

# Organizational and environmental factors that affect worker health and safety and patient outcomes

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This article reviews organizational factors that influence the satisfaction, health, safety, and well-being of health care workers and ultimately, the satisfaction, safety, and quality of care for patients. The impact of the work environment on working conditions and the effects on health care workers and patients are also addressed. Studies focusing on worker health and safety concerns affected by the organization and the physical work environment provide evidence of direct positive and/or adverse effects on performance and suggest indirect effects on the quality of patient care. The strongest links between worker and patient outcomes are demonstrated in literature on nosocomial transmission of infections. Transmission of infections from worker to patient and from patient to patient via health care worker has been well documented in clinical studies. Literature on outbreaks of infectious diseases in health care settings has linked the physical environment with adverse patient and worker outcomes. An increasing number of studies are looking at the relationship between improvement in organizational factors and measurable and positive change in patient outcomes. Characteristics of selected magnet hospitals are reviewed as one model for improving patient and worker outcomes. (*Am J Infect Control* 2002;30:93-106.)

This article reviews organizational factors that have been shown to influence the satisfaction, health, safety, and well-being of health care workers and ultimately, the satisfaction, safety, and quality of care for patients. The impact of the work environment on working conditions and the effects on health care workers and patients are also addressed.

Although this review of these issues cannot be all-inclusive, it provides information that may be used to enhance patient safety programs, including strategies that have been shown to affect quality as well as the bottom line. This understanding of the complexity and magnitude of changes required to positively affect workers, their environment, and patient outcomes will help set future research priorities in areas where there are gaps in knowledge.

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Much attention has been focused on patient safety in recent years. It has been noted that healthy work organizations demonstrate both financial success and a healthy workforce<sup>1</sup>—a fact recognized by many purchasers of health care services. Purchasers are beginning to use this type of data to make contracting decisions. For example, The LeapFrog Group, a consortium of Fortune 500 companies and large purchasers of health care services (eg, General Electric, General Motors), requires providers to implement evidence-based quality and safety practices, including use of computerized physician order entry, referrals to hospitals that handle a specified volume of certain procedures, and management of intensive care units (ICUs) by physicians certified (or eligible) in critical care medicine.

## **WORKER HEALTH AND SAFETY: EFFECT OF THE ORGANIZATION AND THE WORK ENVIRONMENT** Background

A wealth of literature exists on how health care workers experience job- and work-environment-related stressors that adversely affect their safety and health. Studies have identified many stressors, including role ambiguity, role conflict, heavy work-

load, pressure, and physical discomforts.<sup>2</sup> Work stress has been shown to result in job dissatisfaction, burnout (physical, emotional, and mental exhaustion), staff turnover, occupational illness and injuries, reduced mental health, depression, and even suicide.<sup>3-8</sup>

However, studies have also shown that the negative impact of these stressors can be reduced by factors such as a supportive social environment that includes coworkers and supervisors, peer and team cohesion, autonomy, utilization of skills, rewards, and an emphasis on planning and efficiency.<sup>2</sup> Working in an organization with a strong and visible commitment to safety also has a positive impact on the health and safety of workers.<sup>5,9,10</sup> Although empirical evidence is lacking, studies suggest worker attitudes, job satisfaction, and employee health and well-being are related to work performance; productivity; and ultimately, the quality of health care services.

### Safety climate

The safety climate is defined as shared perceptions of workers regarding the level of safety of their work environment.<sup>11</sup> Table 1 lists 6 organizational dimensions that have been identified as part of the hospital safety climate.

Most important of these dimensions are management commitment and safety performance feedback from managers and coworkers.<sup>10,12-14</sup> A strong safety climate is associated with positive attitudes among workers, which can influence the adoption of safe behaviors and practices<sup>15-17</sup> and help reduce accidents and injuries.<sup>8,18,19</sup> Positive attitudes also influence job satisfaction and performance.<sup>8</sup> Incorporating elements needed for a positive safety climate is the first step in influencing worker and patient safety. Workers need to know that administration is concerned about their safety; supports their efforts; and will use information on safety-related issues, problems, and errors only to improve the system and not for retribution.

### Stress and job burnout

Job burnout is believed to result from stress in service occupations such as those in the health care industry and is believed to represent a unique response to frequent and intense client/patient interactions.<sup>20</sup> Workers with burnout report a variety of symptoms, including emotional exhaustion, depersonalization (feeling distant from others), and a sense of diminished personal accomplishment.

Experts have suggested that burnout results from a variety of stresses, including situations in which work demands cannot be met because of a lack of resources such as social support from coworkers and supervisors, job control, participation in decision-making, utilization of skills, and reinforcements such as rewards.<sup>2</sup> Stress and job burnout also are related to specific demands of work, including overload, variations in workload, role conflict, and role ambiguity.<sup>2-4,21-25</sup> Workers who perceive a high level of stress and resulting job burnout have poor coping responses and lack of job satisfaction, which often erode commitment to the organization and lead to higher turnover.<sup>2</sup>

Lack of coworker and supervisor support contributes to perceived stress and resulting burnout.<sup>26,27</sup> In one study of performance among nurses by Salyer,<sup>25</sup> a higher number of admissions to/discharges from a patient care unit in 24 hours had a negative impact on the self-rated quality of performance. Workload (number of emergency admissions), number of deaths on the ward, and number of menial tasks performed contributed to medical residents' perception of being overwhelmed and increased the number of reported minor medical mistakes.<sup>6</sup> Lack of peer support, role ambiguity, and perceived stress were associated with job dissatisfaction and depression among residents.<sup>4</sup>

In a meta-analysis of 61 studies of job burnout, individuals were more sensitive (ie, at greater risk of emotional exhaustion) to demands of the job than to available resources. Lee and Ashforth<sup>2</sup> hypothesized that this sensitivity might be related to the ability to increase resources and thus compensate for the work demands, whereas the emotional demands of the job remained constant.

Several studies have shown that job stress may be a risk factor for hypertension and increases in left ventricular mass index. In physicians, job stress increases diastolic blood pressure.<sup>28</sup> This increase may be related to inexperience because senior staff members had lower blood pressure elevations than their junior colleagues. Finally, shift work is a risk factor for myocardial infarction unrelated to smoking, job strain, or job education level.<sup>29</sup>

### Work-related illnesses and injuries

A number of studies have linked job stressors to increased risk of work-related injuries and illness.

**Coronary artery disease.** Several studies, including the Framington Heart Study, have linked job

design factors and the organization of work to increased risk of cardiovascular disease.<sup>30-37</sup> Among these factors were minimal opportunities to learn new things, hectic or monotonous work, and low levels of job control and social support.

Johnson-Pawlson and Infeld<sup>37</sup> used multivariate logistic regression analysis (controlling for personal and other work organization variables) to show that workers with low levels of job control had an increased relative risk of cardiovascular disease mortality (1.83) compared with workers with higher levels of control. Individuals with combined low job control and poor social support from coworkers had an even higher relative risk (2.62) of cardiovascular disease mortality compared with workers with high job control and social support. Conversely, high levels of job control were found to be protective against cardiovascular disease mortality.

**Musculoskeletal disorders.** A National Institute of Occupational Safety and Health report<sup>38</sup> found a number of work-related factors to be associated with upper-extremity musculoskeletal disorders. These included work pressure, high work demands, surges in work loads, lack of job diversity, little decision-making opportunity, fear of being replaced by computers, and lack of coworker support. Other studies have confirmed that the combination of high work pressure, low task control, fear of job loss, or lack of promotion contributes to increased reports of stress and related musculoskeletal disorders.<sup>39</sup>

**Bloodborne pathogen exposures.** The work environment and hospital safety climate influence compliance with Universal Precautions and other safety-related behaviors.<sup>9-11,14-40</sup> Although numerous factors are cited as essential elements of an overall safety climate, 3 are significantly correlated with compliance with Universal Precautions: (1) senior management commitment and support for safety programs, (2) absence of barriers to safe work practices, and (3) cleanliness and orderliness of worksite. In addition, senior management support was related to both compliance with Universal Precautions and the risk of workplace exposure incidents.<sup>10</sup>

Organizational climate and staffing levels have also been shown to be a predictor of needlestick injuries in hospitals. Clark et al<sup>5</sup> examined the frequency of needlestick injuries and its relationship to organizational climate among nursing staff on 40 units in 20 hospitals. Each unit's organizational climate was determined by staff perception of nurse manager

leadership (support of nursing initiatives and decision-making) and resource adequacy (sufficient staff to provide quality care and enough time to discuss patient care problems with other nurses). Nurses working on hospital units with poorer work climates and lower staffing were found to be twice as likely to incur needlestick injuries or near-misses and to report factors that placed them at risk for injury.

**Other infectious disease exposures.** Many investigations have addressed the risks of occupationally acquired infections among health care workers from exposures to numerous sources, including patients, visitors, other health care workers, and the environment. Also, numerous opportunities exist for health care workers to increase the risk of infection in patients. For example, a health care worker with a transmissible infection may transmit it to a patient during a patient care interaction. Reducing these risks requires identification and management of infected workers as well as appropriate vaccination of workers.<sup>41-45</sup> Positive patient outcomes related to worker health have been reported. For example, influenza vaccination of health care workers has reduced influenza-related mortality in the elderly in long-term care facilities and hospitals.<sup>44,45</sup>

The Centers for Disease Control and Prevention (CDC) has published extensive guidelines that review the evidence for transmission of infection to and from patients and recommend practices for prevention and control of infections.<sup>46</sup>

### **Organizational factors that impact worker performance**

**Delivery systems.** Organized delivery systems that have been implemented as a result of managed care represent various forms of ownership and strategic alliances among hospitals, physicians, and insurers. They provide more cost-effective care through functional, physician-system, and clinical integration. Some evidence suggests that more integrated, organized delivery systems may provide more accessible and coordinated care. They also appear to be associated with increased organizational performance and higher levels of inpatient productivity and greater total system revenue, cash flow, and operating margins. Among the key success factors for developing organized delivery systems are a strong organizational culture, robust information systems, institutionalized total quality management, and physician leadership.<sup>47</sup>

**Specific practices.** Specific practices that enhance organizational performance and economic benefits

include employment security, self-managed teams, training, reduction of status differences, and sharing knowledge.<sup>48</sup> A longitudinal study<sup>49</sup> showed that teamwork, trust, credibility, and common goals also affected an organization's performance.

**Teamwork, errors, attitude, and stress: Impact on performance.**

A systems approach, which focuses on the conditions under which individuals work rather than on errors by individuals, has been suggested to address health care errors. The goal is to build systems that avert errors or mitigate their effects.<sup>50</sup> However, technologic solutions have limitations. Other components of the system also influence worker and patient safety, such as professional and organizational cultural factors (eg, denial of vulnerability to stress) and interpersonal aspects of performance (eg, lack of teamwork within and between disciplines).<sup>51</sup> Research has shown, for example, that as stress increases, thought processes and attention narrow.<sup>52</sup> Poor teamwork and communication have been documented during trauma resuscitation,<sup>53,54</sup> surgical procedures, and treatment of patients in ICUs.<sup>55-57</sup>

Airline industry research has shown that attitudes, which are relatively malleable to training (as opposed to personalities), can predict performance.<sup>58</sup> A study by Sexton<sup>51</sup> and colleagues showed differences in attitudes about error, stress, and teamwork when they compared surgical and ICU health care staff with airline cockpit crews. Unlike pilots, who strongly believed that fatigue influenced their performance, surgeons were likely to deny the effects of fatigue on their performance. Only a minority of health care respondents recognized the effects of stress on performance.

Ninety-four percent of pilots and ICU staff rejected steep hierarchies (with limited opportunities for input from junior members), compared with only 55% of surgeons did so. Residents reported higher levels of teamwork with surgeons than did anesthesiologists, surgical nurses, or nurse anesthetists. In the ICU, physicians reported high levels of teamwork with nurses, but only 40% of the nurses reported high levels of teamwork with physicians. Finally, only one third of health care respondents reported that errors are handled appropriately, but more than half of the ICU staff reported that they were able to discuss mistakes openly.

One team member's perception of lack of teamwork or poor communication, whether actual or per-

ceived, may change team dynamics and cause that team member to withdraw. Preliminary data from behavioral observations by trained observers in surgery suggest that teamwork attitudes represent individual behavior.<sup>51</sup>

Also, steep hierarchies can result in poor communication among team members. In cockpit crews, for example, poor communication within a team can lead to poor threat and error management. Highly effective crews used almost 30% of their communications time to discuss threats and errors, whereas poorly performing teams spent only 5% of their communications time doing so.<sup>51</sup>

Although limited data exist on the relationship between teamwork and error rates or error severity, effective teamwork has been shown to have positive effects in surgery, such as fewer and shorter delays and increased staff morale, job satisfaction, and efficiency.

Much research is needed for a full understanding of the relationship of attitudes and behaviors to patient outcomes. Although many approaches to team training used in aviation may be useful, they must be fully studied to see whether the approaches also have utility in health care. In addition, further study on teamwork in medicine is needed—specifically, on its relationship to error rates and error severity.

**Influence of quality improvement on worker satisfaction.**

Health care organizations are intensely aware of the continuous quality improvement (CQI) principles and practices necessary to meet the requirements of the Joint Commission on Accreditation of Healthcare Organizations. In addition, the National Committee for Quality Assurance and the Peer Review Organization of the Health Care Financing Administration are encouraging organizations to use quality improvement tools, but data are limited on the effectiveness of these efforts in improving quality of care. One limitation of CQI is said to be a too-narrow focus on administrative (as opposed to clinical) aspects of patient care.<sup>59</sup>

There are, however, some benefits of CQI for employees. Some have suggested that CQI has the potential to improve quality of work-life if it increases positive aspects of work, such as participation, and decreases negative aspects, such as poor social relationships.<sup>60</sup> A few studies suggest that CQI leads to improved goal-setting, increased teamwork, and strong employee participation, all of which lead to improved job satisfaction.<sup>61-63</sup>

## OUTCOMES: EFFECTS OF ORGANIZATIONAL AND ENVIRONMENTAL FACTORS ON WORKERS AND PATIENTS

The link between organization of health services or institutions and patient outcomes is rarely tested empirically. Studies on the organizational structure of health care and studies on patient outcomes have been performed independently. The most commonly studied outcome variables are hospital costs; occupancy rates; service mix; and staff outcomes such as job satisfaction, turnover, and vacancy rates. The appropriateness of various outcomes, such as mortality and complication rates, as measures of quality of care has been debated. Few studies have attempted to document how organizational factors influence patient outcomes. Many studies on patient satisfaction have been done, but little research has linked it to organizational dimensions of the health care delivery system. A few of the most significant are summarized in the following.

### Organizational outcomes

**Safety climate.** *High-reliability units reduce patient injury.* High-reliability organizations are technologically complex and intensely interactive. Staff perform exacting tasks under considerable pressure in hazardous conditions with low rates of incidents or adverse events. Most studies have focused on US Navy nuclear aircraft carriers, air traffic control systems, and nuclear power plants. These organizations are preoccupied with failure and recognize that human variability and adaptation to changing events is their most important safeguard: Safety is preserved by timely human adjustments. Moreover, they ensure that all participants clearly understand and participate in achieving the goals of the organization, which are unambiguous and clearly defined.

Knox and colleagues<sup>64</sup> described a perinatal unit that incorporated many of the characteristics of these high reliability organizations, including well-defined clinical practices formed on the basis of nationally recognized guidelines and an operational philosophy/goal of safety first.

**Job stress and burnout.** *Feeling overwhelmed and medical mistakes by residents.* In a study by Baldwin and colleagues,<sup>6</sup> the numbers of emergency admissions, deaths on the ward, and minor menial tasks (such as retrieving equipment or drugs from another ward) contributed to medical residents feeling overwhelmed. Feeling overwhelmed also correlated

with the reported number of minor medical mistakes made in the last month by residents and patient care staff. A *minor mistake* was defined as a patient suffering no pain, discomfort, or loss of function (thus no danger to life) but for which corrective action was or should have been taken.

*Stress affects patient outcomes and frequency of patient incidents.* Dugan and colleagues<sup>65</sup> studied the relationship between levels of stress and staff turnover, nursing incidents (absenteeism, back injuries, needlesticks), and patient incidents (number of falls, medication errors, and intravenous errors). Although the underlying causes of stress were not scrutinized further, they found a strong relationship between the degree of stress (on a stress continuum scale) and the occurrence of patient incidents.

**Teamwork, errors, and stress.** *ICU technology availability and unit culture associated with reduced length of stay.* In a study of 17,440 patients in 42 ICUs, Shortell and colleagues<sup>66</sup> found that availability of technology was significantly associated with lower risk-adjusted mortality. In addition, caregiver interactions, including the culture, leadership, coordination, communication, and conflict management abilities of the unit, were significantly associated with lower risk-adjusted length of stay, lower nurse turnover, and higher evaluations of quality of care.

**Staffing ratios.** Several studies have shown that understaffing, especially during peak occupancy, is associated with adverse outcomes among workers and patients.<sup>67-69</sup>

In a retrospective study of burn unit cases, higher rates of infection with methicillin-resistant *Staphylococcus aureus* (MRSA) were clustered during times of peak occupancy. In addition, the risk for colonization paralleled nurse overtime and the use of temporary staff, suggesting that fatigue and/or inexperience as well as patient density may result in increased infection rates.<sup>70</sup>

Haley and Bergman<sup>71</sup> found that the rate of clustered *S aureus* infections in a neonatal ICU was 16 times higher after a period of understaffing than during other periods. The rate of infection was 7 times higher after periods of overcrowding than during other periods. A later study showed decreased MRSA rates in a neonatal ICU after staffing ratios improved and census decreased.<sup>72</sup> The same relationship between understaffing and overcrowding was found to apply to outbreaks of *Enterobacter cloacae* among patients.<sup>73,74</sup> Pittet and colleagues<sup>75</sup> have theorized

that the increased risk of infection with understaffing may result from decreased compliance with handwashing during periods of high occupancy/activity. Archibald and colleagues<sup>76</sup> found that patient density and decreased nursing-hours-to-patient-day ratios were associated with increases in nosocomial infection rates. However, no relationship could be demonstrated between level of training and infection rates in nurses. Similarly, an increase in patient-to-nurse ratio of 1.18 to 1.40 has been associated with nosocomial bloodstream infections related to use of central venous catheters in an ICU setting.<sup>77</sup> Finally, lower nurse staffing ratios were associated with increased rates of blood and body fluid exposure in nurses.<sup>5</sup>

Pneumonia and urinary tract infections were among 5 medical patient outcomes that were found to be strongly and/or consistently related to overall nurse staffing and the number of registered nurses (RNs), according to a report released by the US Department of Health and Human Services<sup>78</sup> in 2001, which was done on the basis of 1997 discharge data from 799 hospitals in 11 states. That is, hospitals with more nurses were likely to have lower rates of hospital-acquired pneumonia and urinary tract infections among medical patients.

Most research on the relationship of staffing and patient outcomes has taken place in the hospital setting. However, health care is moving out of the hospital, and very little is known about the relationship of staffing and patient outcomes in the ambulatory or home care setting. One such study in nursing homes in New York State showed a decreased risk for outbreaks of communicable disease among patients if employees were granted paid sick leave.<sup>79</sup> More research needs to be conducted in the ambulatory setting to validate these findings.

**Staffing mix and patient outcomes.** In addition to the number of patient care staff on a unit, the mix of RNs, licensed practical nurses (LPNs), and pool staff has also been shown to have an effect on patient outcomes.

*Staff mix.* A study conducted with multivariate analysis to control for patient acuity found that a higher RN skill mix was associated with fewer medication errors and lower patient fall rates.<sup>25</sup> However, the staffing mix did not correlate with cardiopulmonary arrests among patients. Bloodstream infection risk has also been associated with higher use of pool nurses in a surgical intensive care unit, even when the total staffing level remained constant.<sup>80</sup>

*Staff numbers.* Not surprisingly, in an institution where RNs spent little time with patients (only 20 minutes per day), the RN-to-patient ratio did not matter as much as did overall staffing per patient.<sup>37</sup>

Although mortality rates may not be a good quality indicator, lower mortality was found among hospitals with more staffing for all job categories except LPNs.<sup>81</sup>

Even though service quality improved in a patient-focused care model that included single caregivers who cleaned rooms, took vital signs, delivered trays, and otherwise cared for patient needs, the overall impact on quality of care was inconclusive.<sup>82</sup>

**Shift work rotation.** Studies of shift rotation from a variety of industries uniformly show decreased worker satisfaction and poorer performance.

Complaints of sleep deprivation related to rotating shifts have been reported by telecommunications, railway, and other industrial workers.<sup>83</sup> Rotating shifts seem to cause more disruption. Persons who rotate shifts are more likely to report sleep disturbances, less job satisfaction, lower mental health scores, and more accidents than do permanent night shift workers.<sup>84</sup>

In factory workers, changing from rapidly rotating 8-hour shifts (eg, 3 night shifts followed by 3 day shifts) to nonrotating 12-hour shifts resulted in increased worker satisfaction; decreased malaise; improved day sleep quality; less tiredness; and improvement in home-, social-, and work-life quality.<sup>85</sup>

In other studies<sup>85-87</sup> of 12-hour rotating shifts, workers were found to be less safe and productive during the third to fourth day of a series of day shifts. They had difficulty staying awake and a higher risk of accidents after leaving their shift.

Both shift rotation and the number of hours the worker has been on the shift affect work performance. Even performance on simple reaction time tests was worse at the end of shifts.

Longer rotations appear to result in improved performance. Dingley<sup>88</sup> has shown that performance in night shift workers improved through the fourth night of a night shift rotation and, in those working the permanent night shift, performance did not deteriorate thereafter.

**Duration of shift and patient outcome.** Much work still needs to be done in this area. Many stud-

ies looking at duration of shift and the impact on worker were performed in factory workers who often perform repetitive tasks. The extrapolation of these findings to the health care setting and the complexity of the health care delivery process may not be valid.

The widely publicized Libby Zion case, in which a patient's death was partially attributed to fatigued residents, drew much attention to lengthy resident work hours. As a result of this case, work hours for residents in New York were curtailed. Many other states followed suit, as did the Residency Training Program Certification Boards. Even though this legislation was made with the best of intentions for both residents and patients, it appears to have had several unanticipated outcomes:

- Nursing overtime hours increased as a result of resident cutbacks.
- An influx of foreign medical graduates filled vacant positions.<sup>89</sup>
- A study<sup>90</sup> comparing patient outcomes before and after resident work-hour restrictions found greater in-hospital complications and more test delays after the legislation was enacted. This is presumed to be due to fragmented care with shorter resident work-hours.

Several other studies not related to the Libby Zion case have also linked length of shift to lower performance.<sup>91-95</sup> Mills and colleagues<sup>90</sup> reported a significant association between drowsiness and physical impairment and length of shift. Paper-and-pencil test performances revealed more errors over the duration of the shift (from zero to 6 errors in 12 hours). A significant positive association was found between self-reported performance for workers on the day shift compared with those on evening and night shifts.<sup>92</sup> Todd and colleagues<sup>93</sup> found that staff working 8-hour shifts had better scores on nursing tests of performance than those working 12-hour shifts. In addition, staff working 8-hour shifts spent more time directly supervising trainees than did their counterparts on 12-hour shifts.

Studies of sleep deprivation and its effects on residents' performance have been hampered by small numbers of participants, wide variation in tests used to measure performance, and nonstandardized definitions of sleep loss. More study in this area is clearly needed.

In one study of family practice physicians taking internal in-service examinations, statistically signifi-

cant declines in test scores were observed with decreasing amounts of sleep for each level of resident training.<sup>94</sup> The authors suggested that the effects of sleep deprivation can be overcome by increased concentration and an interesting task. However, others believe that prolonged testing of routine tasks may be needed to detect changes in performance in mild to moderately sleep-deprived persons.<sup>95</sup> Clearly, a precise definition and more research are required to validate findings.

**Quality improvement.** Organizations with a flexible, risk-taking culture had quality improvement and decreased cost and length of stay. Shortell and colleagues<sup>95</sup> studied the relationships of organizational culture, quality improvement processes, and selected outcomes for 61 US hospitals. The study found that a participative, flexible, risk-taking organizational culture was significantly related to quality improvement implementation. Quality improvement implementation, in turn, was found to be positively associated with greater perceived patient outcomes and clinical efficiencies (lower patient charges and length of stay).

**Mortality.** *Mortality rates and hospital characteristics.* Death, although not the only measure of adverse patient outcomes, has been studied more than any other variable. Moreover, the risk-adjusted mortality rate is the most commonly referenced outcome indicator for the assessment of quality care in hospitals. A number of studies have looked at the influence of hospital characteristics on mortality rates.

In a meta-analysis of studies from 1990 to 1998, 7 studies reported an inverse relationship between the percentage of board-certified physicians and mortality rates.<sup>97</sup> In the ICU, the presence of a physician trained in critical care medicine contributed to reduced mortality and improved patient outcomes (reduced length of stay, fewer complications).<sup>98-100</sup>

Evidence also demonstrates that high-volume hospitals have lower mortality rates than low-volume hospitals do for certain conditions and procedures such as coronary artery bypass, coronary angioplasty, carotid endarterectomy, esophageal cancer surgery, and deliveries of low-birth weight (< 1500 g) infants.<sup>101-107</sup> These studies served as the basis for the Leapfrog Group's proposed patient safety standards. Most researchers agree that the experience of the care providers, not just the volume, was important in the analyses of mortality rates with specific groups of patients.<sup>97</sup>

**Table 1.** Organizational dimensions of a hospital safety climate\*

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1. Senior management support for safety programs
  2. Absence of workplace barriers to safe work practices
  3. Cleanliness and orderliness of the worksite
  4. Minimal conflict and good communication among staff members
  5. Frequent safety-related feedback/training by supervisors
  6. Availability of personal protective equipment and engineering controls
- 

\*Adapted from Gershon.<sup>10</sup>

The availability and use of technologic resources have also been found to inversely relate to mortality rates.<sup>108-110</sup>

Leading studies of hospital inpatient mortality rates have found that the number of nurses present for care is the single most important factor affecting mortality rate after controlling for all other hospital structural and financial factors with use of risk-adjusted measures. Indeed, a higher ratio of RNs to patients or RNs as a percentage of total nursing personnel has been associated with lower hospital mortality rates in several studies.<sup>108,110,111</sup>

### Environmental outcomes

**The “built” environment.** The “built,” or physical, environment is defined as any aspect of the environment that is constructed by design experts such as architects or designers.<sup>112</sup> More attention is being given to designing facilities that are cost-effective, efficient, and functional for staff that also cultivate a caring, healing environment for patients. The “built” environment is associated with the structure and processes of care and is believed to affect patient outcomes.

Collaborative efforts between the Picker Institute and the Center for Health Design resulted in initiatives to analyze and improve patient outcomes.<sup>112,113</sup> Focus groups identified properties that were important for healing and well-being of patients in acute, ambulatory, or long-term care settings. Participants identified the need for an environment that enables a connection to staff, is conducive to well-being, is convenient and accessible, allows confidentiality and privacy, cares for the family, is considerate of impairments, provides connection to the outside world, and provides safety and security. It is noteworthy that participants identified physical conditions only in terms of comfort (temperature, lighting, and cleanliness) but not in terms of illnesses (eg, *M*

*tuberculosis* associated with ventilation structures). Although numerous studies have reinforced the importance of a safe physical environment, patient perceptions have a powerful—but not always measurable—impact on patient outcomes.<sup>113,114</sup>

**Adverse infectious outcomes and the environment.** Many studies demonstrate an association between the physical health care environment and health outcomes in both workers and patients. Most studies correlating specific design features with health effects investigated adverse infectious outcomes.<sup>115</sup>

Most studies implicating physical features in negative patient outcomes involved improper ventilation design or maintenance associated with opportunistic infections (eg, *Aspergillus* species) in highly immunocompromised populations such as bone marrow transplant patients. Airborne infectious agents (eg, *M tuberculosis*) and waterborne pathogens (eg, *Legionella* species) affect the health of both patients and health care workers. These environmental risks are comprehensively reviewed in the CDC’s *Guidelines for Infection Control in Healthcare Personnel*<sup>46</sup> and the *Guideline for Handwashing and Hospital Environmental Control*.<sup>116</sup>

Insights gained from infectious disease outbreak investigations have been used to improve health care facility design to reduce adverse infectious outcomes. Interventions that were frequently associated with decreased infection rates or that terminated outbreaks have been steadily incorporated as standard design requirements by guideline-setting agencies.<sup>117,118</sup> A few studies are summarized in the following to underscore the importance of specific design issues such as controlled ventilation during construction, general and specialty area ventilation (eg, operating rooms), surfaces, and water systems.

Many publications have addressed the importance of appropriate air handling during construction to reduce the risk of transmission of airborne pathogens such as *Aspergillus* species to susceptible patients. Appropriate air handling includes attention to high-efficiency particulate air (HEPA) filters, negative air pressure,<sup>119-121</sup> air exhaust, and physical isolation of the construction area from patient care areas.<sup>122-124</sup>

Room location and design, including location of air intakes and exhaust vents, have been identified as critical determinants in the transmission of airborne contaminants.<sup>125,126</sup> Negative air pressure in pedi-



atric oncology units, for example, was shown to reduce the spread of varicella zoster virus among workers and patients.<sup>127</sup> Lower bloodstream infection and mortality rates were reported for burn patients in enclosed ICU beds than in patients in open wards.<sup>128</sup> Multiple outbreaks related to *M tuberculosis* were terminated with properly designed and improved maintenance of negative air pressure (isolation) rooms.<sup>129</sup>

Multiple interventions in operating rooms have led to steady reductions in infectious outcomes for surgical patients. As a result, current standards include increased outside air and total air exchanges per hour, improved air filtration efficiency, and proper humidification and filter location in air handlers serving operating rooms.<sup>130-132</sup> Major studies by Lidwell<sup>133,134</sup> focused on the use of ultraclean (laminar air flow) HEPA-filtered air in clean orthopedic surgical procedures. These studies and other multi-site studies<sup>135,136</sup> led to a better understanding of the independent contribution of ultraclean air in reducing clean surgical site infections; its effect is comparable to the use of preoperative prophylactic antibiotics. Accordingly, laminar air-flow HEPA filtration may be considered for specific high-risk populations to reduce surgical site infections.

Numerous patient outbreaks of bacterial and fungal infections associated with aerosols from contaminated ventilation ducts, grills, and damaged barriers (eg, bird screens, ventilation fans), and vacuum cleaners reinforce the importance of maintaining an intact air handling system.<sup>137-139</sup>

Carpeting has been studied extensively, and although it is colonized with a variety of pathogens (eg, *Clostridium difficile*), no direct link to patient infections has been found.<sup>140-142</sup> Accordingly, carpet in patient care areas should be chosen with respect to aesthetics and cleanability and not because of risk to patients.

Contaminated water can be a source of waterborne pathogens. The greatest risk is to immunocompromised patients, and many outbreak investigations have identified potable water systems and storage tanks, showerheads, and ice machines as sources of waterborne pathogens.<sup>143-146</sup> *Legionella* species, for example, have been implicated in patient infections acquired through inhalation of aerosols spread from contaminated storage tanks; showerheads; and equipment that used tap water, such as water baths, and/or entire water systems.<sup>148-151</sup> Contaminated

**Table 2.** Organizational Attributes of Magnet Hospitals\*

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1. Nurse executive member of executive decision-making team
  2. Flat organization structure of nursing
  3. Decision-making decentralized to unit level
  4. Autonomy and control over patient-care decisions
  5. Good communication between nurses and physicians
- 

\*Adapted from Havens.<sup>158</sup>

condensation from window air-conditioning units combined with other work practices led to *Acinetobacter* species bloodstream infections in high-risk pediatric populations.<sup>152</sup>

Although interventions in each study helped reduce risk and adverse outcomes in specific patient populations, it is not known whether these interventions reduce risk across all patient populations. As such, more research is needed to determine the best interventions for specific adverse outcomes affecting specific patient populations.

## Magnet hospitals

**Models of organizational excellence and outcomes.** In the early 1980s, 41 hospitals were designated as magnet hospitals on the basis of organizational attributes that made them good places to work and demonstrated their success in attracting and keeping nurses despite a nursing shortage.<sup>153</sup>

Magnet hospitals have received a special designation by the American Nurses Credentialing Center for Excellence in Nursing. In follow-up studies in 1986 and 1989, the magnet hospitals were found to have retained the positive organizational features found in the original study.<sup>153-157</sup> The organizational characteristics of magnet hospitals, particularly the organization of nursing, form one model that has empirically demonstrated positive outcomes for both staff and patients. The organizational attributes shared by the magnet hospitals are summarized in Table 2.<sup>158</sup>

The magnet organizations acquired reputations for excellent patient care and professional patient environments because they empower nurses to use their professional knowledge and skills on behalf of patients. This is believed to be the key for high-quality, safe, and cost-effective patient care.<sup>158</sup> Nurses provide bedside health care with round-the-clock surveillance. Moreover, nurses are physicians' primary source of information about changes in patients' conditions and often have to act in the absence of physi-

cians when timely intervention is required. It has been suggested that the organizational support in magnet hospitals permits nurses to exercise their professional knowledge, judgment, and skills to initiate interventions that promote patient safety and rescue them—and the organization—from dire and costly consequences.<sup>108,158</sup>

**Worker safety.** The magnet hospital model has demonstrated workplace safety, with nurses reporting lower levels of emotional exhaustion (a component of burnout) and lower rates of needlestick injuries.<sup>158,159</sup> The Institute of Medicine and the Agency for Healthcare Research and Quality have targeted the safety of the work environment as a research priority,<sup>160-162</sup> recognizing that the safety and well-being of health care providers are essential to their providing high-quality and safe patient care. The magnet hospitals provide a model for the agency's research agenda.

**Job satisfaction.** Staff working in magnet hospitals reported significantly more job satisfaction than their nonmagnet counterparts. These findings suggest that organizational design has a positive impact on job satisfaction, which in turn has been linked to positive patient outcomes.<sup>163</sup>

**Patient satisfaction.** Patient satisfaction has been positively influenced by magnet hospitals, even in nonmagnet hospitals. In a large multisite study comparing outcomes of inpatient care for AIDS, patients experienced greater satisfaction on units in which the organizational attributes of magnet hospitals were present.<sup>164</sup> Patient satisfaction is considered a prime indicator of quality of care.

**Lower mortality rates.** The organizational features common among the magnet hospitals are similar to those associated with lower mortality in many other studies. These include decentralized decision-making at the nursing unit level, ward specialization, standardization of procedures, qualifications of nurses and physicians, and good relations between nurses and physicians.

Compelling evidence that these organizational attributes in magnet hospitals produce positive benefits for patients was derived from a study of 39 magnet hospitals that were each matched with 5 comparison hospitals.<sup>108</sup> Magnet hospitals were found to have lower mortality rates than their matched control hospitals by a factor of approximately 5 per 1000 Medicare discharges, or a 5% reduction in excess mortality.

The impact on the 30-day AIDS death rate was striking. Mortality was lower for AIDS patients on both dedicated AIDS units in nonmagnet hospitals and general nonspecialty units in magnet hospitals. Specifically, among 1205 consecutive patients admitted to 40 units in 20 different hospitals for AIDS-related conditions, the odds of dying were reduced by a factor of 0.61 for those admitted to a dedicated AIDS unit, even if located in hospitals that were not found to have a particularly favorable climate for nursing practice.<sup>164,165</sup> The AIDS patients treated on nonspecialty units in magnet hospitals with positive practice environments (nurse autonomy and control over practice and higher nurse-to-staff ratios) had odds that were similarly reduced by a factor of 0.41. In this study, the positive organizational climate appeared to have a greater impact than did specialization on reducing death rate.<sup>164,165</sup>

## CONCLUSION

The multi agency Quality Interagency Coordination Tack Force (QuIC) coordinates activities and plans for quality measurement and improvement across all US federal agencies involved in health care. In October 2000, QuIC convened a conference to examine how health care workplace quality influences the quality and safety of patient care. There was general consensus at this meeting on the need for a serious, evidence-based approach to identify opportunities to improve the quality of the health care workplace, and in so doing, improve both the health and safety of health care workers and the patients for whom they care.<sup>166-169</sup>

The literature reviewed in this article helps clarify current efforts being made to establish links between health care workers and patient outcomes. The selected studies focused on worker health and safety concerns that are affected by the organization of work and the work and physical environments. Issues examined included the safety climate; stress and job burnout; worker-related illnesses and injuries (eg, musculoskeletal disorders and sharps injuries); and organizational factors that impact worker performance, such as teamwork, staffing ratios, and quality improvement processes. Overall, the studies provide evidence of direct positive and/or adverse effects on work performance and suggest indirect effects on the quality of patient care.

The strongest links between worker and patient outcomes are found in literature on nosocomial transmission of infections. Transmission of infections

from worker to patient and from patient to patient via health care worker-related incidents (eg, lack of handwashing, lapses in aseptic protocols) has been well documented in clinical studies.

Many studies on outbreaks of infectious diseases in the health care setting have linked the physical environment and adverse patient and worker outcomes.

An increased number of studies are now looking at improving organizational factors that demonstrate a measurable and positive change in patient outcomes.

The magnet hospital model has provided evidence that organizational attributes and an environment that maximizes use of clinicians' knowledge and skills to provide patient care can indeed positively impact patient outcomes.

However, we are only at the beginning of a long journey. What we do know about changes in organization and structure of hospitals and the potential for those changes to affect patient outcomes pales by comparison to what we do not know. More research is needed to validate findings and to ensure that recommended changes actually produce the results desired for both workers and patients.

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