likert scale ranging from "never" to "always." The mean of all items was the compliance score. The Pearson correlation between safety climate and compliance scored 0.22 with 1,706 degrees of freedom, $p < .0001$. A correlation of this magnitude may be meaningful and warrants further investigation in a multivariate analysis.

Discussion

The results of this study provided some support for the one-factor model (organizational safety climate is correlated with safety program effectiveness) measuring safety climate among the population surveyed. The measure of safety climate had a high reliability score. Evidence of validity is suggested by the positive association between the availability of PPE and perceived safety climate consistent with our hypotheses and suggestive of management's commitment to safety. The significant positive association between perceived safety climate and healthcare worker compliance is also consistent with study hypotheses and suggestive of the effect of workplace culture on employees' safety behavior.

The hypothesis that there would be no relationship between safety climate and gender, age, tenure in position, or hours worked in a day was supported by the data. These findings support the validity of the construct (safety climate) because it suggests that the measure is equally meaningful whether a healthcare worker is male or female, old or young, experienced or inexperienced in their position, and employed full or part time. Regardless of the healthcare workers' characteristics, the measure is evaluated consistently across groups, providing evidence of reliability.

The hypothesis that there would be no relationship between safety climate and gender, age, tenure in position, or hours worked in a day was supported by the data.

The hypothesis that there would be differences among the four professions' perception of safety climate was not supported by the data. The differences among the scores, although statistically significant, are not meaningful due to the large number of survey participants. Even though findings were different than expected hypotheses, they suggest the validity of the measure across disciplines. Other hypotheses not supported by the data included those specific to healthcare workers with respect to education, perceived risk, attitude toward risk, and training in UP and PPE. Our factor analysis showed that one factor was highly significant in determining employee's perceptions of safety climate: whether the protection of workers from occupational exposure to HIV is a high priority with management. This would be evidenced by the importance management places on safety (i.e., availability of PPE).

Further research is needed to determine whether the safety climate measure is consistent in other healthcare settings such as community hospitals or nursing homes or whether it is relevant to other industries (e.g., manufacturing, construction, etc.) consistent with one of Zohar's (1980) two most important dimensions of safety climate.

The National Institute for Occupational Safety and Health identified infectious disease as a priority topic in the National Occupational Research Agenda (NORA, 1996):

Research is needed to determine the extent of occupational transmission of these infectious diseases, to understand the barriers to the use of safe work practices and vaccines and to develop and evaluate new control measures (p. 16).

Although healthcare workers generally possess a good knowledge base of OSHA's UP regulations, this study and others suggest healthcare workers' compliance is suboptimal. Hospital quality improvement (QI) departments could use survey items, such as that displayed in Table 1, to assess their organization's safety climate. For instance, if management believes it places a high priority on protecting workers from HIV exposures and employees feel otherwise, analysis of the difference in perceptions could be beneficial. Health and safety professionals could use such results to improve safety within their organizations. If employees

answer questions negatively, management would want to target those departments or employees. Management may want to form focus groups or meet with supervisory staff to learn more about employees' perceptions of safety climate.

There remains a widespread lack of compliance with UP even after institution of the bloodborne pathogens standard. Because compliance with safety among workers is still not well understood, health and safety professionals should adhere to OSHA's hierarchy of controls placing priority on advanced engineering controls to improve safety at the workplace.

Authors' Biographies

Elizabeth Anderson is an infection control practitioner for Fairview University Medical Center. She has a master's degree from the University of Minnesota School of Public Health in Environmental and Occupational Health. Through her work she performs surveillance of nosocomial infections and conducts the planning and execution of investigations relevant to infection control.

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