Respiratory Infection Control Practices Among Healthcare Workers in Primary Care and Emergency Department Settings

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This is to certify that I have examined this copy of a doctoral dissertation by

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Abstract

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This cross-sectional study used a self-administered questionnaire to survey healthcare workers (HCWs) at five medical centers, to evaluate reported use of CDC (Centers for Disease Control and Prevention) recommended respiratory infection control practices in first contact patient care settings. The study was guided by a conceptual model and questionnaire adapted from previous studies of practices related to bloodborne pathogens. All HCWs in emergency department and primary care settings at each of the surveyed medical centers were invited to participate, and 653 (53%) completed surveys. The study found important shortcomings in overall reported personal or institutional use of CDC recommended practices, including: posted alerts (75%) or personal instructions (56%) about respiratory hygiene and cough etiquette; coughing patients seated 3 feet apart from others in waiting areas (32%); and patients with influenza-like illness placed in private exam areas (57%). Deficiencies were also observed in reported use of hand hygiene recommendations after following direct contact with patient skin while taking a pulse or blood pressure (58%), and after touching items in the immediate vicinity of a patient (59%). Use of recommended practices was generally reported more often by nursing staff than physicians, and in emergency room than primary care settings. Multivariate logistic regression revealed use of practices was positively associated with supervisory status, prior training, perceived cleanliness and orderliness of the workplace, and

knowledge of notifiable condition reporting, although these associations were more pronounced among nursing staff than physicians. The findings of this study could be used to target future changes or corrective interventions in national and institutional policies, worker training strategies, and institutional facilitation of recommended practices by healthcare workers. Future research and interventions should consider the influences of the organizational climate and other possible barriers to implementation of recommended practices, as well as individual practices, perceptions and beliefs.

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DEDICATION

To Patty and Sophie

1. Introduction

The risk of occupationally acquired respiratory infection to healthcare workers increases when respiratory diseases are unrecognized in the medical setting and infection control measures are inconsistently applied (Health Canada, 2003). Lessons from the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic highlight this hazard. Of the 8,098 probable cases of SARS observed worldwide, 21% involved healthcare workers (WHO, 2003a).

SARS emerged as an unknown respiratory infection from the Guangdong Province in China. Because of modern air travel, this novel coronavirus quickly spread to different parts of the world carried by those who were infected while visiting China in February 2003. Early SARS symptoms are not unlike other common respiratory infections, and many healthcare workers treating these patients did not follow standard infection control procedures designed to prevent transmission of infectious respiratory agents. In addition, SARS was unknown at the time, and the world's communicable disease surveillance systems did not provide early warning of a potential threat. As a result, the SARS virus quickly spread to healthcare workers treating these patients.

The SARS outbreak highlighted the vulnerability of healthcare workers to infection from naturally emerging pathogens and from intentional use of bioterrorism agents during first contact with undiagnosed persons. From this experience the Centers for Disease Control and Prevention (CDC) re-evaluated its infection control recommendations to specifically address procedures in settings where undiagnosed patients first arrive for treatment (first contact settings), such as emergency departments or primary care clinics (e.g., physician offices, outpatient clinics)(CDC, 2004a).

Although developed in 2003 to address the immediate infection control needs of the SARS epidemic, the CDC guideline, "Respiratory Hygiene / Cough Etiquette in Healthcare Settings," was designed to prevent transmission of all respiratory infections to healthcare workers and patients in first contact healthcare settings (CDC, 2004c). How well first contact respiratory infection control procedures are observed by healthcare industry workers, and how practical they are to implement is unknown.

Use of recommended infection control practices is also influenced by early warning of infectious disease activity from institutional, local, national, and international communicable disease surveillance systems. Awareness of a potential infectious disease threat can serve as a cue to action for healthcare workers to use recommended infection control practices (Hofmann and Turnberg, 2005).

This study was designed to address these needs by: 1) examining whether the reported practices of healthcare workers in primary and emergency care settings are consistent with CDC recommended first contact respiratory infection control practices (CDC, 2004c), 2) identifying factors related to incomplete use, and possible barriers to complete use, of CDC recommended first contact respiratory infection control practices, and 3) examining awareness and knowledge about infectious disease surveillance and notifiable conditions reporting.

The following introductory sections describe perennial and emerging respiratory pathogens. Lessons learned from the world experience with the SARS epidemic are presented to highlight the vulnerability of human populations to novel respiratory infections and the need for healthcare workers to use recommended infection control measures. Nonpharmaceutical interventions and public health surveillance awareness are explained in context with CDC first contact respiratory infection control recommendations. Factors associated with infection control practices are illustrated, and the study aims and research questions presented.

Respiratory Pathogens

Perennial respiratory pathogens of the respiratory tract include *Neisseria meningitides*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Mycobacterium tuberculosis*, influenza viruses, adenoviruses, respiratory syncytial virus, rhinoviruses, and pertussis (Musher, 2003). Emerging infections such as SARS also occasionally arise in human populations. The term "emerging infections" includes truly emerging infectious diseases such as pandemic influenza (Glezen, 1996) "that have been identified and taxonomically classified recently" and re-emerging older diseases such as tuberculosis (Kaye and Frieden, 1996) "that have experienced a resurgence because of changed host-agent-environment conditions" (Last, 2001). A recent literature survey identified 1,407 recognized human pathogen species (Woolhouse and Gowtage-Sequeria, 2005). Of these, 13% were viewed as emerging or re-emerging infections, with most being viruses.

Susceptible healthcare workers are at risk of acquiring respiratory infections from patients if infection control practices are not observed. To highlight this risk, occupationally acquired pertussis infections and two viral emerging infections of current public health concern, SARS and pandemic influenza A, are described in the following sections.

Pertussis – Pertussis, or whooping cough, is a vaccine preventable perennial condition caused by the bacterium *Bordatella pertussis*. It is highly contagious through respiratory secretions or large aerosol droplets that are created during coughing or sneezing (Bolyard et al., 1998). Initial symptoms are common and non-distinct, similar to a cold-like upper respiratory infection, and may include a low-grade fever, sneezing, runny nose or mild cough, during which time the patient may be highly contagious. Pertussis is often not recognized in adults, who exhibit much milder symptoms than children. The disease presents a greater hazard to infants who can be infected by older children or adults who are unaware of their infection, and develop pneumonia as a complication of the disease, which may result in death.

Recent events in Seattle highlight the infection hazards that can result when infection control measures are not fully implemented. Washington tends to have higher pertussis rates than elsewhere in the country. For example, in 2002, the national rate for pertussis was 3.5 cases per 100,000 compared to 9.5 per 100,000 in Washington (Washington State DOH, 2004). Recently, a major hospital in Seattle reported that an emergency room physician, who unknowingly carried pertussis, potentially exposed more than 400 emergency-room patients and hospital employees between July 1 through 18, 2004 (King, 2004a). In a separate children's hospital in Seattle, two nurses, a staff person and a physician tested positive for pertussis, again exposing both patients and employees to the infectious bacterial agent (Green, 2004). In each event, those potentially exposed who could be identified were treated with antibiotics.

SARS – The global outbreak of SARS was caused by a novel corona virus, SARS-CoV, an emerging pathogen (Woolhouse and Gowtag-Sequeria, 2005). Based on genetic analysis and epidemiologic investigation, it is speculated that SARS-CoV was an animal virus that only recently crossed to humans via cross-species transmission (Guan et al., 2003; Zheng et al., 2004). It is hypothesized that the SARS coronavirus had evolved and been maintained in an animal host (Weingartl et al., 2004). SARS-like coronavirus has been isolated from Himalayan palm civets at a live animal market in Guangdong, China and was detected in other small wild animals (e.g., the raccoon dog) at the market as well (Guan et al., 2003). In that study, SARS-like coronavirus antibody was observed in eight of 20 wild animal traders and three of 15 individuals who slaughter the wild animals – individuals in unusually close contact with the animals. None however reported SARS-like symptoms in the prior six months. Full-length genome sequences of two virus isolates isolated from the palm civet were observed to be 99.8% homologous to the human SARS-CoV indicating the close relationship between the human and animal SARS-like coronaviruses. From these findings it was suggested that exotic animal markets provided a setting for animal SARS-like coronaviruses to amplify and be transmitted to new hosts, including humans (Guan et al., 2003).

Two studies examining bat populations as a possible source for SARS-CoV were published during the Fall of 2005 (Lau et al., 2005; Wendong et al., 2005). In parts of China, bats are eaten as an exotic food. They are also used in traditional medicine. Live bats are sold in markets along with civet cats (Normile, 2005). Findings from the studies published by Lau et al., and Wendong et al., indicate that species of Chinese horseshoe bats harbor variants of SARS-CoV. From these studies, it is speculated that bats may be natural reservoirs of SARS-like coronaviruses, and that the virus is spread to and amplified by Civet cats in live markets in China. The impact of SARS on healthcare workers and lessons learned in its control are described in a section below.

Pandemic influenza – Cross-species transmission of new pathogens from animal reservoirs to humans may be caused by ecological changes that increase opportunities for the pathogen to enter the human population and generate subsequent human-to-human transmission (Antia et al., 2003). A pandemic influenza virus may emerge by: 1) virus re-assortment when humans or pigs are co-infected with an influenza virus such as H5N1 and a human influenza virus, and genetic material is swapped between viruses resulting in a new virus subtype infectious to humans, and 2) adaptive mutation during human infection (WHO, 2004a). For an emerging influenza pathogen to start a pandemic, three conditions must be met: 1) a novel sub-type must be transmitted to humans, 2) the new virus must be able to replicate in humans and cause disease, and 3) a new virus must be efficiently transmitted from one person to another (WHO, 2004a). Three influenza pandemics occurred in the 20^{th} century (CDC, 2005c; Kilbourne., 2006). The 1918-1919 "Spanish Flu" influenza A (H1N1) is believed to have been responsible for over 500,000 deaths in the United States and more than 2,000,000 deaths worldwide. The 1957-1958 "Asian flu" A (H2N2) is believed to have caused more than 70,000 deaths in the United States. The 1968-69 "Hong Kong flu" A (H3N2) caused 34,000 deaths in the United States.

The avian influenza virus was first observed to transmit from birds to humans in a 1997 outbreak in Hong Kong involving 18 individuals, in which six died (CDC, 2005a;

WHO Writing Committee, 2005). The avian H5N1 virus identified from the Hong Kong outbreak was novel among avian viruses, appearing to be based on assortments between viruses from geese and either quail or teal, species that are often tightly caged in live markets (Bush, 2004). Since 1997, the avian influenza A (H5N1) virus has caused large outbreaks in chickens in various Southeast Asian countries. Human infection from avian influenza A (H5N1) has occurred infrequently but with a high case fatality rate. As of November 13, 2006, there had been a total of 258 laboratory-confirmed human cases of influenza A/H5N1 reported by the World Health Organization (WHO) since 2003, with 153 deaths reported from nine countries (Azerbaijan, Cambodia, China, Egypt, Indonesia, Iraq, Thailand, Turkey, Viet Nam) (WHO, 2006a). Cases often involved children and young adults who had direct close contact with live, sick or dead poultry (BCCDC, 2006). About 90% of human cases have involved individuals under 40 years old. Of those, 63% involved individuals less than 20 years old (BCCDC, 2006).

As of May 23, 2006, person-to-person transmission is not efficient or sustained, had not been conclusively identified, nor had it been ruled out (WHO, 2006b; WHO, 2006c). In the village of Kubu Sembelang, located in the Karo district of North Sumatra, Indonesia, a 37 year old woman succumbed to an unconfirmed respiratory illness with symptoms compatible with H5N1 infection on May 4, 2006. Seven other members of the woman's extended family were subsequently confirmed to have H5N1 infection, and six of these individuals died. The 37 year old woman is suspected to be the index case of the cluster, possibly from exposure to infected poultry or poultry feces. Infection did not continue into the community from this cluster. The investigators concluded that if person-to-person infection did occur, it did not take place efficiently.

Nevertheless, the probability of re-assortment may increase with greater numbers of people co-infected with both the human and avian strains. The mathematical risk of avian influenza A (H5N1) resulting in a pandemic is small although not negligible (Ferguson et al., 2004).

Once an influenza pandemic has begun, pharmaceutical interventions involving vaccines and antiviral therapies may provide a primary intervention when available. However, effective vaccines and antiviral agents are not likely to be available at the beginning of a pandemic event. Therefore, nonpharmaceutical interventions remain the primary protective tool. Even after vaccination becomes available, non-pharmaceutical interventions will likely remain necessary to curb the spread of disease to healthcare workers and patients in the hospital setting and the community, particularly if the pandemic is severe. Strict application of such interventions may be necessary depending on clinical and epidemiological considerations including the severity of illness, attack rates, subgroups in the population, and the estimated basic reproductive number (R_0; see SARS Transmission Dynamics, page 13) of the virus. Although such factors differ between pathogens, the infection control lessons learned from the SARS epidemic are likely to be a valuable resource for controlling influenza transmission in healthcare settings.

Lessons Learned from SARS

The following sections describe the emergence of SARS from its origin in Guangdong Province, China, to its rapid spread to healthcare workers and the public around the world. The experiences learned from the SARS epidemic are relevant to other respiratory infections that may be encountered in healthcare institutions.

Emergence of SARS in the world – Towards the end of 2002, reports of a pneumonia-like outbreak of unknown etiology began surfacing in China's Guangdong province. An early Chinese-language news report about this unusual flu-like outbreak was forwarded to the WHO on November 27, 2002 with an English heading, although the full report was not translated or given much attention (Health Canada, 2003). On February 11, 2003, the Guangdong Province Health Department issued its first official statement about an unusual pneumonia epidemic in that region, and on February 14, 2003, the WHO published its first report about the outbreak, bringing worldwide attention to this novel disease. This report was followed by a WHO global alert about cases of a severe respiratory illness that may be spread to hospital staff (WHO, 2003b). This unknown infection, later to be recognized as SARS, quickly spread from mainland China to regions around the world in a matter of days.

Nils Daulaire and William Foege of the Global Health Council describe the source of SARS as the "cough heard round the world" (Daulaire and Foege, 2003). Dr. Liu Jianlun, a 64 year old physician from the southern Chinese province of Guangdong had been treating patients with an aggressive atypical pneumonia that began with non-specific symptoms of fever, cough and headache, but led to respiratory distress and death in an unexpectedly high number of cases. On February 21, 2003, Dr. Jianlun, who had developed respiratory symptoms five days earlier, traveled from the provincial capital of Guangzhou to Hong Kong where he stayed for one night on the 9th floor of the Metropole Hotel in Room 911 to attend a wedding (WHO, 2003c). During his stay at the hotel, Dr. Jianlun presumably infected at least 16 other local and international guests. These guests subsequently carried the virus to different parts of the world, triggering outbreaks in Hong Kong, Singapore, Hanoi and Toronto (WHO, 2003c).

One guest at the Metropole Hotel, a 78 year old woman from the Toronto area, returned from Hong Kong on February 23, 2003. Shortly after her return, she developed a high fever, muscle aches and a dry cough. On March 5, 2003, she died at home. Because the circumstances of her death did not seem unusual, no autopsy was performed, and her cause of death was listed as heart attack by the coroner (Health Canada, 2003). On March 7, 2003, her 44 year old son checked into a Toronto area emergency department with high fever, severe cough and difficulty breathing. He remained on the open area observation ward of the emergency department for about 20 hours before being admitted. The following day he was transferred to the intensive care unit, where he required intubation and a ventilator to breathe. The attending physician suspected that he was suffering from tuberculosis and isolated him per tuberculosis infection control protocols, but not before exposing several other healthcare staff and guests. The disease spread to others in the hospital. The patient succumbed to the disease on March 13, 2003 (Health Canada, 2003).

The attending physician was unaware of the unusual pneumonia-like illness in Guangdong Province and his patient's epidemiologic connection to that outbreak. Other physicians in the Toronto area who cared for SARS patients during the initial wave of cases were also unaware of the outbreak in China. The respiratory infection control procedures that may have prevented SARS infection of healthcare workers and the public in Toronto were presumably not observed. Ulimtately, 43% (109 of 251) of SARS infections in the Toronto outbreak were among healthcare workers (Health Canada, 2003).

On March 12, 2003, the WHO issued a global alert about an outbreak of a new severe respiratory illness that was spreading to hospital staff (WHO, 2003b). About this time a man who also had stayed at the Metropole Hotel in Hong Kong checked into an emergency department in British Columbia with pneumonia. Although the hospital was not aware of the outbreak beginning in Toronto, the British Columbia Centre for Disease Control (BCCDC), prompted by the March 12th WHO alert and other recent reports of possible avian influenza reported in Hong Kong, had issued a reminder to healthcare providers to be aware of patients who had recently visited Southeast Asia and presented with respiratory illness. Because of this alert, this patient was quickly masked and placed into a respiratory isolation room in the intensive care unit, thereby containing the infection. The next day, as the patient's condition deteriorated, the hospital notified the BCCDC about the suspected connection between their patient and the events in Southeast Asia. The BCCDC in turn alerted the Washington State Department of Health's Office of Communicable Disease Epidemiology, which transmitted an alert through Washington's public health alerting system. This collaboration between the healthcare and public health system was instrumental in containing the spread of SARS in the Pacific Northwest (Hofmann and Turnberg, 2005). This experience, in contrast to that in Toronto, clearly illustrates the potential value of public health surveillance and alerting systems in curtailing the impact of an outbreak of infectious respiratory disease.

SARS epidemiology – From November 1, 2002 to July 31, 2003, the WHO identified 8,042 probable cases of SARS in 26 countries, which resulted in 774 deaths (crude case fatality rate = 9.6%) (WHO, 2003a). Over 98.9% of all probable SARS cases were identified in seven localized regions of the world. Information about these SARS cases is presented in Table 1-1.

Table 1-1. Summary of probable SARS cases with onset of illness from Nov 1, 2002 to Jul 31, 2003 (WHO, 2003a).

Area	Cumulative number of cases [1]	Number of deaths [2]	Case fatality rate (%) [3]	Number of HCW affected (%) [4]
Canada	251 (3%)	43 (6%)	17%	109 (43%)
China	5327 (66%)	349 (45%)	7%	1002 (19%)
China, Hong Kong Special Administrative Region	1755 (22%)	299 (39%)	17%	386 (22%)
China, Taiwan	346 (4%)	37 (5%)	11%	68 (20%)
Singapore	238 (3%)	33 (4%)	14%	97 (41%)
Viet Nam	63 (1%)	5 (1%)	8%	36 (57%)
United States	29 (0.3%)	0	0	0
Total Other Countries	89 (1%)	8 (0.1%)	9%	9 (10%)
TOTAL	8098 (100%)	774 (100%)	9.6%	1707 (21%)

[1] Percent "cumulative number of cases" is based on the fraction of 8,098 cumulative cases
[2] Percent "number of deaths" is based on the fraction of 774 deaths
[3] Percent "case fatality rate" is based on the fraction of cumulative cases, by country
[4] Percent "number of healthcare workers (HCW) affected" is based on the fraction of cumulative cases, by country

As noted above, SARS is initially difficult to distinguish clinically from other respiratory conditions. In a study of 1,425 cases from the Hong Kong Special Administrative Region of China up to April 8, 2003, Donnelly and coworkers reported the most common clinical symptoms at admission to hospital to be fever (94%), influenza-like symptoms (72%), chills (65%), malaise (64%), loss of appetite (55%), myalgia (51%), cough (50%) headache (50%), rigor (44%), dizziness (31%), shortness of breath (31%), sputum (28%), night sweat (28%), diarrhea (27%), sore throat (23%), nausea (22%), vomiting (14%), and abdominal pain (13%) (Donnelly et al., 2003). In the review, 88% of patients reported fever ($\geq 38^0$ C or $\geq 100.4^0$ F) plus one other symptom, and 79% reported fever plus one of the five most common symptoms. Most patients with laboratory evidence of SARS also developed lymphopenia and radiographic evidence of pneumonia (CDC, 2004b).

The incubation period of an infectious disease is measured from the time of infection to the time that symptoms appear. Although infection events cannot be observed, estimates of the incubation period can be based on information from patients with defined exposure periods to known SARS cases (Donnelly, 2003). Most countries reported a mean SARS incubation period of four to six days (range one to 14 days) (WHO, 2003d). The WHO concluded that the best estimate of the maximum incubation period is 10 days (WHO, 2003e).

The time of symptom onset and time of hospital admission are observable events that were measured by most countries involved in the SARS epidemic (Anderson et al., 2004). It was recognized early in the SARS epidemic that reducing the time between symptom onset and hospital admission could reduce the net rate of infection in a community by allowing for patient isolation before becoming extremely ill and highly contagious (Donnelly et al., 2003). Once admitted to a hospital, the mean duration of stay for those who recovered was 25 days, and 36 days for those who died, based on one study of Hong Kong hospitals (Anderson et al., 2004).

The SARS case fatality rate (the ratio of those who succumb to disease to those with disease) ranged from 0% to 50% depending upon the age group affected and the presence of underlying disease (Table 1-2) (WHO, 2003e). The crude worldwide case fatality rate was estimated to be 9.6% (WHO, 2003a).

Table 1-2. Estimated case fatality rate by age group*

Age Group	Case Fatality Rate
24 years or younger	0%
25 to 44 years	6%
45 to 64 years	15%
65 years and older	50%

**WHO, 2003e*

Risk factors for SARS include household contact with a probable case of SARS, increasing age, male sex, and co-morbid illnesses. Healthcare workers were observed to be at high risk of contracting SARS, accounting for about 21% of all cases of SARS worldwide and 43% of all cases in Canada (WHO, 2003a).

It is generally believed that SARS-CoV is only spread efficiently by symptomatic patients and that the greatest transmission efficiency appears to occur during the second week of illness among patients who are either severely ill or experiencing rapid deterioration (WHO, 2003d; Peiris et al., 2003a). The viral load in infectious body secretions appears to play an important role in transmission, with maximum excretion of virus from the respiratory tract occurring on about day 10 of illness and then declining (Peiris et al., 2003b). Virus has been recovered in stool, although viral load appears to increase later than in respiratory secretions, peaking at about day 12 to 14. Virus has also been recovered in urine (Peiris et al., 2003b).

The possible prevalence of asymptomatic SARS infection has been reviewed. In a study of over 1,000 serum samples taken from over 3,000 contacts of recorded SARS cases, immunoglobulin-G antibody to SARS-CoV was observed in only 0.3% of the specimens, indicating a low occurrence of asymptomatic carriers (Anderson et al., 2004). In a separate study of 105 healthcare workers who were exposed to SARS patients without personal protective equipment, 7.5% were identified as having asymptomatic SARS-CoV infection based on antibody tests (Wilder-Smith, 2005). Other studies also found an absence of asymptomatic infections (Ho, 2004;

Chow et al., 2004). There have been no reports of SARS transmission from asymptomatic individuals (WHO, 2003d; Anderson et al., 2004).

SARS transmission dynamics – Epidemiologic evidence suggests that the most common transmission route is from human to human by direct mucous membrane contact with infectious respiratory droplets and person-to-person contact (Seto et al., 2003; Low, 2004). Transmission may also occur via close contact with fecal or urine contamination on surfaces (Anderson et al., 2004). Evidence exists that transmission may occur via small-particle aerosols although not efficiently (WHO, 2003d).

SARS transmission has been examined by infectious disease transmission dynamic mathematical modeling. Two studies calculated the basic case reproduction number, R_0, which is an estimate of the average number of secondary infectious cases produced by an infectious case in an unprotected population (Lipsitch et al., 2003; Riley et al., 2003). For the early epidemic in Hong Kong, R_0 was estimated by piecing together data on the course of infection based on susceptible, exposed (latent), infectious, and recovered (immune) individuals (SEIR). Estimates of R_0 were calculated to be in a moderate range of two to four, which means that each case resulted in two to four secondary infections in the absence any public health intervention (Lipsitch et al., 2003; Riley et al., 2003). The modeling indicated that SARS is transmissible enough to cause a very large epidemic, but not so contagious that it can not be controlled with basic public health interventions (Dye and Gay, 2003).

SARS is most efficiently spread in settings such as hospitals where there is close contact between infected and susceptible individuals. Once the disease is recognized and isolation practices put into place, the R_0 of SARS-CoV has consistently dropped below an R_0 value of one, bringing the infection under control (Low, 2004). Outside of the hospital setting where close contact conditions do not exist, the virus has failed to establish and maintain itself in the community (Low, 2004).

In general, R_0 estimates of three or less are consistent with transmission by larger droplets that travel only a short distance (WHO, 2003d). In contrast, diseases that are efficiently transmitted by smaller aerosol particles that float in the air have much higher basic reproductive numbers (WHO, 2003d). Examples of agents that may be transmitted by airborne routes include influenza (R_0 of seven or more) and measles (R_0 of 15-18 prior to widescale immunization) (Anderson et al., 2004). Such agents are more challenging to contain by basic public health measures alone and may also require antiviral drugs or vaccines to bring epidemics under control. In addition, agents such as influenza, with a relatively high R_0 value, short incubation period (e.g., two-day mean incubation period) resulting in higher attack rates, that may be transmitted before symptoms appear, add further challenges to controlling transmission by nonpharmaceutical interventions alone.

SARS superspreading events have been defined as transmission to at least eight contacts (Zhuang, 2003). During the SARS epidemic, occasional superspreading SARS cases were observed. For example, more than 4,000 cases and 550 SARS-related deaths outside of China and Taiwan can be traced to the SARS-infected physician who visited the Metropole hotel in Hong Kong from Guangdong Province on February 21, 2003 (WHO, 2003d). Factors that trigger superspreading events are not well understood but most likely involve both environmental factors (e.g., contamination of fomites, close contact in healthcare settings) and the degree of viral shedding by the index patient (Anderson et al., 2004).

SARS infection among healthcare workers – As noted, healthcare workers accounted for 21% of all SARS cases worldwide. This is a remarkable degree of infection given that the transmissibility R_0 of SARS appeared to be only moderate. An infection with higher R_0 such as influenza could result in a higher attack rate among HCWs, particularly if influenza reached the scale of a pandemic. During the SARS outbreak in Hong Kong, 1,755 SARS patients were hospitalized in 16 of the 27 hospitals of Hong Kong's Hospital Authority (Lau, 2004). Fourteen of these 16 hospitals had at least one hospital worker who was infected by SARS. Of these 14 hospitals, attack rates were examined among three categories of hospital workers (nurses, non-medical support staff, and other technical or medical staff). The pooled attack rate (cumulative incidence of infection) among healthcare workers for all 14 hospitals was 1.2%. The pooled attack rate for non-medical support staff was 2.7%, for nurses, 1.2%, and for other technical/medical staff, 0.3%. Of note, non-medical support staff had a 2.3-fold higher odds of SARS infection than nurses and a 9.8-fold higher odds than other technical/medical staff ($p<.001$) indicating that risk of SARS infection was not limited to healthcare workers directly involved in patient care (Lau, 2004).

To date there are no effective SARS antiviral drugs or vaccine interventions available, nonpharmaceutical public health interventions remain the primary protective tool (Taylor, 2006). Such public health interventions are identified in recommendations by the CDC (CDC, 2004a).

Pharmaceutical and Nonpharmaceutical Interventions

In general, pharmaceutical interventions for controlling occupationally acquired infections among healthcare workers include vaccination and chemoprophylaxis to prevent infection, and treatment with drugs following exposure and onset of infection. Occupationally acquired infections can also be prevented by nonpharmaceutical public health interventions such as the use of recommended infection control practices. Use of infection control practices is strengthened by early warning of activity through infectious disease surveillance.

Vaccination – When available, vaccination can provide protection in preventing certain respiratory infections. However, healthcare worker vaccination rates are often low (Bridges, 2006; Rea, 2001). The CDC recommends that healthcare facilities offer influenza vaccinations to all healthcare workers free of charge, including night and evening staff, beginning in October of each year (CDC, 2006a). The CDC also recommends that healthcare workers be educated about the benefits of vaccination and consequences of the infection (CDC, 2006a). In a telephone survey of 2,231 adults, 43% of adults and 69% of children with influenza-like illness (ILI) symptoms visited a healthcare provider for treatment, potentially placing unvaccinated providers at a high occupational risk of influenza infection from their patients (CDC, 2004e). In a randomized, prospective, double-blind controlled trial conducted over three years at two large teaching hospitals, unvaccinated healthcare worker controls experienced an overall 13.9% incidence of influenza infection versus 1.7% among those vaccinated (Wilde et al., 1999).

Nonpharmaceutical interventions – In a condition such as SARS, where there is no effective antiviral treatment or vaccine, six categories of nonpharmaceutical interventions can be considered: 1) restrictions on entry to the country and screening at the point of arrival for fever, 2) isolation of suspect cases, 3) encouragement of rapid reporting to a health care setting following the onset of defined clinical symptoms, with subsequent isolation, 4) rigorous infection control measures in healthcare settings, 5) restrictions on movements within a country (e.g., restricting travel, limiting congregations such as attendance at school), and 6) contact tracing and isolation of contacts (Anderson et al., 2004).

CDC isolation precautions in hospitals – The CDC's "Guideline for Isolation Precautions in Hospitals" established a non-medical intervention system of infection control based on two tiers of precautions. The first tier, termed "Standard Precautions," identifies infection control procedures that apply to all patients regardless of their diagnosis or presumed infection status. Included in this tier are recommendations for use of personal protective equipment (e.g., gloves, masks, eye protection, face shields, gowns), sharps management, and patient placement (Garner et al., 1997). The second tier of the CDC Isolation Precautions, termed "Transmission Based Precautions," was designed to be used for patients infected with suspected or diagnosed epidemiologically important pathogens that can be transmitted by droplet routes (Droplet Precautions), airborne routes (Airborne Precautions), or contact with contaminated surfaces (Contact Precautions; Garner et al., 1997).

A primary component of Standard Precautions involves hand hygiene practices (Garner, 1997). Hand hygiene is defined as "a general term that applies to either handwashing, antiseptic handwash, antiseptic hand rub, or surgical hand antisepsis" (CDC, 2002). Based on the CDC hand hygiene guideline (CDC, 2002), hands should be decontaminated before having direct contact with a patient, but also after direct contact with a patient's intact skin, such as when taking a pulse or blood pressure (Ehrnkranz and Alfonso, 1991; McFarland et al., 1989; Casewell and Phillips, 1977; Mortimer et al., 1962), after contact with inanimate objects in the immediate vicinity of a patient, including medical equipment (Samore et al., 1996; Ojajarvi, 1980; Boyce et al., 1997), and after removing gloves (Olsen et al., 1993; Tenorio et al., 2001; Doebbeling et al., 1988). Healthcare workers are also advised to practice hand hygiene when examining or caring for a patient exhibiting signs of respiratory infection (CDC, 2004e).

Despite known infection control protections provided by hand hygiene to both patient and worker, observance of hand hygiene recommendations by healthcare workers has been historically low (Pittet, 2001a). In a study involving 163 physicians at a university hospital in which practices were evaluated by both direct observation and self-report surveys, overall use of recommended hand hygiene practices averaged 57% (Pittet et al., 2004). In a separate observational study of 1,043 hospital healthcare workers, the average compliance with recommended hand hygiene practices was observed among 52% of nurses (n=520), 47% of nurse assistants (n=166), and 30% of physicians (n=158)(Pittet, 1999). In literature reviews of hand hygiene studies published from 1981 to 1999, overall observance ranged from 16% to 51% in 11 of 12 studies of healthcare workers (Pittet, 2000; Pittet, 2001b).

Most respiratory infections can be transmitted to others on large droplets (greater than 5μm in size) that are sneezed or coughed from an infected person and are inhaled or sprayed into the eyes or mouth of an uninfected person (Musher, 2003). Because the droplets are large and relatively heavy, they drop from rather than float through the air, usually within a distance of three feet or less from their source.

Droplet Precautions are recommended for healthcare workers when examining patients with symptoms of respiratory infections (e.g., patients who are known or suspected of carrying an infection that can be transmitted by droplets), especially when the patient presents with a fever (CDC, 2004c). Droplet Precaution recommendations include placing such patients in a private room when available, or minimally separating infected patients from other patients or visitors by at least three feet. Healthcare workers are advised to wear a mask when working within three feet of a patient, and to have the infected patient wear a mask during movement or transport from the examination area to minimize spraying of droplets from coughs or sneezes.

Airborne Precautions are recommended during patient care when it is known or suspected that microorganisms transmitted by airborne routes are involved (Garner et al., 1997). Airborne transmission involves epidemiologically important infectious agents that can be transmitted to humans on droplet nuclei or dust suspended in the air such as the measles virus, chickenpox (varicella zoster virus) or tuberculosis (*Mycobacterium tuberculosis)*. Recommendations include placing infected patients in a private negative air pressure room monitored with an air pressure sensor when available. Healthcare workers are advised to wear respiratory protection (N95 or higher respirator) when entering the room of an infected patient, and to limit the movement of the patient in the facility. If movement is necessary, the infected patient should wear a surgical mask to minimize dispersal of droplet nuclei.

One component of infection control involves use of surgical masks or respirators to prevent the spread of infection from infected to uninfected individuals. Surgical masks (also called procedure or isolation masks) provide protection against pathogens that are spread by large respiratory droplets (greater than 50 to 100 µm in diameter) through splashes to the nose and mouth. They are also used to contain the spread of infected droplets created and spread during coughing, sneezing or talking. Air-purifying respirators provide protection against both large and small (less than 10 µm in diameter) airborne particles. These include the disposable facepiece particulate respirator (e.g., N95 filtering facepiece respirator), the elastomeric respirator that uses a replaceable filter, and the powered air-purifying respirator (PAPR) which provides filtered breathing air using a battery-powered blower (US-DHHS, 2006). Disposable particulate respirators such as the N95 respirator are rated by the National Institute of Occupational Safety and Health (NIOSH), based on their ability to filter out small inhalable particles (e.g., 95%, 99%, or 100% small particulate removal). Ratings are also based on filter resistance to degradation from oil ("N" for no resistance, "R" for some resistance, and "P" for strong resistance to oil)(NIOSH, 2006). For example, the N95 facepiece respirator, which is commonly used in healthcare settings when treating patients with suspected or confirmed pathogens transmitted by airborne routes, is rated for 95% filtering of small inhalable particles and has no resistance to oil.

First contact respiratory infection control practices – In response to the SARS epidemic, the CDC developed additional infection control recommendations to prevent the transmission of respiratory infections in first-contact healthcare settings, as a component of Standard Precautions (CDC, 2004a; 2004e). The recommended practices are directed to patients, those who accompany them, visitors, and healthcare personnel. Recommendations are presented within four headings: 1) visual alerts, 2) respiratory hygiene/cough etiquette procedures, 3) masking and separation of persons with respiratory symptoms, and 4) following standard and droplet precautions. Because of their key importance in the present study, the CDC recommendations are presented verbatim (CDC, 2004c).

> ***Visual alerts*** – Post visual alerts (in appropriate languages) at the entrance to outpatient facilities (e.g., emergency departments, physician offices, outpatient clinics) instructing patients and persons who accompany them (e.g., family, friends) to inform healthcare personnel of symptoms of a respiratory infection when they first register for care and to practice Respiratory Hygiene/Cough Etiquette.
>
> ***Respiratory hygiene / cough etiquette*** – The following measures to contain respiratory secretions are recommended for all individuals with signs and symptoms of a respiratory infection.
>
> - Cover the nose/mouth when coughing or sneezing;
> - Use tissues to contain respiratory secretions and dispose of them in the nearest waste receptacle after use;

- Perform hand hygiene (e.g., hand washing with non-antimicrobial soap and water, alcohol-based hand rub, or antiseptic handwash) after having contact with respiratory secretions and contaminated objects/materials.

Healthcare facilities should ensure the availability of materials for adhering to Respiratory Hygiene/Cough Etiquette in waiting areas for patients and visitors.

- Provide tissues and no-touch receptacles for used tissue disposal;
- Provide conveniently located dispensers of alcohol-based hand rub; where sinks are available, ensure that supplies for hand washing (i.e., soap, disposable towels) are consistently available.

Masking and separation of persons with respiratory symptoms – During periods of increased respiratory infection activity in the community (e.g., when there is increased absenteeism in schools and work settings and increased medical office visits by persons complaining of respiratory illness), offer masks to person who are coughing. Either procedure masks (i.e., with ear loops) or surgical masks (i.e., with ties) may be used to contain respiratory secretions (respirators such as N95 or above are not necessary for this purpose). When space and chair availability permit, encourage coughing persons to sit at least three feet way from others in common waiting areas. Some facilities may find it logistically easier to institute this recommendation year-round.

Droplet precautions – Advise healthcare personnel to observe Droplet Precautions (i.e., wearing a surgical or procedure mask for close contact), in addition to Standard Precautions, when examining a patient with symptoms of a respiratory infection, particularly if fever is present. These precautions should be maintained until it is determined that the cause of symptoms is not an infectious agent that requires Droplet Precautions.

Infectious Disease Surveillance

Infectious disease surveillance involves monitoring disease burden in a population, including early recognition of unknown, unusual or emerging infectious disease outbreaks. Surveillance can be conducted globally, regionally, locally, and institutionally within a hospital. This section summarizes infectious disease surveillance systems and the importance of these systems in recognizing and controlling infectious disease outbreaks.

Global surveillance – World efforts to establish a comprehensive global infectious disease surveillance system have been referred to as a "network of networks" (Institute of Medicine, 2003) The WHO is a primary hub of the network, coordinating responses to international outbreak events through its Global Outbreak Alert & Response Network (GOARN). The GOARN is described as "a technical collaboration of existing institutions and networks who pool human and technical resources for the rapid identification, confirmation and response to outbreaks of international importance" (WHO, 2006d).

Established in 1993, the Program for Monitoring Infectious Diseases (ProMED-Mail) serves as a rapid early warning system for global infectious disease outbreaks (Madoff and Woodall, 2005; ProMED-Mail, 2006). The system operates as a moderated listserve. Surveillance information is passively gathered through infectious disease-related information sent in by subscribers, gathered from sources including personal observation or stories from media publications. Information is also actively gathered by ProMED-mail staff through a network of surveillance informational sources, including the media and non-government organizations. Reports are edited for validity by ProMED-Mail staff prior to posting to the ProMED-mail website. Reports are distributed by email to over 32,000 subscribers in more than 150 countries (Madoff, 2004). Early accounts of the SARS epidemic were first reported on ProMED-mail (ProMED-Mail, 2003).

Another source of surveillance information is the Public Health Agency of Canada's Global Public Health Intelligence Network (GPHIN). The GPHIN is a web-based, early warning surveillance system that gathers information on outbreaks through monitoring of global media sources (Public Health Agency of Canada, 2006). The data are analyzed by officials of the Public Health Agency of Canada and made available to subscribers from the global public health community. Users are also notified about events of significant public health consequence. Created in 2000, GPHIN is managed by the Public Health Agency of Canada's Centre for Emergency Preparedness and Response.

Federal, state, and local surveillance – As described in the example of SARS in the Pacific Northwest, advance warning of possible outbreak agents through existing communicable disease surveillance systems can alert healthcare workers to fully use recommended infection control practices.

The notifiable conditions reporting system in Washington State is defined by Chapter 246-101 of the Washington Administrative Code (WAC). As stated in the rule, "The purpose of notifiable conditions reporting is to provide the information necessary for public health officials to protect the public's health by tracking communicable diseases and other conditions." A notifiable condition is defined as "a disease or condition of public health importance, a case of which, and for certain diseases, a suspected case of which, must be brought to the attention of the local health officer or the state health officer."

Under this surveillance system, healthcare providers, public health laboratories, healthcare facilities, and others must notify local health jurisdictions and/or the Washington State Department of Health (WA-DOH) of suspected or confirmed cases of selected conditions within a specified time period, as described by the regulation. Local health jurisdictions must then report findings to the WA-DOH. The WA-DOH, as well as health departments of all other US states and territories, then reports this information to the CDC.

Washington's hospitals are required to immediately report an "immediately notifiable condition," which is defined in the rule as "a notifiable condition of urgent public health importance, a case or suspected case of which must be reported to the local health officer or the state department of health immediately at the time of diagnosis or suspected diagnosis." Immediately reportable agents that may be spread by respiratory routes include anthrax and smallpox (diseases of suspected bioterrorism origin), *Haemophilus influenzae* invasive disease (under age five, excluding otitis media), measles (rubeola), pertussis, tuberculosis, and outbreaks of disease that occur or are treated in the hospital (e.g., pertussis, influenza or other nosocomial infections), or rare diseases of public health significance (e.g., SARS).

A critical complement to the reporting system is the communication mechanism to the public health and healthcare community. Internationally, infectious disease reports are provided to the WHO, which in turn relays alerts through worldwide public health networks. In the United States, alerts of national, state and local concern are broadcast by the CDC and locally by the WA-DOH through public health networks to public health partners and the heathcare community. The CDC provides an architectural framework for secure public health information exchange systems through its Public Health Information Network (PHIN) initiative (CDC, 2006b). Routine information on notifiable conditions is reported by states to the CDC through either the National Electronic Disease Surveillance System (NEDSS) (CDC, 2006c) or the National Electronic Telecommunications System for Surveillance (CDC, 2006d). The CDC's Health Alert Network (HAN) is a secure electronic communication system allowing the rapid 24/7 online transmittal of health advisories such as infectious disease outbreaks to public health officials and other responders (CDC, 2006e). The CDC's Epidemic Information Exchange (Epi-X) provides a secure web-based mechanism for exchange of health alerts and other public health information with public health officials (CDC, 2006f).

In Washington State, communicable disease notifiable conditions information is collected by local health jurisdictions and reported to the WA-DOH by faxes for hardcopy reports, and electronically through the Public Health Issue Management System (PHIMS; Washington DOH, 2006a). Public health alerts and other communications are transmitted to public health partners and first responders using the secure web-based Washington Secure Electronic Communication, Urgent Response and Exchange System (SECURES; Washington DOH, 2006b). When completed, the Public Health Reporting Electronic Data (PHRED) system will automate the reporting and collection of notifiable conditions information from Washington laboratories and the WA-DOH and local health jurisdictions (Washington DOH, 2006c).

Examining Barriers to Infection Control Practices

The occurrence of occupationally acquired infection among healthcare workers is often associated with certain behaviors or social norms. For example, healthcare-acquired infections can be associated with failure to practice certain behaviors such as handwashing, use of gloves, gowns or masks, or other infection control procedure when indicated. Attempts to improve self-protective infection control behaviors can be challenging, and under certain circumstances, taking care of patients' needs may take precedence over the need for workers to protect themselves (Gershon et al., 1995). It has been suggested that to achieve such change requires targeting both the individual and the organizational environment (Kretzer et al., 1998; Larson et al., 2000).

A theoretical model was developed by Gershon and colleagues to address personal and worksite characteristics that influence compliance with universal precautions for protection against infection by bloodborne pathogens among hospital-based healthcare workers (Gershon et al., 1995). The model, which was based on several preventive health theories, focused on three major conceptual areas hypothesized by the authors to play significant roles as barriers to compliance behaviors: demographic and individual factors, organizational factors, and psychosocial factors.

Gershon and colleagues conducted a cross-sectional study of 1,716 hospital-based healthcare workers, to evaluate the influence of demographic/individual, organizational, and psychosocial factors on (reported) use of Universal Precautions against bloodborne pathogens (Gershon et al., 1995). The study included physicians, nurses, technicians, and phlebotomists working in emergency, surgery, critical care, and laboratory departments at three geographically distinct hospitals. A number of variables showed significant bivariate associations with reported use of Universal Precautions (Table 1-3), and multivariate modeling revealed particularly important influences to be: years of education, conflict of interest (self-protection vs. patient care), perception of risk, fear of HIV contagion, rating of organizational safety climate, and training on Universal Precautions.

Based on the Gershon model, the following conceptual model (Figure 1-1) was used to guide the questionnaire design and statistical analysis in the present study. The model differs from Gershon's model by including the construct "public health surveillance."

Table 1-3. Selected factors associated with compliance with Universal Precautions*

	Bivariate Analysis			Multivariate Analysis	
	n	**Percent compliant (11 item scale)**	**p-value**	**Adjusted odds ratio**	**95% Confidence Interval**
Demographic and Individual Factors					
Profession			.001		
Nurse	893	26.5			
Technician/phlebotomist	283	19.8			
Physician	321	16.2			
Education			.001		
<16 years	324	31.8		1.7	1.25-2.20
≥16 years	1379	21.7		1	
Hours worked/week			.002		
<50 hours	1357	25.4			
≥50 hours	342	17.3			
Self-protection vs. patient care			.001		
High	157	10.2		2.3	1.31-3.90
Low	1557	25.0		1	
Psychosocial Factors					
Perception of risk			.001		
High	810	24.0		0.7	0.54-0.87
Low	895	10.0		1	
Fear of HIV contagion			.001		
High	810	20.1			
Low	895	26.8			
Organizational Management Factors					
Rating of organizational safety climate			.001		
Low	236	9.3		2.6	1.61-4.19
High	1479	25.9		1	
Training of Universal Precautions			.001		
Yes (at least one hour)	1283	26.3		1.6	1.19-2.24
No	424	15.3		1	

*Source: Gershon, et al., 1995.

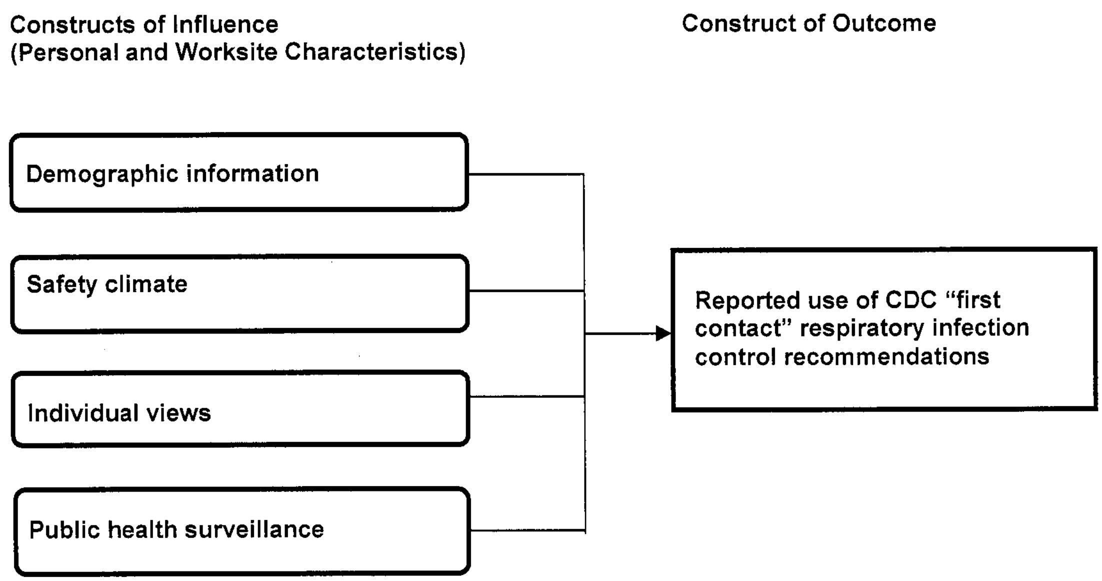

Figure 1-1. Conceptual model: Likelihood of following first contact respiratory infection control guidelines.

Research Questions

Healthcare workers (HCWs) routinely encounter undiagnosed patients seeking care at primary care settings and emergency departments. The first line of defense against acquiring respiratory infections from patients is observance of recommended infection control practices. The CDC developed recommendations to increase early recognition and prevention of SARS-CoV and other respiratory infections during a patient's initial encounter with a health care setting. These practices, in conjunction with public health communicable disease surveillance, form a public health foundation for protecting HCWs from acquiring and spreading respiratory infections on the job. Although HCW compliance with bloodborne pathogen standards has been examined, the readiness and feasibility of healthcare workers to use recommended respiratory infection control measures, and their awareness of communicable disease reporting and feedback systems are less well known. Therefore, the present study addressed the following specific aims and study questions:

Aim 1: Reported Use of Respiratory Infection Control Practices. To examine healthcare worker (HCW) reported use of respiratory infection control practices in primary and emergency care settings recommended by the CDC during the first encounter with a potentially infected person.

Question 1a – Do respiratory infection control practices differ by HCW occupation?

Question 1b – Do respiratory infection control practices differ by medical setting?

Aim 2: Personal and Worksite Characteristics Associated with Reported Use. To identify personal and worksite characteristics associated with reported use of CDC recommended respiratory infection control practices by HCWs in primary and emergency care settings.

Question 2a – Is infection control training associated with use of recommended practices?

Question 2b – Is increased attention to patient care (conflict of interest) associated with use of recommended practices?

Question 2c – Do factors and possible barriers associated with use of CDC recommended respiratory infection control practices differ by HCW occupation?

Question 2d – Do factors and possible barriers associated with use of CDC recommended respiratory infection control practices differ by healthcare setting?

Question 2e – Are HCW perceptions about their employer's communicable disease information feedback programs associated with their use of recommended respiratory infection control practices?

Aim 3: Public Health Surveillance Awareness. To examine HCW awareness of public health surveillance based on knowledge about notifiable condition reporting, and perceptions about their employer's communicable disease surveillance, feedback, and training programs.

Question 3a – Does awareness of notifiable condition reporting among healthcare workers differ by occupation?

Question 3b – Is knowledge of notifiable condition reporting among HCWs associated with employer training?

Findings from this work can be used to guide development of strategies to encourage and support the willingness and ability of healthcare workers to use the recommended infection control guidelines and understand infectious disease surveillance and notifiable conditions reporting practices.

Organizational Relationships

The organizational relationships of the study aims and research questions are presented in context with dissertation chapters and constructs of the conceptual model (Table 1-4).

Table 1-4. Relationship of dissertation chapters to research aims/questions and the conceptual model

Chapter	Research Aims/Questions	Conceptual Model
Chapter 1 – Introduction		
Chapter 2 – Methods		
Chapter 3 – Practices	**Aim 1 (Use of Practices)** • Question 1a – Do practices differ by occupation? • Question 1b – Do practices differ by medical setting?	**Outcome construct** • Reported use of CDC "first contact" respiratory infection control recommendations
Chapter 4 – Multivariate Associations	**Aim 2 (Multivariate Associations)** • Question 2a – Is infection control training associated with use of practices? • Question 2b – Is conflict of interest associated with use of practices? • Question 2c – Do factors differ by occupation? • Question 2d – Do factors differ by medical setting? • Question 2e – Are HCW perceptions of their employer's reporting system associated with use of practices?	**Outcome construct** • Reported use of recommended practices factors **Influence constructs**[1] • Demographic variables • Safety climate factors • Individual views factors • Public health surveillance factors
Chapter 5 – Safety Climate		**Influence construct**[1] • Safety climate factors development
Chapter 6 – Public Health Surveillance	**Aim 3 (Public Health Surveillance)** • Question 3a – Does notifiable condition reporting awareness differ by occupation? • Question 3b – Does notifiable condition reporting awareness differ by training?	**Outcome construct** • Reported use of recommended practices factors **Influence constructs**[1] • Demographic variables • Public health surveillance factors
Chapter 7 – Factor Analysis		**Outcome construct**: • Reported use of recommended practices factors development **Influence constructs**[1] • Individual views factors development • Public health surveillance factors development
Chapter 8 – Validity/Reliability		
Chapter 9 – Conclusions		

[1] Personal and worksite characteristics

2. Methods

This cross-sectional study used a self-administered questionnaire to survey healthcare workers (HCWs) at primary care and emergency department settings in five medical centers, to evaluate reported use of recommended practices for respiratory infection control. Data analysis was guided by the chosen conceptual model (Chapter 1, Figure 1-1). Factor analysis was used to identify questionnaire items (questions) that could be condensed into single variables (factors), representing underlying dimensions of components (major constructs) of the conceptual model. Separate factor analyses were conducted for the study outcome (use of respiratory infection control practices), and three of the four constructs of influence (safety climate, individual views, and public health awareness, but not demographic information). A number of approaches were used to assess validity and reliability of the survey instrument.

The study protocol was approved by the University of Washington, Office of Research, Grant and Contract Services, Human Subjects Division prior to commencement. Letters of cooperation were obtained from each participating medical center. One participating medical center required an independent review by its Institutional Review Board (IRB) that was subsequently approved. The University of Washington IRB review was accepted by four participating medical centers in lieu of an independent institutional review.

Study Sample

Healthcare workers were recruited from five medical centers in King County, Washington, willing to allow the study at their institution within the timeframe of the study. Four additional medical centers were approached but did not participate. Of these, two agreed to participate but could not do so within the study's time frame, due to a delayed IRB review at one and an ongoing hospital accreditation review at the other. Two medical centers chose not to participate.

Of the five participating medical centers, four were larger-sized urban medical centers, and one a smaller rural hospital. Three medical centers included participation by emergency departments and associated primary care clinics. Two medical centers only included participation by emergency departments.

Following each medical center's written agreement to participate, each was asked to provide the number of healthcare workers employed in its primary care and/or emergency department settings. The raw number of all eligible healthcare workers, stratified by occupational category, was then conveyed to the investigators. Based on that number, the investigators prepared enough survey packets to be anonymously distributed to each healthcare worker at each primary and emergency care location.

Eligibility for inclusion in the study required that healthcare workers currently work in either a primary or emergency care setting at least one day per week, and that the work involved routine contact with patients either through direct patient care or reception and admittance.

To promote the study, the principal investigator provided each setting manager with promotional posters. Posters were displayed at the discretion of each clinic manager. The posters described the study and provided information about how potential participants could voluntarily obtain and complete the anonymous questionnaire, or how to pick up another copy of the survey packet if their first had been lost or discarded. The investigator also described the study during department or clinic meetings to both managers and staff whenever the opportunity became available.

Survey packets included a cover letter with instructions and implied informed consent language, the survey instrument, and a stamped return envelope. An espresso card was also included in each survey packet for four medical centers as an incentive to participate. The IRB of one medical center did not allow inclusion of the espresso card incentive. Surveys were either distributed directly by the clinic manager to staff or placed in each worker's clinic mailbox. The investigators provided extra survey packets to clinic managers for healthcare workers who discarded or lost their original survey. Completed surveys were anonymously returned to the investigators in a stamped addressed envelope. The response rate denominator was based on the difference between the original number of survey packets provided to each setting, and the number undistributed. The numerator was based on the number of completed surveys returned to the investigators.

All healthcare workers (1,241) at each of the surveyed medical settings were invited to participate. Six hundred fifty-three surveys were returned for a response rate of 53%. Of those, 630 respondents met the study's eligibility criteria. The other 23 respondents were excluded from the study because they did not work at least one day per week in a primary or emergency care setting or their work did not involve routine contact with patients. The response rate was 76% at two medical centers and approximately 56% at two others. One medical center that did not authorize inclusion of the study's espresso card incentive in survey packets had a response rate of 39%.

The estimated percentage of non-participants from each medical center is presented by occupation (Table 2-1). The percentage denominator is based on the approximate number of healthcare workers, by occupation, provided by clinic managers to the investigators, when available. The numerator is based on the number of eligible respondent surveys received. Non-participation by occupation varied markedly between medical centers, but tended to be highest for all occupations at the one center that had the lowest overall participation. Otherwise, there was no consistent pattern across medical centers in participation by different occupational groups.

Table 2-1. Estimated percent non-respondents, by occupation and medical center

	Medical Center 1	Medical Center 2	Medical Center 3	Medical Center 4	Medical[1] Center 5	Total Eligible Respondents
Physician[2]	20%	59%	29%	57%	---	165
Practitioner	0%	0%	25%	78%	---	22
Nurse (RN/LPN)	37%	35%	22%	62%	---	277
Technician	22%	25%	0%	56%	---	82
Administration	57%	55%	75%	73%	---	84

[1] Response rate estimates could not be calculated by occupation for Medical Center 5
[2] Percent based on the estimated percent of respondents, by occupation

Sample Size Calculation

Sample size estimates were based on *a priori* associations of factors testing the effects of safety climate and individual views upon healthcare worker compliance with Universal Precaution infection control guidelines (Gershon et al., 1995). From that work, an independent variable of interest to this study was identified: "Training on Universal Precautions." Compliance among study subjects who reported training compared to those who did not was 0.26 and 0.15 respectively. The required sample size for $\alpha = 0.05$ and the power of 0.80 is $n_1=229$, $n_2=229$; $n_{total} = 458$ (Two-Sample Test of Equality of Proportions). From this, the goal for eligible subject recruitment for the present study was 458 respondents.

The expected response rate for this study was based on experiences of other investigators for surveys of healthcare workers in hospital settings (Table 2-2). Based on previous studies, higher response rates were observed among participants surveyed from medical centers rather than through the members of a professional organization.

Table 2-2. Response rates for hospital-based healthcare worker studies

Reference	Survey Environment	Number of Questionnaires Returned	Response Rate (%)
Gershon et al., 1995	Healthcare workers from three geographically distinct large (~1,000 bed) acute care hospitals	n=1,716	57%
Gershon et al., 2000	Healthcare workers from a large (1000+ beds) urban research medical center	n=789	61%
Teppei et al., 2005	Healthcare workers from seven hospitals in Japan	n=7,282	73%
Osborne, 2003	Australian College of Operating Room Nurses membership	n=500	45%

Questionnaire

The study questionnaire was developed to examine the degree to which HCWs reported using the US Centers for Disease Control and Prevention's (CDC's) first contact infection control recommendations (CDC 2004c).

The questionnaire was based on the chosen conceptual model (Figure 1-1), the questionnaire used by Gershon and colleagues to assess protective behavior related to bloodborne pathogen exposure (Gershon et al., 1995; Gershon et al., 2000), and CDC infection control guidelines (Garner et al., 1997; CDC, 2002; CDC 2004a; CDC, 2004c; CDC, 2004e; CDC, 2005b), particularly the "Respiratory Hygiene/Cough Etiquette in Healthcare Settings" guideline (CDC, 2004c). The study questionnaire is presented in Appendix A, and sources of questionnaire items are in Appendix B.

Questions about constructs of personal and worksite characteristics—demographic information, safety climate, and individual views—were adapted from the Gershon questionnaires (Gershon et al., 1995; Gershon et al., 2000), with minor modifications that reflected the focus of the present study on respiratory infection hazards rather than bloodborne pathogens. Gershon and colleagues used focus groups, structured interviews, and work site surveys to develop 46 safety climate questions (Gershon et al., 2000). Their factor analysis of those questions identified 20 questions that represented six dimensions of the major construct of safety climate. The present study used those questions, with context-appropriate modifications, and added five questions to capture additional concepts relevant to the CDC respiratory hygiene guideline. The safety climate questions are presented in Chapter 4, Table 4-2.

Survey questions relating to the individual views construct were modified from questions developed by Gershon and colleagues (1995). Additional questions were developed to address dimensions of risk perception, conflict of expectations, influenza vaccination views and sick leave expectations. A new set of questions was developed to assess public health awareness, based on input from communicable disease epidemiologists of the Washington State Department of Health and Harborview Medical Center. Questionnaire items were reviewed for relevance and accuracy during pilot testing by a small sample of healthcare workers and infection control practitioners.

Questionnaire responses were based on Likert scales with the exception of the demographic variables and variables measuring length of time. Questions involving practices used responses of "Almost Always," "Often," "Sometimes," "Rarely," "Never" and either "Does Not Apply" or "Don't Know." Questions involving personal views used responses of "Strongly Agree," "Agree," "Neutral," "Disagree," "Strongly Disagree," and "Don't Know." Responses of "Does Not Apply" or "Don't Know" were coded as missing values for analysis purposes.

Data Analysis

Statistical analysis was guided by the study's conceptual model to examine use of "first contact" respiratory infection control recommendations relative to the constructs of influence (demographic information, safety climate, individual views, and public health awareness). The first analyses (Chapter 3) focused on HCW occupation and demographic characteristics, to address Research Question 1. The second analyses (Chapter 5) examined constructs of influence from the conceptual model, utilizing the factors derived by factor analysis for each construct, to address Research Question 2. Research Question 3 was examined in a separate analysis (Chapter 6). Associations were examined by bivariate and multivariate modeling techniques.

Data were analyzed using SPSS version 13.0 and Stata 9.0 statistical software. Each variable was individually examined for errors or inconsistencies through inspection of histograms and distribution summaries. Most of the collected data was categorical. The numerical variable "age" was divided into logical categories by decade suitable for the observed distribution.

Factor analysis – Following data cleaning and examination of variables, factor analysis was conducted by the principal components analysis method, principal axis factoring method, and maximum likelihood method. Factor analysis was conducted separately for each construct in the conceptual model (except demographic information), to identify groups of questions that represented different dimensions of each construct. Factor loadings were examined by varimax orthogonal rotation and direct oblique rotation to interpret latent variables underlying an item. Variables with factor loadings of 0.45 or greater were grouped and judgments made on their applicability to an underlying latent variable (Pett, 2003; Comrey and Lee, 1992). Extracted questions comprising a construct were examined by Cronbach's alpha for internal consistency (Cronbach, 1951). Detailed methods and results of factor analyses are described in Chapter 5 (safety climate) and Chapter 8 (use of infection control practices, individual views, and public health awareness).

Four types of missing values were identified during the study. These included: 1) lack of response, 2) improper response (e.g., marking two responses in a one-response question, 3) responses of "Does Not Apply", and 4) responses of "Don't Know."

Because factor analysis models eliminate observations by listwise deletion, questions with ≥ 30% missing values were excluded from the factor analysis model to retain an adequate representation of the population sample.

After the questions comprising each of the factors was identified, the factors were prepared for analysis by dichotomizing each question to indicate use of a practice or agreement with a statement (coded "1"), or non-use or disagreement (coded "0") (Michalsen et al., 1997; Gershon et al., 1995; McCoy et al., 2001). Use of a practice was defined by a response of "almost always" or "often," and agreement was defined by a response of "strongly agree" or "agree."

A new variable was created by dichotomizing each factor as "1" if all questions in the factor were coded "1." If any response to a question was coded "0," then the dichotomized factor variable was coded "0." If any question response had a missing value, then the factor variable was coded as a missing value by listwise deletion. Therefore, the dichotomized factor variables were only created for subjects who responded to all component questions in the factor.

Associations – Bivariate analysis of associations between dependent and independent variables and factors (latent variables representing dimensions of each major construct) used contingency tables and the Pearson chi square test. Only responses from HCWs in direct patient care (clinicians, e.g., physicians, practitioners, nurses and nurse assistants) were used in the modeling. HCWs categorized as allied professionals or administration (predominantly reception) were excluded because of frequent non-response on questions not relevant to their job duties. Odds ratios and 95% confidence intervals were calculated and significant associations identified.

Multivariate logistic regression modeling was conducted to describe the relationship of dichotomous outcome variables with several independent variables. Exploratory modeling was begun using stepwise forward and backward likelihood ratio logistic regression methods, with variables entering the model at $p<.10$ and exiting the model at $p>.20$. Both forward and backward methods were used to compare models derived from each approach, recognizing that stepwise models do not necessarily identify best models (Garson, 2006a). Models were constructed for two outcome variables, "hand hygiene" and "respiratory precautions," which were identified by factor analysis (Chapter 8) as two dimensions (factors) underlying the outcome construct of the study conceptual model, use of infection control practices.

All demographic variables were first entered into both forward and backward stepwise logistic regression models, and variables significant to each model were flagged for further examination. Stepwise analysis was then conducted on models containing all dimensions (factors) of the three major constructs (safety climate, individual views and public health awareness), controlling for healthcare worker occupation, medical center and medical setting. Significant variables from both the forward and backward stepwise analysis of the "major construct dimensions" models were also identified for further examination.

The "Enter Method" was used to identify the final parsimonious model (Garson, 2006a). This was done by examining the influence on model precision and significance of variables entering a model that included only occupation and healthcare setting as the independent variables. Variables that held or improved model precision or significance were retained. Both demographic variables and variables representing construct dimensions (factors) that were significant either from bivariate or stepwise analysis were individually added to the existing model, to determine their effect on the new model. The variables representing occupation and healthcare setting were retained in all models for *a priori* reasons, until the decision on final models was made. All variables deemed important to the model were retained in the final model. Additional methods are presented in the dissertation chapters to follow, specific to the section topic.

Reliability and Validity

In research, validity refers to whether a study's measurement tool truly measured what it intended to measure. Reliability of a survey instrument refers to the extent to which instrument scores are free from measurement error (Pett, 2003). Two aspects of validity were examined in the present study: content validity and construct validity. Three tests of reliability were examined in the present study: internal consistency, test-retest, and situational reliability.

Reliability and validity are described in Chapter 8 of this dissertation.

3. Respiratory Infection Control Practices in Primary and Emergency Healthcare Settings

The SARS epidemic highlighted risks of infection faced by healthcare workers when first encountering patients with symptoms of respiratory infection in walk-in first-encounter healthcare settings. The CDC addressed these risks by providing recommendations to prevent the transmission of all respiratory infections, including SARS, at the first point of contact with an undiagnosed person as a component of Standard Precautions (CDC, 2004c). These measures include infection control instructions to patients with symptoms of respiratory infection, protecting others from ill patients by separation and masking, infection control procedures for healthcare workers (hand hygiene and personal protective equipment), and administrative measures (written procedures and training). The extent to which these measures are followed by healthcare workers and their institutions is uncertain.

The aim of this chapter is to examine responses by healthcare workers to survey questions about individual and institutional use of recommended CDC respiratory infection control practices, in primary care and emergency department settings (CDC, 2004c). This chapter specifically addresses the study research questions: Do respiratory infection control practices differ by HCW occupation? (Question 1a) and, Do respiratory infection control practices differ by medical setting? (Question 1b).

Methods

Detailed study methods are presented in Chapter 2.

Results

Demographic Information – Survey respondents were combined into five occupational categories for purposes of display and analysis (Table 3-1).

Physician/practitioners and nurses each comprised about 30% of respondents. Nurse aides, allied professionals, and administrative staff each comprised 13-15%. Within these categories, 88% of physician/practitioners were physicians, 94% of nurses were registered nurses, 86% of nurse aides were medical assistants, and 77% of administrative staff were patient receptionists. Although 17% of the allied professionals were respiratory therapists, the majority were self-identified as technicians or technologists. This report uses the abbreviated term, "physician," to refer to the physician/practitioner category.

Table 3-1. Study sample, by healthcare worker occupation

Occupation	Number of respondents	Percent by occupational category	Percent of total respondents
Physician/Practitioner	**187**		**30%**
Physician	165	88%	
Physician assistant	4	2%	
Nurse practitioner	18	10%	
Nurse	**180**		**29%**
Registered nurse	170	94%	
Licensed practical nurse	10	6%	
Nurses Aide	**97**		**15%**
Nurse aide	14	14%	
Medical assistant	83	86%	
Nursing (other)	4	4%	
Allied Professionals	**82**		**13%**
Radiology technician	36	44%	
Respiratory therapist	14	17%	
Phlebotomy technologist	6	7%	
Medical technician	26	32%	
Technician (other)	17	21%	
Administrative	**84**		**13%**
Patient reception	65	77%	
Administration	7	8%	
Patient coordinator	7	8%	
Social worker	5	6%	
Total	**630**	**100%**	

Demographic information, stratified by occupational category, is presented in Table 3-2. Most of the subjects were employed at two medical centers. A higher percentage of physicians, nurses aides, and administrative staff were from primary care settings. Most nurses (81%) were from emergency departments. Allied professionals were equally divided between the two healthcare settings.

Table 3-2. Demographic characteristics by healthcare worker occupation

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)	
Medical Center [1]										
Med Ctr A	5	(3%)	19	(11%)	0	(0%)	18	(23%)	3	(4%)
Med Ctr B	15	(8%)	14	(8%)	10	(11%)	3	(4%)	9	(11%)
Med Ctr C	13	(7%)	48	(27%)	13	(14%)	1	(1%)	1	(1%)
Med Ctr D	52	(29%)	55	(31%)	35	(39%)	56	(72%)	35	(42%)
Med Ctr E	95	(53%)	40	(23%)	32	(36%)	0	(0%)	35	(42%)
Medical setting										
Primary care	107	(66%)	33	(19%)	72	(77%)	32	(49%)	64	(77%)
Emergency care	54	(34%)	143	(81%)	21	(23%)	33	(51%)	19	(23%)
Gender										
Male	87	(46%)	30	(17%)	9	(9%)	36	(44%)	10	(12%)
Female	99	(53%)	149	(83%)	86	(91%)	46	(56%)	74	(88%)
Age										
21-29	28	(15%)	15	(9%)	34	(37%)	9	(12%)	23	(28%)
30-39	52	(28%)	43	(26%)	26	(28%)	15	(20%)	15	(18%)
40-49	55	(30%)	44	(26%)	14	(15%)	23	(31%)	25	(30%)
50+	48	(26%)	65	(39%)	18	(20%)	28	(37%)	19	(23%)
Education										
High school	0	(0%)	3	(2%)	35	(38%)	9	(11%)	22	(26%)
Associates	1	(1%)	58	(33%)	40	(43%)	42	(52%)	26	(31%)
College	2	(1%)	97	(54%)	12	(13%)	25	(31%)	28	(33%)
Grad	183	(98%)	20	(11%)	6	(7%)	5	(6%)	8	(10%)
Ethnicity										
Asian	20	(11%)	10	(6%)	12	(13%)	3	(4%)	12	(16%)
Black	0	(0%)	2	(1%)	10	(11%)	2	(3%)	8	(10%)
Native Am	1	(1%)	3	(2%)	2	(2%)	0	(0%)	2	(3%)
White	156	(87%)	152	(87%)	63	(68%)	69	(91%)	52	(68%)
Other	3	(2%)	7	(4%)	5	(5%)	2	(3%)	3	(4%)
Work week										
≤ 40 Hours	68	(37%)	142	(79%)	69	(73%)	46	(56%)	52	(62%)
> 40 Hours	118	(63%)	37	(21%)	26	(27%)	36	(44%)	32	(38%)

(continued)

Table 3-2: (continued)

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)	
Current employer [1]										
≤ 5 Years	98	(53%)	88	(49%)	61	(64%)	41	(50%)	42	(50%)
> 5 Years	88	(47%)	91	(51%)	34	(36%)	41	(50%)	42	(50%)
Present occupation										
≤ 5 Years	67	(36%)	37	(21%)	40	(42%)	24	(29%)	47	(56%)
> 5 Years	119	(64%)	142	(79%)	55	(58%)	58	(71%)	37	(44%)
Healthcare yrs										
≤ 5 Years	42	(23%)	14	(8%)	32	(34%)	13	(16%)	29	(35%)
> 5 Years	144	(77%)	165	(92%)	63	(66%)	69	(84%)	55	(65%)
Supervisor										
No	138	(74%)	136	(77%)	89	(95%)	74	(90%)	68	(81%)
Yes	48	(26%)	41	(23%)	5	(5%)	8	(10%)	16	(19%)

[1] Table shows number of respondents (column percentages by variable in parentheses)

Most subjects were female. The highest percentage of females was observed among nurse aides, followed by administrative staff and nurses. About half of the physicians and allied professionals were female. Nurse aides and administrative staff comprised the youngest workers, and nurses and allied professionals the oldest. There was a wide range of education in all categories except physicians. Most respondents (82%) reported their race as white.

Physicians were most likely to work more than 40 hours per week, although overtime was reported by respondents in all other job categories. About half of all subjects had been with their current employer, and two thirds in their present occupation, for more than five years. Most subjects had worked in the healthcare industry for more than five years. About one fifth of respondents reported working as a supervisor. All of the demographic variables showed significant differences between the occupational categories (chi-square test, $p<.001$) except years with current employer ($p=.27$).

Use of Recommended Measures –

Patient guidance – Overall, about three quarters of respondents reported that the recommended visual alerts for patients were present in their workplace, although

10% of all subjects reported that they did not know. While respondents directly involved in patient care (physicians, nurses, nurse aides) were more likely than technical or administrative workers to report that visual alerts advised patients to inform staff if they had respiratory symptoms, such differences were not observed regarding instructing patients about how to prevent respiratory illness (Table 3-3). However, it is noteworthy that physicians and nurse aides were less likely than nurses to give such instructions personally, and the overall percentage of respondents who personally offered instructions (56%) was significantly lower than those reporting institutional instructions (82%, p<.001).

Table 3-3. Use of patient guidance recommendations

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)		p-value[4]
Visual alerts											
Inform staff of respiratory symptoms (env23)[1,2,3]	133 [28]	(84%)	129 [10]	(76%)	70 [7]	(78%)	47 [9]	(64%)	51 [6]	(65%)	.004
Practice respiratory precautions (env24)	116 [30]	(74%)	121 [13]	(72%)	69 [7]	(77%)	50 [7]	(67%)	58 [3]	(72%)	.70
Patient instructions											
I instruct patients about respiratory precautions (icp11)	86 [6]	(48%)	134 [4]	(76%)	56 [8]	(63%)	31 [7]	(41%)	26 [13]	(37%)	<.001
Patients are instructed about how to prevent spread to others (icp18)	132 [14]	(76%)	143 [9]	(84%)	70 [19]	(90%)	27 [48]	(79%)	13 [69]	(87%)	.11

[1] Number and percent positive responses. A positive response (i.e., use or practice) is a response of either "Almost Always" or "Often." Percent is based on the number of subjects who provided a measurable response to the question
[2] Number of non-responses (subjects who provided a "does not apply," "don't know," or blank response) are shown in square brackets
[3] Complete survey questions are provided in Appendix A, icp=survey infection control practice section, env=survey working environment section
[4] p-value based on chi square test of homogeneity

Patient masking and separation – Most respondents, regardless of occupation, reported that masks are offered to coughing patients (Table 3-4). On the other hand, fewer nurses reported that suspected measles patients are given masks. Overall, only about one-third of respondents said that patients with symptoms of influenza-like illness (ILI) are asked to sit at least three feet away from others, although a larger proportion (57%) said they are eventually placed in a private examination room. A substantial fraction of subjects could not answer questions about patient separation practices (44%). One third of physicians could not answer questions about patient isolation practices.

Table 3-4. Use of patient masking and separation recommendations

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)		p-value[4]
Disposable masks are offered to coughing patients (icp9)[1,2,3]	143 [20]	(86%)	166 [4]	(94%)	76 [5]	(83%)	54 [9]	(74%)	71 [6]	(91%)	<.001
Suspected measles patients are masked (icp15)	107 [57]	(82%)	126 [19]	(78%)	55 [26]	(77%)	33 [39]	(77%)	34 [48]	(94%)	.20
ILI patients are asked to sit 3 feet from others (icp10)	29 [119]	(43%)	39 [40]	(28%)	21 [38]	(36%)	12 [48]	(35%)	12 [31]	(23%)	.12
ILI patients are placed in a private exam room (icp14)	81 [62]	(65%)	105 [15]	(64%)	41 [10]	47%)	19 [38]	(43%)	22 [36]	(46%)	.004
Suspected measles patients are placed in an airborne isolation room (icp16)	105 [56]	(80%)	148 [16]	(90%)	71 [17]	(89%)	32 [43]	(82%)	37 [41]	(86%)	.13

[1] Number and percent positive responses. A positive response (i.e., use or practice) is a response of either "Almost Always" or "Often." Percent is based on the number of subjects who provided a measurable response to the question
[2] Number of non-responses (subjects who provided a "does not apply," "don't know," or blank response) are shown in square brackets
[3] Complete survey questions are provided in Appendix A, icp=survey infection control practice section
[4] p-value based on chi square test of homogeneity

Hand hygiene – A high percentage of respondents reported practicing hand hygiene before having direct contact with a patient (91%), and after working with a coughing patient (95%; Table 3-5). Fewer reported practicing hand hygiene immediately after removing disposable gloves (81%). Physicians were less likely than nurses, nurse aides or allied professionals to use this recommendation (p<.001). Only half of the physician and nurse respondents reported practicing hand hygiene after taking a pulse or blood pressure, and 13% of physicians reported that this did not apply. Less than half of physicians, but about 60% of nurses and nurse aide respondents reported practicing hand hygiene after touching items within the immediate vicinity of a patient.

Table 3-5. Use of hand hygiene practice recommendations

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)		p-value[4]
Before direct contact with a patient (icp1) [1,2,3]	174 [1]	(94%)	165 [1]	(92%)	86 [2]	(91%)	70 [1]	(86%)	58 [14]	(83%)	.06
After taking a pulse or blood pressure (icp2)	92 [24]	(56%)	91 [1]	(51%)	63 [3]	(67%)	32 [39]	(74%)	5 [77]	(71%)	.02
After working with a coughing patient (icp3)	178 [1]	(96%)	173 [1]	(97%)	90 [2]	(95%)	80 [0]	(98%)	65 [12]	(90%)	.20
After touching items near a patient (icp4)	81 [1]	(44%)	103 [2]	(58%)	62 [3]	(66%)	60 [0]	(73%)	57 [8]	(75%)	<.001
After removing my disposable gloves (icp7)	135 [6]	(75%)	151 [2]	(85%)	82 [4]	(88%)	68 [2]	(85%)	20 [55]	(69%)	.01

[1] Number and percent positive responses. A positive response (i.e., use or practice) is a response of either "Almost Always" or "Often." Percent is based on the number of subjects who provided a measurable response to the question
[2] Number of non-responses (subjects who provided a "does not apply," "don't know," or blank response) are shown in square brackets
[3] Complete survey questions are provided in Appendix A, icp=survey infection control practice section
[4] p-value based on chi square test of homogeneity

Personal protective equipment – About three quarters of nurses and allied professional respondents reported wearing gloves when they attended a patient with influenza-like illness (ILI) symptoms (Table 3-6), but only half of the nurse aides and 28% of physicians reported doing so. Almost all respondents in patient care or allied professional roles removed gloves promptly after use and before going to another patient. However, one quarter or less of respondents in any occupation reported using eye protection or a mask in the presence of sneezing or coughing patients.

Table 3-6. Use of personal protective equipment practice recommendations

	Physician/ Practitioner (n=187)		Nurse (n=180)		Nurse Aide (n=97)		Allied Professional (n=82)		Admin-istration (n=84)		p-value[4]
Disposable gloves											
Wear when with a ILI patient (icp5)[1,2,3]	52 [1]	(28%)	135 [2]	(76%)	47 [7]	(52%)	61 [0]	(74%)	11 [49]	(31%)	<.001
Remove promptly after use (icp6)	174 [11]	(99%)	178 [2]	(100%)	93 [4]	(100%)	78 [3]	(99%)	26 [58]	(100%)	.47
Change before going to another patient (icp8)	176 [11]	(100%)	178 [2]	(100%)	89 [8]	(100%)	77 [3]	(97%)	11 [73]	(100%)	.02
Eye protection											
Wear when with a sneezing patient (icp12)	36 [5]	(20%)	39 [4]	(22%)	18 [7]	(20%)	20 [1]	(25%)	3 [54]	(10%)	.52
Respiratory protection											
Wear a mask when examining a coughing ILI patient (icp13)	41 [2]	(22%)	57 [5]	(33%)	28 [14]	(34%)	25 [9]	(34%)	2 [74]	(20%)	.11
I wear a respirator in a suspected TB patient room (icp17)	95 [65]	(78%)	109 [36]	(76%)	35 [44]	(66%)	52 [19]	(83%)	6 [74]	(60%)	.20

1 Number and percent positive responses. A positive response (i.e., use or practice) is a response of either "Almost Always" or "Often." Percent is based on the number of subjects who provided a measurable response to the question
2 Number of non-responses (subjects who provided a "does not apply," "don't know," or blank response) are shown in square brackets
3 Complete survey questions are provided in Appendix A, icp=survey infection control practice section
4 p-value based on chi square test of homogeneity

About three quarters of physician and nurse respondents reported wearing a fit-tested or powered air-purifying respirator when entering the room of a patient with suspected infectious pulmonary tuberculosis. Physicians (35%), nurses (20%), and nurse aides (45%) reported that this did not apply to their practice.

Written first encounter procedures – Overall, about three quarters of respondents reported that their practice setting had clear written procedures on what to do, and infection control actions to take, when an undiagnosed patient arrives with symptoms of respiratory infection. Conversely, almost 20% of physicians, 15% of reception/administrative staff, but only 6% of nurses and nurse aides reported that they did not know if their setting had developed first-encounter procedures.

Infection control training – About one quarter of responding physicians, 15% of nurses, nurse aides and allied professionals, and 40% of administrative staff reported that they had not received any training on respiratory infection control and personal protection practices during the previous twelve months. Almost 40% of physicians, nurses, nurse aides and allied professionals indicated that they received less than one hour of training, and about one third, from one to two hours of training during the previous year.

Primary and Emergency Care Settings – Overall, 53% (n=308) of respondents reported working most often in a primary care clinic and 47% (n=270) in an emergency department, while 53 subjects did not identify a setting. Two thirds of responding physicians and almost 80% of nurse aides reported working in primary care settings, while about 80% of nurses reported working in emergency departments the most often. About three quarters of administrative staff were from primary care clinics, while allied professionals were evenly split between settings.

Although it might be acknowledged that there were occupational dissimilarities between respondents from primary care and emergency department settings, some differences in reported practices were observed between the two settings based on aggregated responses. Seventy percent of all respondents from emergency departments reported wearing disposable gloves when working with a coughing patient with influenza-like illness, in contrast to 38% from primary care clinics, representing a substantial and significant overall difference (chi square test; $p<.001$). Practices that differed significantly ($p<.001$) but less substantially (about 20% difference between settings) involved instructing patients about respiratory hygiene/cough etiquette practices, and placing patients with flu-like illness in a private examination room, with about two thirds of respondents. About two thirds of emergency department workers reported following these two practices in contrast to less than half of the primary care setting respondents. Other differences, although significant ($p<.05$) were less pronounced, differing by 10% or less overall. These practices involved the offering of disposable masks to coughing patients (92% emergency department, 83% primary care), placing suspected measles patients in an airborne isolation room (90% emergency department, 82% primary care), practicing hand hygiene after touching inanimate objects in a patient's vicinity (65% emergency department, 55% primary care), and wearing eye protection when caring for a patient who is coughing or sneezing (26% emergency department, 16% primary care). For each, emergency department workers were more likely to follow the practices than workers from primary care settings.

Discussion

This study found that many of the CDC guidelines for healthcare workers confronting patients with undiagnosed respiratory infections are not used routinely in primary and emergency care first-encounter settings. This study identified shortcomings in healthcare workers' knowledge or awareness of first-encounter practices at their institution, and frequent deficiencies in their reported individual use of recommended practices. Lapses were observed in use of recommended practices across all healthcare worker occupations, although nurses tended to be more compliant with recommended practices than workers in other occupations. Historically understudied healthcare workers, particularly reception and administration and technical staff who routinely interact with patients in first-contact settings, commonly received no training on infection control procedures and were often not familiar with practices that are potentially applicable to their work situation.

Complete use of recommended practices can effectively protect healthcare workers from occupationally acquired infections (Health Canada, 2003), although to do so routinely can be challenging. The findings of the present study could be used to target future changes or corrective interventions in national and institutional policies, worker training strategies, and institutional facilitation of recommended practices by healthcare workers. These findings, however, also raise serious concerns about the feasibility of routinely implementing all recommended practices to protect healthcare workers from acquiring and spreading respiratory infections in first-encounter clinical settings, such as separating coughing patients by three in clinic waiting areas.

The CDC recommendation for clinics to display visual alerts instructing patients to inform healthcare staff of their respiratory symptoms upon arrival, and providing basic respiratory infection control instructions is relatively new (CDC, 2004c; CDC, 2004e). While most physicians and nursing staff reported that visual alerts were adequate in their practice setting, fewer administrative staff working in front-desk reception areas agreed, indicating a need for improved visual alerts at clinic entrances. In a study of hospital workers in 16 hospitals in Hong Kong, non-medical support staff experienced a pooled SARS attack rate of 2.7%, compared to an attack rate for nurses of 1.21%, and other medical staff of 0.3%. This observation highlights the need for infection control protection among non-medical healthcare workers (Lau et al., 2004).

The patient's role in preventing the spread of infection to others is also strengthened by personal instruction from their healthcare providers. During the SARS epidemic, a possible association was identified between personal hygiene education and the reduced incidence of influenza and other common respiratory illnesses in the community (Lau et al., 2005). In the present study, nurses were much more likely to personally instruct patients about how to prevent the spread of respiratory infections than physicians or other workers who have patient contact in technical or administrative/reception roles. In addition, responses from all occupations were lower when asked about information that was actively conveyed by the worker, rather than passively conveyed by the institution. This may indicate a perception by healthcare staff that, because patient instruction is done by others in their practice setting, personal involvement is less important. Infection control staff should actively promote the need for healthcare workers, particularly physicians, to provide basic infection control instructions to their patients with respiratory illness.

The CDC recommends that patients with respiratory symptoms be encouraged to sit three feet from others in waiting areas to prevent spread of respiratory agents to others, particularly during periods of increased respiratory illness in the community (CDC, 2004c). In the present study, respondents from all occupations rarely asked ILI patients to sit three feet apart, and almost half did not know if spatial separation was practiced in their setting. Unprotected exposure to a SARS patient of less than three feet, with or without physical contact, was identified as a potential infection hazard during the SARS epidemic (Varia et al., 2003). However, while evidence suggests that spatial separation can reduce the spread of droplet-transmissible infections (Feigen, et al., 1982), implementation in a crowded waiting room can be challenging (Chen et al., 2005) and may be unrealistic without sufficient planning and physical resources.

Only about half of direct care providers reported placing ILI patients in a private examination room as recommended by the CDC. Patient separation was reported more commonly in emergency rooms than primary care settings, which may reflect differences in physical capacity relative to patient volume and turnover. Separating ILI patients into private examination rooms or cubicles is good practice from an infection control perspective, but will undoubtedly be difficult or impossible because of space limitations during flu seasons. Clinic preparedness infection control plans should consider alternative strategies to expand examination room capacity and achieve patient separation if usual capacity is exceeded.

One alternative strategy involves "cohorting" or grouping patients with the same infection or symptoms in areas separated from other patients (Garner et al., 1997).

For example, during the SARS epidemic, the CDC recommended that SARS patients requiring hospitalization be placed in an Airborne Infection Isolation Room (AIIR) due to the possibility of airborne transmission (CDC, 2004a). However, recognizing that a sufficient number of AIIRs may not be available, the CDC suggested a strategy of cohorting patients in individual rooms on the same floor (e.g., a dedicated SARS unit), rather than in multiple locations throughout a hospital (CDC, 2004a). This practice was successfully used in Toronto and Taiwan to control SARS transmission in hospitals (McDonald et al., 2004). Benefits include concentrating resources and intensive infection control activities in one hospital area, minimizing contact with other patients, and designating a relatively smaller number of healthcare personnel specializing in SARS-patient care (Srinivasan et al., 2004).

The CDC recommends offering a surgical or procedure mask to coughing patients to contain the spread of infected droplets, particularly during periods of high respiratory illness in the community (CDC, 2004c; CDC, 2005b). Patients arriving at an emergency room or other healthcare setting with respiratory symptoms should be provided with a disposable mask that they should wear until evaluated (CDC, 2004e; Lenehan, 2004). During the SARS epidemic, masks were commonly placed on patients with respiratory symptoms to curb the spread of SARS, and this was judged to be an effective preventive measure (McDonald et al., 2004). In the present study, most respondents reported offering masks to coughing patients, although nurses and administrative staff were more likely to do so than physicians, nurse aides, or technical staff.

The practice of offering masks to ILI patients in waiting areas is contradicted by reported patient experiences. In a random-dialed telephone survey of 2,231 households conducted during February 6-22, 2004 from eleven Emerging Infections Programs surveillance areas of the United States (Pinner et al., 2003), 17.8% of adults reported "yes" to the question, "Have you had an illness you thought was flu at any time since October?" Of those, about 8% of adults who sought treatment for ILI reported that their healthcare provider asked them to wear a mask, although 82% said that they would do so if requested (CDC, 2004d). These findings, plus those of the present study, indicate a need to enhance efforts to provide masks for coughing patients at clinic entrances, with particular attention toward healthcare workers in occupations where this may be less likely to be considered their responsibility. Hand hygiene was identified as a critical infection control measure during the SARS epidemic (Chen et al., 2004a; Farquharson et al., 2003). During the SARS epidemic, transmission to healthcare workers was observed from contact with contaminated objects in the vicinity of SARS patients, which could have been prevented by following hand hygiene recommendations (Chen et al., 2004a). In the present study, use of recommended hand hygiene practices was mixed. Most workers reported practicing hand hygiene before and after direct contact with a patient. However, fewer did so immediately after touching items near a patient with ILI symptoms, or checking a pulse or blood pressure. This may be partly due to a perception that touching intact healthy-appearing skin does not warrant hand hygiene, even though there is a strong theoretical rationale for this recommendation (CDC, 2002).

These observations are consistent with other literature reports. Despite the known protection provided by hand hygiene to both patient and worker, adherence to hand hygiene recommendations by healthcare workers has been historically low (Pittet, 2001a). In a study involving 163 physicians at a university hospital in which practices were evaluated by both direct observation and self-report surveys, overall use of recommended hand hygiene practices averaged 57% (Pittet et al., 2004). In a separate observational study of 1,043 hospital healthcare workers, the average compliance with recommended hand hygiene practices was observed among 52% of nurses (n=520), 47% of nurse assistants (n=166), and 30% of physicians (n=158)(Pittet et al., 1999). In literature reviews of hand hygiene studies published from 1981 to 1999, overall observance ranged from 16% to 51% in 11 of 12 studies of healthcare workers (Pittet, 2000; Pittet, 2001b).

The use of some but not all recommended practices was also evident in the use of personal protective equipment. Almost all workers who were directly involved in patient care reported removing disposable gloves after use, and changing gloves before going to another patient. About three quarters of nurses and allied professionals reported using gloves when caring for patients with ILI; however, physicians were much less likely to do this. Furthermore, few healthcare workers in any occupation reported wearing eye protection or a disposable mask when examining an ILI patient who is sneezing or coughing. These basic practices were judged necessary to contain the SARS epidemic (Chen et al., 2005; Lau et al., 2004; Chen et al., 2004b; Farquharson et al., 2003; Chow, 2004), but clearly they are not routinely implemented outside of unusual circumstances.

Overall, training in respiratory infection control and personal protection practices reported by respondents during the previous year was low. One quarter of physicians, approximately 15% of nurses, nurse aides and allied professionals, and 40% of administrative staff reported no training, and 40% overall reported having less than one hour of training during the previous year. Furthermore, about one quarter of all respondents said their practice setting did not have clear written procedures on infection control actions to take when confronted by an undiagnosed patient presenting with respiratory infection symptoms, and 20% of physicians did not know.

The overall findings and conclusions from the present study probably provide a meaningful picture of contemporary worker and institutional practices in primary and emergency care workers and institutions, but specific quantitative findings should be interpreted with caution. The generalizability of findings is potentially limited by the study's reliance on reported practices, rather than observations or other independent confirmation. Most previous, broadly based studies of healthcare worker practices have relied on similar study design and self-reported knowledge, beliefs, or behaviors (Osborne, 2003; Williams et al., 1994; Gershon et al., 1995; Gershon et al., 2000). However, even though respondents were asked to answer questions based on what they do, rather than what they think should be done, responses may have been biased towards desirable practices. Responses also might have differed if the survey had been conducted during influenza season, rather than during summer and fall. On the other hand, the chosen study approach is appropriate for describing healthcare worker practices during routine circumstances, as might occur at the beginning of an unanticipated outbreak of infectious respiratory illness. The study was restricted to primary care and emergency department settings of five independent medical centers in a densely populated county in Washington State, possibly limiting generalization of findings to other healthcare worker populations or settings. Overall differences in reported practices observed between respondents from primary and emergency care settings were influenced by significant occupational dissimilarities between the settings, and are therefore difficult to interpret.

The overall participation rate of 53% may have biased sample selection toward workers with an interest in following infection control recommendations. If so, the true use of respiratory infection control practices would be even lower than what was found in this study. Participation was lowest in a medical center that did not allow use of an espresso card incentive for survey completion (39%, versus 62% overall, elsewhere), suggesting that the incentive influenced sample selection. It is doubtful that coffee consumption would influence use or reporting of infection control practices, and this difference in participation seems unlikely to represent a substantial source of bias. This incidental finding, however, suggests that inexpensive incentives can have a substantial positive impact on subject recruitment. Regardless, it is reassuring that the overall participation rate in the present study is comparable to that achieved in similar, previous studies (Gershon et al., 1995; Gershon et al., 2000; Teppei et al., 2005; Osborne, 2003), suggesting that findings of the present study can reasonably be compared with existing literature.

This study raises important concerns about the challenges of using CDC first-encounter recommendations for the control of respiratory infections in clinical settings. Although gaps in recommended practices can be consequential during routine conditions, they can have severe impacts during an unanticipated outbreak of a highly communicable infection. By the time that healthcare providers recognize the emergence of such an event, the usual level of respiratory precautions may have allowed substantial spread of disease to healthcare workers and other patients. This was illustrated graphically by the SARS epidemic. Without the availability of vaccines or other treatments, firm adherence to infection control measures was essential to bring the SARS epidemic under control in 2003. Failure to do so allowed the infection to spread to healthcare workers, patients and visitors within medical institutions. In Toronto, for example, strict use of infection control measures waned at the end of the first wave of the SARS epidemic, allowing a second epidemic wave to build (Health Canada, 2003). In contrast, in British Columbia, where healthcare providers had been alerted about patients who had recently visited Asia and presented with respiratory illness, appropriate precautions were implemented for patients with SARS, and the outbreak was well circumscribed in that region (Hofmann and Turnberg, 2005).

For respiratory infection control practices to be effective, they must be used (Lynch, 2004). There is clearly a need for clinic management to build a climate of safety within each institution to reinforce the need for healthcare workers to use respiratory infection control measures routinely, including providing the necessary training to convey institutional expectations. However, in spite of theoretical grounds for recommended practices, it may not be realistic to expect them to be fully implemented at all times, because of practical constraints such as limited available resources and space, job and productivity demands, and human nature. Physical constraints may be compounded by the expanded influx of patients during outbreaks, forcing need to consider alternative and otherwise less desirable strategies such as cohorting patients with similar illness. Finally, the British Columbia experience demonstrates the potentially critical role for surveillance and provider bulletins to ensure maximal use of recommended practices in outbreak circumstances. Although recommended infection control practices should be used at all times, the present study demonstrates that shortcomings are common in routine conditions. The complementary role of public health surveillance and bulletins can provide timely alerts for healthcare workers to be even more careful than usual.

In conclusion, respiratory infection control practices were observed to differ significantly by healthcare worker occupation and setting. This component of the study, in conjunction with an understanding of personal and worksite characteristics associated with infection control use described in Chapter 4, is particularly important for designing subsequent interventions targeted to specific occupational groups. In addition to direct healthcare providers (physicians, physician assistants, nurse practitioners, nurses, and nurse aides), intervention strategies should also be directed towards historically understudied healthcare workers (reception, administration and allied professional staff) who routinely interact with patients in first-contact settings.

4. Personal and Worksite Characteristics Associated with Reported Use of First Contact Respiratory Infection Control Practices

The precautionary infection control measures recommended by the CDC against respiratory infections provide an early line of defense for workers in first contact healthcare settings. Strict adherence to infection control practices was necessary to control the SARS epidemic of 2003 (Health Canada, 2003). However, the willingness or ability of healthcare workers to routinely use recommended infection control practices has been historically low (Gershon et al., 1995; Larson et al., 2000; McCoy et al., 2001; Michalsen et al., 1997; Pittet, 2001a).

The aim of this chapter is to identify personal and worksite characteristics associated with use and non-use of respiratory infection control practices recommended by the CDC for healthcare workers in primary and emergency care settings. The analysis was guided by the study's conceptual model (Figure 1-1). The model focuses on four major conceptual "constructs" hypothesized to be associated with use of recommended respiratory infection control measures: demographic information, safety climate, and individual views; and public health surveillance. The outcome factors, demographic variables, and factors representing personal and worksite characteristics are identified in the model.

This chapter addresses the following dissertation aims and research questions from Chapter 1: Aim 2: Personal and Worksite Characteristics Associated with Use of Recommended Practices.

- Is infection control training associated with use of recommended practices? (Question 2a)
- Is increased attention to patient care (conflict of interest) associated with use of recommended practices? (Question 2b)
- Do factors and possible barriers associated with use of CDC recommended respiratory infection control practices differ by:
    - Healthcare worker occupation? (Research Question 2c)
    - Medical setting? (Research Question 2d)

- Healthcare worker perceptions about their employer's communicable disease information feedback programs? (Research Question 2e)

Aim 3: Public Health Surveillance

- Are HCW perceptions about their employer's communicable disease surveillance, feedback and training programs associated with their use of recommended respiratory infection control practices? (Question 3c)

Methods

Detailed study methods are presented in Chapter 2. Methods relevant to this chapter are summarized for reader convenience or described in further detail.

During the Summer and Fall of 2005, all eligible healthcare workers (1,241) from participating walk-in settings of five medical centers were invited to participate in a study on first contact respiratory infection control practices. Participants were asked to complete an anonymous self-report questionnaire primarily comprised of Likert-scale responses. Study eligibility required that participants work at least one day per week in either a primary care or emergency department setting, and have routine contact with patients. Six hundred fifty-three surveys were returned for a response rate of 53%. Of those, 630 respondents met the study's eligibility criteria, and the other 23 respondents were excluded from the study. Respondents were grouped into categories of physician/practitioners, nurses, nurse aides, allied professionals, and reception/other. The present analysis was restricted to healthcare workers who are directly involved in patient care (physician/practitioners, nurse, nurse aide) because of the high number of survey questions that did not apply to allied professionals and reception/other healthcare workers, resulting in unusable responses (missing values) for analysis. Four subjects originally categorized as nurse aides were removed from the analysis of associations due to uncertain categorization. A detailed factor analysis of safety climate is presented in Chapter 5, and of infection control practices, individual views and public health surveillance in Chapter 7. The study questionnaire is presented in Appendix A, and the source of questions and item labels in Appendix B.

Factor analysis – Factor analysis was used to derive factors from groups of survey questions (items) chosen to represent three of the personal and worksite characteristics constructs (safety climate, individual views, and public health surveillance) and the outcome construct (use of respiratory infection control practices) that comprised the conceptual model (Figure 4-1).

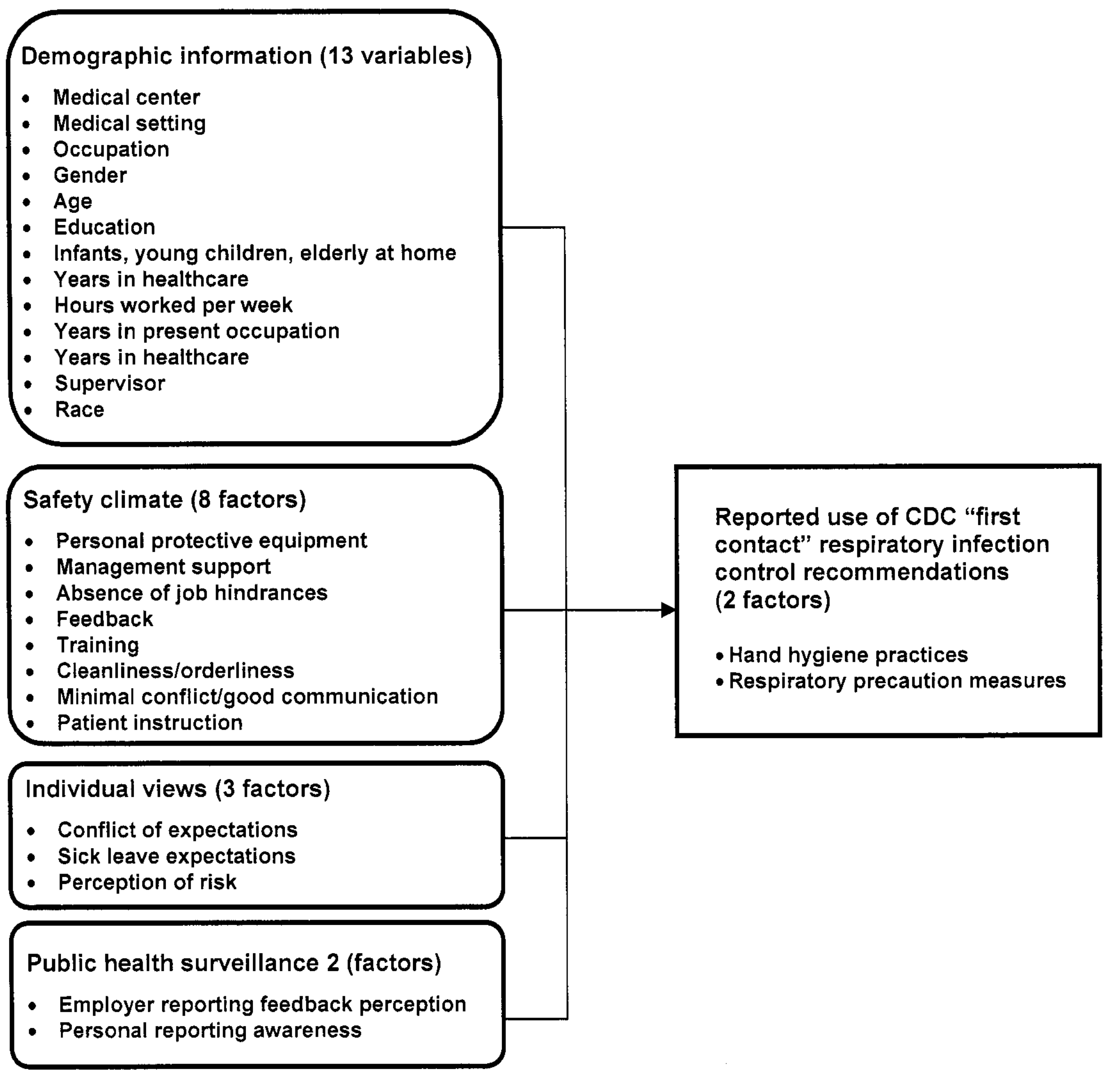

Figure 4-1. Conceptual model: Likelihood of following first contact respiratory infection control guidelines

Factors were extracted by the principal axis factoring method and examined by varimax orthogonal rotation to identify the distinguishable concepts (factors) underlying each of the major constructs. Questions (items) with factor loadings $\geq$0.45 were grouped, and judgments were made on their applicability to an underlying concept (factor). The extracted questions comprising each factor were examined with Cronbach's alpha coefficient to estimate the internal consistency of the questions (Table 4-1), and correlation coefficients were used to judge independence of the factors.

After the questions comprising each of the factors were extracted, the factors were prepared for analysis by dichotomizing each question to indicate use of a practice or agreement with a statement (coded "1"), or non-use or disagreement (coded "0") (Gershon et al., 1995; Michalsen et al., 1997; McCoy et al., 2001). Use of a practice was defined by a response of "almost always" or "often," and agreement was defined by a response of "strongly agree" or "agree."

Bivariate analysis – Logistic regression was conducted to identify unadjusted bivariate associations between variables representing personal and worksite characteristics (demographic variables and factors derived from constructs of safety climate, individual views and public health surveillance) and each of the two factors derived for the infection control outcome construct (hand hygiene practices and respiratory precautions; see Chapter 7). Associations with statistical significance $p \leq .10$ were considered for potential inclusion in multivariate logistic regression models.

Multivariate analysis – Multivariate logistic regression was conducted to describe the relationship between each of the two outcome variables and the independent variables identified in bivariate analyses. In the first modeling step, all demographic variables, whether significant or not during bivariate modeling, were examined in stepwise forward and backward likelihood ratio method logistic regression models, with variables allowed to enter the model at $p<.10$ and leave the model at $p<.20$. In the second step, all factors derived for the three constructs of potential influence were analyzed individually in forward and backward stepwise models, while controlling for occupation and healthcare setting (forced into the models because of their relevance to Research Questions 2a and 2b). In the final step, all variables that had been found to have a significant association with the examined outcome variable (by bivariate or stepwise modeling), or that were required for hypothesis testing (occupation and setting), or for *a priori* reasons were examined to determine a final parsimonious model. Modeling methods are further described in Chapter 2.

Results

Demographic information – Survey respondents were combined into three occupational categories. Physician/practitioners comprised 41% (n=187) of respondents, nurses, 39% (n=180) and nurse aides, 20% (n=93). Within the physician/practitioner category, 165 of physician/practitioners were physicians, 4 physician assistants, and 18 nurse practitioners. Among the nurse category, 170 were registered nurses, and 10 licensed practical nurses. Of the nurse aides, 82 were medical assistants and 11 nursing aides. This report uses the abbreviated term, "physician," to refer to the physician/practitioner category.

Factors for constructs of influence – Eight factors were derived from the 25 questions representing the safety climate construct (Table 4-1; see Chapter 5). About two thirds of respondents agreed that personal protective equipment was available in their workplace, and that their job responsibilities did not hinder their ability to follow infection control procedures. About half agreed that their institution provided management support and infection control training, that there was minimal conflict and good communication in their workgroup, and that their units were clean and orderly. However, less than one third indicated that their supervisors promoted safe work practices with staff, and 20% reported that they were unaware. All safety climate factors demonstrated good psychometric properties. Internal consistency of the factors, measured by Cronbach's alpha, ranged from 0.62 to 0.88, which is conventionally considered adequate to very good for group comparisons (DeVellis, 2003). Correlation between factors was low ($p \leq .48$), indicating that the factors were measuring different concepts of the safety climate construct.

Three factors were identified from the 13 questions representing the individual views construct (Table 4-1, see Chapter 7). One factor, conflict of expectations, was originally extracted from six questions during factor analysis. However, it was found that only 1% of respondents expressed agreement with all six questions. To create a more usable factor, the factor analysis was repeated after excluding three questions for which a disproportionately large number of subjects expressed disagreement (env4, env5, and env6; see Appendix B). This yielded a modified "conflict of interest" factor consisting of three questions (env3, env7, env8), with 5% of respondents expressing agreement. The modified factor, used for the modeling analysis, demonstrated adequate internal consistency (Cronbach's alpha=0.76).

Two factors were identified from the eleven questions representing the public health surveillance construct (Table 4-1). Although about 60% of surveyed clinicians agreed that their employer provided them with timely infectious disease surveillance information, only about 20% agreed that they understood their responsibilities under Washington State's notifiable condition reporting system. Each factor demonstrated good psychometric properties, with Cronbach's alpha coefficients of 0.86 and 0.90.

Factors for outcome constructs – Overall, about one third of the surveyed healthcare workers responded positively on all five items (questions) comprising the hand hygiene factor, in contrast to only 8% with fully positive responses for the six items comprising the respiratory precautions factor (Table 4-1). Almost 20% of workers indicated that one or more of the six items in the respiratory precautions factor did not apply to them. Both factors demonstrated acceptable internal consistency (Cronbach's alpha > 0.70)

Table 4-1. Overall responses to factors extracted from four constructs[1]

	Yes[2]		No		Missing		Cron-bach's alpha	Number of Items[3]
Infection control practices factors[4]								
Hand hygiene	168	(37%)	257	(56%)	35	(8%)	.76	5
Respiratory precautions	39	(8%)	383	(83%)	38	(8%)	.68	4
	Agree[5]		**Disagree**		**Missing**			
Safety climate factors[6]								
PPE availability[7]	307	(67%)	123	(27%)	30	(7%)	.62	2
Management support	246	(54%)	167	(36%)	47	(10%)	.88	4
Absence of job hindrances	278	(60%)	170	(37%)	12	(3%)	.66	2
Feedback	139	(30%)	231	(50%)	90	(20%)	.76	2
Training	246	(53%)	162	(35%)	52	(11%)	.80	4
Cleanliness/orderliness	205	(45%)	246	(53%)	9	(2%)	.84	3
Minimal conflict/good communication	263	(57%)	169	(37%)	28	(7%)	.88	3
Patient instructions	240	(52%)	143	(31%)	77	(17%)	.84	3
Individual views factors[3]								
Conflict of expectations	25	(5%)	408	(89%)	27	(6%)	.76	3
Sick leave expectations	79	(17%)	323	(70%)	58	(13%)	.84	3
Perception of risk	81	(18%)	369	(80%)	10	(2%)	.73	2
Public health surveillance factors[3]								
Employer surveillance feedback	271	(59%)	157	(34%)	32	(7%)	.90	2
Notifiable conditions reporting	102	(22%)	275	(60%)	83	(18%)	.86	6

[1] Responses from physicians, physician assistants, nurse practitioners, nurses, nurse aides
[2] "Yes" response based on all respondent items answered with responses of either "Almost Always" or "Often"
[3] Number of questions (items) comprising the factor
[4] Factor development and factor items described in Chapter 7
[5] "Agree" response based on all respondent items answered with responses of "Strongly Agree" or "Agree"
[6] Factor development and factor items described in Chapter 5
[7] PPE (personal protective equipment)

Bivariate analysis of demographic variables – The only demographic variable that showed a significant association with both of the infection control (outcome) factors was occupation, based on responses from the aggregated group of physicians, nurses, and nurse aides (Table 4-2). Overall, reported use of hand hygiene practices differed significantly between medical centers but not between medical settings. The reverse was true for use of respiratory precautions.

Table 4-2. Bivariate association of demographic variables with infection control factors

	Hand hygiene factor			Respiratory precautions factor		
Demographic variables	OR[1]	95% CI[2]	p-value[3]	OR	95% CI	p-value[1]
Occupation			**.01**			**<.001**
Physician/practitioner	1	---	---	1	---	---
Nurse	1.3	0.80 - 1.95	.33	2.63	1.12 – 6.17	.03
Nurse Aide	2.2	1.32 - 3.81	<.001	4.0	1.56 – 10.24	<.001
Medical Center			**.01**			**.24**
Med Center A	0.2	0.08 – 0.74	.01	0.4	0.05 – 3.34	.41
Med Center B	0.3	0.14 – 0.83	.02	---	---	---
Med Center C	0.7	0.39 – 1.28	.26	1.8	0.75 – 4.19	.20
Med Center D	1			1		
Med Center E	0.9	0.55 – 1.40	.58	0.8	0.35 – 1.81	.59
Medical setting			**.83**			**.02**
Primary care	1			1		
Emergency department	1.1	0.70 - 1.57	.83	2.4	1.14 – 4.96	.02
Gender			**.64**			**.73**
Male	1			1		
Female	1.1	0.71 - 1.73	.64	1.14	0.54 – 2.43	.73
Age			**.71**			**.61**
21-29	1.4	0.77 - 2.51	.27	0.9	0.31 – 2.52	.83
30-39	1.1	0.62 - 1.79	.85	1.3	0.55 – 2.99	.57
40-49	1.1	0.61 - 1.80	.87	0.7	0.25 – 1.81	.43
50+	1			1		
Education			**.31**			**.02**
High school	1.9	0.95 - 3.97	.07	5.3	1.75 – 16.1	<.001
Associates	1.3	0.78 - 2.15	.32	1.8	0.70 – 4.82	.22
College	1.2	0.73 - 1.96	.47	2.8	1.20 – 6.54	.02
Grad	1			1		

(continued)

Table 4-2: (continued)

	Hand hygiene factor			Respiratory precautions factor		
Demographic variables	OR[1]	95% CI[2]	p-value[3]	OR	95% CI	p-value[1]
Ethnicity			**.45**			**.08**
Asian	1.5	0.77 - 2.87	.24	1.3	0.42 – 3.83	.67
Black	2.3	0.71 - 7.39	.16	5.6	1.57 – 19.60	<.001
Native Am	1.6	0.33 - 8.25	.55	5.6	0.97 – 31.67	.05
White	1			1		.94
Other	1.4	0.51 - 4.05	.50	0.9	0.12 – 7.38	
Work week			**.80**			**.88**
≤40 Hours	1			1		
>40 Hours	1.0	0.63 - 1.42	.80	1.1	0.54 – 2.06	.88
Current employer			**.54**			**.34**
≤ 5 Years	1			1		
> 5 Years	0.9	0.60 - 1.31	.54	1.4	0.71 – 2.67	.34
Present occupation			**.10**			**..48**
≤ 5 Years	1			1		
> 5 Years	0.7	0.46 - 1.07	.10	0.8	0.39 – 1.55	.48
Healthcare years			**.14**			**.28**
≤ 5 Years	1			1		
> 5 Years	0.7	0.42 - 1.31	.14	1.7	0.62 – 4.39	.31
Supervisor			**.88**			**.04**
No	1			1		
Yes	1.0	0.59 - 1.57	.87	2.19	1.07 – 4.48	.03

[1] Odds ratio
[2] 95% confidence interval
[3] p-value based on likelihood ratio chi square

Physicians were less likely to use either hand hygiene or respiratory precaution infection control measures compared to nurses or nurse aides (Table 4-2). Workers in emergency departments were more likely to report using respiratory precautions than those in primary care settings, although there was no significant difference in use of hand hygiene. Supervisors were more likely to use respiratory precaution measures than non-supervisors, but no significant difference was observed for hand hygiene practices. Neither gender nor age was associated with either infection control factor.

Bivariate analysis of factors of influence – Six of eight safety climate factors were significantly associated with hand hygiene practices, and four of eight with use of respiratory precaution measures (p<.05; Table 4-3). Of the three factors extracted for the individual views construct, only perception of risk was associated with an outcome factor, use of respiratory precautions. Healthcare workers who understood notifiable condition reporting were also more likely to provide a positive response to both infection control outcome measures.

Table 4-3. Bivariate association of infection control factors with factors of influence

	Hand hygiene factor			Respiratory precautions factor		
Constructs and factors[1]	**OR[2]**	**95% CI[3]**	**p-value[4]**	**OR**	**95% CI**	**p-value[4]**
Safety climate						
PPE availability[5]	1.6	1.03 - 2.56	.04	5.7	1.71 – 18.75	<.001
Management support	1.7	1.11 - 2.62	.01	3.4	1.43 – 7.85	<.001
Absence of job hindrances	1.8	1.87 - 2.72	.01	0.7	0.38 – 1.45	.38
Feedback	2.0	1.29 - 3.10	<.001	3.6	1.77 – 7.34	<.001
Training	2.5	1.59 - 3.87	<.001	5.1	1.93 – 13.28	<.001
Cleanliness/orderliness	1.6	1.09 - 2.40	.02	1.2	0.64 – 2.41	.51
Minimal conflict/good communication	1.0	0.63 - 1.43	.82	0.7	0.35 – 1.35	.27
Patient instructions	1.4	0.90 - 2.18	.13	1.7	0.81 – 3.70	.15
Individual views						
Conflict of expectations	1.2	0.50 - 2.72	.73	1.4	0.40 – 5.10	.57
Sick leave expectations	1.3	0.79 - 2.20	.28	1.5	0.71 – 3.36	.27
Perception of risk	1.5	0.92 - 2.45	.11	3.2	1.61 – 6.52	<.001
Public health surveillance						
Employer surveillance feedback	1.2	0.81 - 1.90	.31	2.3	1.05 – 5.24	.04
Notifiable condition knowledge	1.9	1.17 - 3.02	.01	4.7	2.25 – 9.70	<.001

[1] Analysis based on an aggregated grouping of three occupational categories: physician/practitioner, nurse, and nurse aide
[2] OR (odds ratio)
[3] 95% CI (95% confidence interval)
[4] p-value based on chi-square test of homogeneity
[5] PPE (personal protective equipment)

Multivariate modeling – Multivariate modeling was conducted to build a final parsimonious model for the two outcome factors of hand hygiene and respiratory precautions, adjusting for influential covariates. Models were estimated for each outcome factor, first including all clinical workers (physician/practitioners, nurses, and nurse aides; models 1 and 2), and then separately for physician/practitioners (models 1a and 2a) and for nurses plus nurse aides combined (models 1b and 2b). There were not enough nurse aides with positive responses to hand hygiene questions to support separate examination of nurses and nurse aides.

The strong association between occupation and each of the outcome measures persisted in the multivariate models (Table 4-4, model 1; Table 4-5, model 2). Nurse aides had about a two-fold higher odds of reporting use of hand hygiene practices, and seven-fold higher odds of reporting use of respiratory precaution measures than physicians. Overall, workers in emergency departments were more likely than workers in primary care clinics to report using either hand hygiene practices or respiratory precaution measures as recommended, and at least for hand hygiene practices, there were significant differences between institutions included in this study. Although the association of respiratory precaution measures utilization and medical setting was not apparent among physician/practitioners or nurse/nurse aides (models 2A and 2B), the association was pronounced among nurse aides when they were examined separately (odds ratio, OR=11.8, p=.01).

Training appeared to play an important role overall, in that workers who reported receiving training were significantly more likely to use either mode of recommended infection control practices (Tables 4-4 and 4-5). However, although training was significantly associated with better practices among nurses and nurse aides, the association was not evident among physician/practitioners. Nevertheless, a positive association was evident for physician/practitioner use of respiratory precaution practices (model 2A), although it was not statistically significant.

Table 4-4. Variables and factors associated with use of hand hygiene practices: multivariate models

	Model 1 [1]		Model 1A [2]		Model 1B [3]	
	Physician / Practitioner, Nurse, Nurse Aide (n=460)		Physician / Practitioner (n=187)		Nurse / Nurse Aide (n=273)	
	OR [4]	p-value [5]	OR	p-value	OR	p-value
Occupation [6]						
Physician/Practitioner	1		---	---	---	---
Nurse	1.2	(.64)	---	---	---	---
Nurse Aide	2.1	(.03)	---	---	---	---
Medical Center [6]						
Medical Center A	0.3	(.04)	0.8	(.06)	0.2	(.03)
Medical Center B	0.4	(.06)	1.0	(.21)	0.3	(.03)
Medical Center C	0.6	(.14)	1.9	(.32)	0.5	(.05)
Medical Center D	1		1		1	
Medical Center E	1.1	(.66)	1.0	(.95)	1.1	(.74)
Medical Setting [6]						
Primary Care	1		1		1	
Emergency Department	2.0	(.03)	0.8	(.75)	1.9	(.08)
Infants/Children/Elderly at Home [6]						
No	1		1		1	
Yes	1.5	(.07)	0.9	(.77)	2.1	(.01)
Training [7]						
Disagree	1		1		1	
Agree	2.1	(<.001)	1.0	(.98)	3.2	(<.001)
Cleanliness/Orderliness [7]						
Disagree	1		1		1	
Agree	1.6	(.05)	1.0	(.96)	1.8	(.05)
Model n [8]	347	(75%)	107	(57%)	240	(88%)
Model p-value		(<.001)		(.99)		(<.001)

[1] Aggregated grouping of three occupational categories: physician/practitioner, nurse, and nurse aide
[2] Aggregated grouping of two occupational categories: physicians (n=165), and practitioners (n=22)
[3] Aggregated grouping of two occupational categories: nurse (n=180), and nurse aide (n=93)
[4] OR (odds ratio)
[5] p-value based on chi-square test of homogeneity
[6] Demographic variable
[7] Safety climate factor
[8] Number and percent of sample retained following logistic regression due to missing values

Table 4-5. Variables and factors associated with use of respiratory precaution measures: multivariate models

	Model 2 [1]		Model 2A [2]		Model 2B [3]	
	Physician / Practitioner, Nurse, Nurse Aide (n=460)		Physician / Practitioner (n=187)		Nurse / Nurse Aide (n=273)	
	OR [4]	p-value [5]	OR	p-value	OR	p-value
Occupation [6]						
Physician/Practitioner	1		---	---	---	---
Nurse	1.1	(.88)	---	---	---	---
Nurse Aide	7.4	(<.001)	---	---	---	---
Medical Setting [6]						
Primary Care	1		1		1	
Emergency Department	5.4	(<.001)	3.8	(.20)	2.2	(.14)
Supervisor [6]						
No	1		1		1	
Yes	2.8	(.03)	12.4	(.03)	1.1	(.80)
Training [7]						
Disagree	1		1		1	
Agree	5.8	(.02)	6.3	(.14)	8.5	(.04)
Notifiable Condition Reporting [8]						
Disagree	1		1		1	
Agree	2.4	(.04)	0.4	(.50)	3.2	(.01)
Model n [9]	299	(65%)[4]	108	(58%)	191	(70%)
Model p-value		(<.001)		(.04)		(<.001)

[1] Aggregated grouping of three occupational categories: physician/practitioner, nurse, and nurse aide
[2] Aggregated grouping of two occupational categories: physicians (n=165), and practitioners (n=22)
[3] Aggregated grouping of two occupational categories: nurse (n=180), and nurse aide (n=93)
[4] OR (odds ratio)
[5] p-value based on chi-square test of homogeneity
[6] Demographic variable
[7] Safety climate factor
[8] Public health surveillance factor
[9] Number and percent of sample retained following logistic regression due to missing values

Cleanliness and orderliness of the workplace, as well as having infants, young children or elderly adults living at home were associated with using hand hygiene recommendations among nurse/nurse aides (model 1B), although this association was not evident among physician/practitioners (model 1A). Both supervisory status and knowledge of notifiable condition reporting were associated with use of respiratory precaution measure utilization, although the association was not evident among either occupational grouping.

Discussion

This study identified a number of personal and worksite characteristics associated with clinicians' use of CDC-recommended respiratory infection control measures in walk-in clinical settings. Overall, clinicians in emergency departments were more likely to use recommended respiratory infection control practices than those in primary care clinics. Physician/practitioners were the least likely to report consistent use of recommended respiratory infection control measures, and also presented a greater challenge to identifying factors associated with use of infection control practices than nurse/nurse aides. Reported use of hand hygiene practices was higher among clinicians who reported cleanliness and orderliness of the establishment where they worked, who had infants, small children or elderly adults at home, and who had received respiratory infection control training during the year preceding the survey, although these factors were mostly or only influential for nurse/nurse aides. Respiratory precaution measure utilization was higher among clinicians who were supervisors, reported knowledge about notifiable condition reporting, and had also received infection control training.

While several studies have examined factors associated with adherence to CDC Universal Precautions and Occupational Safety and Health Administration bloodborne pathogen infection control regulations (Gershon et al, 1995; Michalsen et al, 1997; Grosch et al, 1999; Gershon et al, 2000; McCoy et al, 2001), this study is among the first to examine factors associated with the use of CDC's respiratory infection control recommendations for first-contact patient care settings (CDC, 2004c). In the present study, clinicians who reported receiving training in respiratory infection control practices from their employer were also more likely to report using recommended respiratory infection control practices. Similarly, in a study of 1,716 healthcare workers from three acute care hospitals, the "infection control training" factor was associated with safe practices (Gershon et al, 1995), and in a study involving 322 hospital-based physicians, "hours of training" was significantly associated with Universal Precautions practice compliance (Michalsen et al, 1997). Another study examined the influence of safety climate factors on bloodborne pathogen exposures among 789 employees of a large urban research medical center, and found feedback and training to be associated with blood and body fluid exposure incidents (Gershon et al, 2000). During the SARS epidemic, one study demonstrated an association of developing SARS with clinicians who had received less than two hours of respiratory infection control training (Lau et al, 2004).

Although training was found to be significantly associated with infection control practice utilization, the type and method of training conducted was not specified in the referenced studies or the present study. Many educational approaches may be employed, including in-service programs, group discussions, lectures, workshops, or through the distribution of printed materials (Diekma and Doebbeling, 1995). However, in a recent review examining training practices to prevent the spread of respiratory infections among healthcare workers, Yassi and colleagues concluded that training methods to promote safe practices in healthcare settings and to verify training's effectiveness have not been adequately studied (Yassi et al., 2005).

In the present study, the factor "cleanliness and orderliness" in the workplace was significant in the multivariate model examining hand hygiene practices as the outcome variable (Gershon et al., 2000). In Gershon and colleague's study of 789 hospital workers of a large urban research medical center using a comparable conceptual model, the cleanliness and orderliness factor was significant in a multivariate analysis examining bloodborne pathogen-related infection control practices as the outcome variable (Gershon, 2000).

Notifiable conditions are diseases or conditions of public health importance in which a case, or in some instances, a suspected case, must be reported to either the local or state public health authority by healthcare providers, medical institutions, clinical laboratories or others. In Washington State, clinicians are responsible for notifying local or state public health agencies about diagnosed and suspected cases of certain diseases such as measles or pertussis, as well as infectious disease outbreaks and suspected outbreaks. In the present study, nurse/nurse aides who understood their clinic's notifiable condition reporting procedures, as well as their individual responsibilities under Washington State's reporting standards, were also more likely to utilize CDC's respiratory infection control measures as well. This association demonstrates the potential value of infectious disease surveillance as a component of respiratory infection control.

Nurses and nurse aides who reported having children or elderly adults living with them at home were also more likely to report use of hand hygiene practices than those who did not. In the present study, 37% of nurses and nurse aides reported having infants, young children or elderly adults living in their households. Those who did had a two-fold higher odds of reporting use of hand hygiene recommendations than those who did not. This finding may have parallels to factors associated with healthcare workers' ability and willingness to report to work during a catastrophic disaster such as the SARS epidemic (Quereshi et al, 2006). In a study of 6,428 healthcare workers from 47 healthcare facilities in the greater New York City metropolitan area, one of the predominantly reported reasons for not reporting to work included fear and concern for family. Findings in the present study suggest that concern for health of family may serve as an additional incentive for self-protection through use of hand hygiene infection control practices in the workplace.

This study had potential limitations beyond those discussed in Chapters 3 and 5. Loss of observations during variable preparation and analysis due to responses of "does not apply" and "don't know" may have contributed to differential response bias by only including subjects willing to answer all questions grouped in a factor. Further attrition of subjects occurred during logistic regression when subjects did not have usable values for all tested variables, resulting in losses of 25% in the hand hygiene practices multivariate model, and 35% in the respiratory precautions model. The number of "does not apply" and "don't know" responses may have been due in part to survey questions about relatively new but unfamiliar CDC recommendations.

Although data imputation strategies were explored during analysis, the investigators decided to accept the bias associated with loss of observations instead of the bias introduced by data imputation.

Respiratory infection control practices recommended by the CDC are designed to prevent infection among healthcare workers and their patients, provided that they are used (Lynch, 2003). In this study, safety climate and other personal and worksite characteristics associated with healthcare workers' use of respiratory infection control measures were identified in multivariate statistical models. These potentially influential characteristics should be considered as targets or guides for intervention strategies. In addition, various measurement tools have been developed to measure the safety climate of healthcare institutions in an effort to bring about change leading to improved safety practices among employees (see Chapter 5 of this dissertation). By understanding a work setting's safety climate, guided by knowledge of other personal and worksite characteristics that influence safety behaviors identified in this chapter, it may be possible to develop effective training programs and intervention strategies, resulting in enhanced protection of healthcare workers and their patients.

5. Assessing a Healthcare Safety Climate Measurement Tool

There is no standardized definition for safety climate, but one common definition is the "summary of perceptions that employees share about the safety of their work environment" (Zohar, 1980). Safety climate is typically measured using questionnaires that ask employees to rate their employer's commitment to safety (Moore et al., 2005; DeJoy et al., 2004). In 2000, Gershon and colleagues published a new safety climate measurement tool to measure hospital commitment to bloodborne pathogen risk management programs and to determine its relationship to safe work behavior (Gershon et al., 2000). Factor analysis was used to analyze responses to a questionnaire that included 46 safety climate questions (items). The analysis identified 20 items clustered in six dimensions (factors) of safety climate, which were labeled as: 1) employee compliance with safe work programs; 2) absence of workplace barriers to safe work practices, 3) cleanliness and orderliness of the work site, 4) minimal conflict and good communication among staff members, 5) frequent safety-related feedback/training by supervisors, and 6) availability of personal protective equipment and engineering controls.

The Gershon study collected questionnaire data from a stratified sample of healthcare workers with a high risk of blood or body fluid exposure at a 1000+ bed urban research medical center in 1997 (Gershon et al., 2000). A dichotomized Universal Precautions compliance factor consisting of 14 questions previously developed by Gershon was used as the outcome measure. Based on responses from 789 healthcare workers, statistically significant relationships were observed between compliance with Universal Precautions and three safety climate factors: senior management support for safety programs, absence of workplace barriers to safe work practices, and cleanliness and orderliness of the worksite. The authors concluded that the safety climate factors could be used by hospitals to "target problem areas and guide the development of intervention strategies to reduce bloodborne exposures in the workplace."

The purpose of this chapter is to examine construct validity and reliability of the Gershon safety climate instrument when modified to address a different aspect of healthcare worker safety. Differences in the present study include nominal modifications to the Gershon safety climate questions appropriate for exposures to respiratory rather than bloodborne pathogens, addition of five questions uniquely applicable to respiratory hazards, and application to a healthcare worker population in different healthcare settings, geographic location, and time period. Consistent performance of the safety climate questions in these differing circumstances would suggest that the questions could be used or adapted for other settings as well.

Methods

Detailed study methods are presented in Chapter 2. Methods relevant to this chapter are summarized for reader convenience or described in further detail.

The study questionnaire was administered to healthcare workers from five medical centers in Washington State working in first-contact patient settings during the summer and fall of 2005. To be eligible for the study, respondents had to indicate that they worked at least one day per week in either a primary care or emergency department setting, and had routine contact with patients.

All eligible healthcare workers (1,241) at each of the surveyed medical settings were invited to participate, and 653 surveys were returned for a response rate of 53%. Of those, 630 respondents met the study's eligibility criteria. The other 23 respondents were excluded from the study. Respondents were grouped into categories of physician/practitioners, nurses, nurse aides, allied professionals, and reception/other. The analysis was restricted to healthcare workers involved in direct patient care (physician/practitioners, nurse, nurse aide; Table 5-1) because of the high number of survey questions that did not apply to allied professionals and reception/other healthcare workers (see Chapter 3), resulting in unusable responses (missing values) for analysis.

Table 5-1. Study sample, by healthcare occupation

Occupation[1]	Number of respondents	Percent by occupational category	Percent of total respondents
Physician/Practitioner	**187**	---	**41%**
Physician	165	88%	
Physician assistant	4	2%	
Nurse practitioner	18	10%	
Nurse	**180**	---	**39%**
Registered nurse	170	94%	
Licensed practical nurse	10	6%	
Nurse Aide	**93**	---	**20%**
Nurse aide	11	12%	
Medical assistant	82	88%	
Total	**460**	**100%**	

[1] Allied professionals and reception/administrative staff were excluded from the present analysis

The safety climate items used in the present study instrument consisted of the 20 items that comprised the six safety climate factors by Gershon and colleagues (Table 5-2; Gershon et al., 2000). The questions were modified to address respiratory infection control practices, and to update references to infection control standards. Five new items were added to the Gershon safety climate items to address issues relating to the present study of respiratory infection control practices, for a total of 25 items examined in the factor analysis. Two negatively worded items (questionnaire items env8 and env10) were reverse coded for analysis.

Consistent with Gershon, questions were rated on a Likert scale with responses of “strongly agree,” “agree,” “neutral,” “disagree,” and “strongly disagree” (with assigned numeric values, 1 to 5, respectively) and “don’t know.” Responses of “don’t know” and blank responses were coded as missing values.

Table 5-2. Adaptation of the Gershon safety climate questions for the present study[1]

Safety Climate Factors and Items
Gershon Factor 1: Personal protective equipment and engineering control equipment availability
1) ~~Sharp containers~~ *Disposable masks* are readily available in my work area (env1)
2) Disposable gloves are readily available in my work area (env2)
Gershon Factor 2: Management support
3) The protection of workers from occupational exposures to ~~HIV~~ *respiratory infections* is a high priority with management where I work (env4)
4) On my unit, all reasonable steps are taken to minimize hazardous job tasks and procedures (env5)
5) Employees are encouraged to become involved in employee safety and health matters (env6)
6) Managers on my unit do their part to insure employee protection from occupational ~~HIV/AIDS~~ *respiratory infections* (env7)
Gershon Factor 3: Absence of job hindrances
7) My job duties often interfere with my being able to follow ~~Universal~~ *Standard* Precautions (env8)
8) I have enough time in my work to always follow ~~Universal~~ *Standard* Precautions (env9)
9) I usually have too much to do to always follow ~~Universal~~ *Standard* Precautions (env10)
Gershon Factor 4: Feedback/Training
10) On my unit, unsafe work practices are corrected by supervisors (env11)
11) My supervisor often discusses safe work practices with me (env12)
12) I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from ~~HIV~~ *respiratory infection* exposures (env13)
13) Employees are taught to be aware of and to recognize potential health hazards at work (env14)
14) On my unit, ~~a copy of the safety manual is available~~ *I know how to access information about clinic safety* (env15)
Gershon Factor 5: Cleanliness/orderliness
15) My work area is kept clean (env16)
16) My work area is not cluttered (env17)
17) My work area is not crowded (env18)
Gershon Factor 6: Minimal conflict/good communication
18) There is minimal conflict within my department (env19)
19) The members of my unit support one another (env20)
20) On my unit, there is open communication between supervisors and staff (env21).
Added questions
21) *Eye protection is readily available in my work area (env2)*
22) *In my job, there are clear written procedures on infection control actions to take based on signs and symptoms of infection, before the diagnosis is made (env22)*
23) *Signs are adequately posted at the entrance of my practice setting (i.e., unit or clinic) instructing arriving patients and those with them to tell staff if they have respiratory infection symptoms (env23)*
24) *My practice setting (i.e., unit or clinic) adequately posts signs that instruct coughing patients in waiting areas to cover their nose/mouth, use tissue, and wash their hands (env24)*
25) *My practice setting (i.e., unit or clinic) has clear procedures on what to do when patients arrive with symptoms of respiratory infection (env25)*

[1] From Gershon et al., 2000
[2] Change in text denoted by italics; original text denoted by strike-through

Results

Item analysis – Of the 25 items analyzed from the working environment section of the questionnaire, missing values ranged from 1.3% to 13.0% of 460 responses, after excluding the 166 subjects employed in allied professional or administrative jobs. No items were excluded from the factor model due to excessive missing values. The means ranged from 1.04 to 2.85 and standard deviations ranged from 0.20 to 1.29. Corrected item-total correlation coefficients were calculated to compare each item with the total scale. Items env2 and env8 (Table 8-2) had item total correlation coefficients of less than 0.20, indicating insufficient association with the overall scale to be included in the factor model (Nunnally, 1978). Both items were dropped from further analysis. Of the remaining items, the item-total correlation coefficients ranged from 0.25 to 0.76, indicating sufficient correlation without multicollinearity for the overall scale (Leske, 1991).

Factor analysis – The Pearson correlation matrix summarizing the interrelationships between the safety climate items was examined. The determinant of the matrix was 2.7×10^{-7}, which raised concerns about the unwanted presence of linear dependency among safety climate items. However, examination of the correlation matrix revealed no correlations greater than 0.80, indicating the desired absence of multicollinearity.

Bartlett's test of sphericity is a chi-square test conducted to test the null hypothesis of no relationship between the items (i.e., the matrix is an identity matrix with 1's along the diagonal and 0's on the off-diagonal). For the safety climate matrix, a p-value of <0.0001 was observed. The null hypothesis that the matrix is an identity matrix was favorably rejected.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy examines whether the items have enough in common to justify conducting a factor analysis. Results are reported in a range from 0 to 1, with desirable values closer to 1. For the safety climate matrix of the present study, the KMO measure of sampling adequacy was 0.92. Based on a well recognized KMO rating scale, the matrix was deemed "marvelous" in terms of the items having enough in common to justify conducting a factor analysis (DeVellis, 2003; Kaiser, 1974).

The anti-image correlation matrix was reviewed. Measures of sampling adequacy for 16 individual items were ≥ 0.900. Based on the Kaiser evaluation system (Kaiser, 1974), these items were labeled as "Marvelous." Six items with values between 0.800 to 0.899 were labeled as "Meritorious", and one item with a KMO value of 0.796 was labeled as "Middling." Item env9 had a KMO score of 0.650 ("Mediocre"). Although marginally acceptable, the decision was made to include the item in the factor model because of *a priori* knowledge of acceptance in the Gershon factor (Gershon et al., 2000). From these tests it was determined that the matrix was suitable for factor extraction.

Factor extraction – The principal axis factor extraction method was conducted on the remaining 23 items, using both varimax and oblimin rotations (see below). Extracted communalities were calculated, representing the total amount of an item's variance that is explained by the factors. All items had communality values near or exceeding 0.40 (range=0.37-0.89), indicating sufficient common variance among the items (Leske, 1991).

Based on previous research, a seven factor solution was anticipated – six from the Gershon questions and an additional factor from the added items. Two breaks in the scree plot eigenvalue curve were observed – one at factor number 3, indicating a two factor solution, and one at factor number 9, indicating an eight factor solution (Figure 5-1; Fabrigar et al., 1999). A two factor solution was tested but resulted in an uninterpretable factor structure (e.g., the grouped questions did not comprise two interpretable concepts). Therefore, analysis proceeded based on an eight factor solution.

Factor rotation – In an effort to attain a simple structure and a more interpretable solution, two types of rotations were examined following factor extraction by the principal axis method: varimax "orthogonal", and oblimin "oblique" rotations.

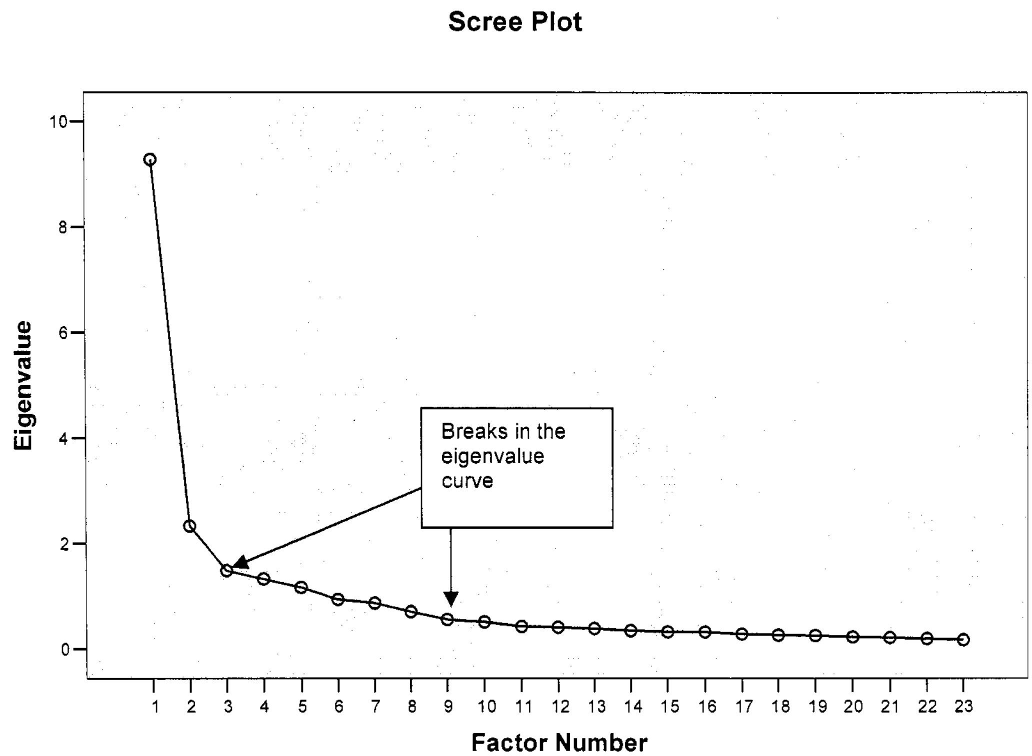

Figure 5-1. Scree plot of safety climate eigenvalues

An orthogonal rotation assumes that factors are uncorrelated (independent). In contrast, an oblique rotation assumes there is some correlation between at least two rotated factors (Pett, 2003). Both rotations included Kaiser normalization for relative stability attainment of solutions across samples (Pett, 2003). The process involves dividing the loading of each item by the square root of its individual communality before rotation to scale the factors. Following rotation, the item loadings on the factors are rescaled by multiplying each item's communality by the generated item loading.

Factors loaded in the same way when rotated by the varimax and oblimin methods, and the former was chosen for the remaining analyses, consistent with Gershon and colleagues (Gershon et al., 2000). A structure matrix for the principal axis factor method, varimax rotation method is presented in Table 5-3. Factors were grouped by items loading at or above 0.45. Also presented is the number and percent of subjects who provided usable responses to each factor. Although 460 subjects participated in the study, any respondent who answered either "Don't Know" or left a blank response to any question in a given factor was not included in that factor due to listwise deletion, which eliminates those subjects with a missing value response.

Table 5-3. Factor loadings, rotated component matrix[1]

	Factors and factor loadings							
Factor names and items	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
A. Personal protective equipment availability (n=430, 93%) [2,3]								
Disposable face masks are readily available in my work area (env1).	**0.51**	0.22	0.13	-0.06	0.27	0.08	0.05	0.13
Eye protection is readily available in my work area (env3).	**0.81**	0.20	0.11	0.15	0.16	0.03	0.05	0.11
B. Management support (n=413, 90%)								
The protection of workers from occupational exposures to respiratory infections is a high priority with management where I work (env4).	0.28	**0.63**	0.09	0.18	0.27	0.12	0.18	0.25
On my unit, all reasonable steps are taken to minimize hazardous job tasks and procedures (env5).	0.19	**0.70**	0.06	0.14	0.23	0.24	0.24	0.14
Employees are encouraged to become involved in employee safety and health matters (env6).	0.13	**0.64**	0.03	0.14	0.35	0.28	0.20	0.17
Managers on my unit do their part to insure employee protection from occupational respiratory infections (env7).	0.20	**0.62**	0.07	0.17	0.37	0.15	0.22	0.27
C. Absence of job hindrances (n=448, 97%)								
I have enough time in my work to always follow Standard Precautions (env9).	0.15	0.15	**0.66**	0.25	0.15	0.23	0.12	0.13
I usually have too much to do to always follow Standard Precautions (env10).	0.07	0.00	**0.59**	-0.05	0.03	0.07	0.10	0.06
D. Feedback (n=370, 80%)								
On my unit, unsafe work practices are corrected by supervisors (env11).	0.17	0.37	0.08	**0.48**	0.19	0.22	0.24	0.24
My supervisor often discusses safe work practices with me (env12).	0.06	0.29	0.07	**0.66**	0.24	0.16	0.30	0.15

(continued)

Table 5-3 (continued)

Items	A	B	C	D	E	F	G	H
	Factors and factor loadings							
E. Training (n=408, 89%)								
I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures (env13).	0.24	0.27	0.04	0.15	**0.64**	0.12	0.15	0.11
Employees are taught to be aware of and to recognize potential health hazards at work (env14)	0.24	0.39	0.03	0.12	**0.69**	0.18	0.18	0.18
On my unit, I know how to access information about clinic safety (env15).	0.07	0.16	0.12	0.07	**0.68**	0.16	0.05	0.21
In my job, there are clear written procedures on infection control actions to take based on signs and symptoms of infection, before the diagnosis is made (env22).	0.15	0.31	0.11	0.16	**0.46**	0.09	0.19	0.39
F. Cleanliness/orderliness (n=451, 98%)								
My work area is kept clean (env16).	0.06	0.27	0.17	0.11	0.18	**0.67**	0.22	0.08
My work area is not cluttered (env17).	0.06	0.11	0.04	0.05	0.07	**0.91**	0.20	0.02
My work area is not crowded (env18).	0.02	0.12	0.15	0.08	0.14	**0.68**	0.19	0.00
G. Minimal conflict/good communication (n=432, 94%)								
There is minimal conflict within my department (env19).	0.07	0.14	0.10	0.12	0.10	0.30	**0.77**	0.09
The members of my unit support one another (env20).	0.06	0.21	0.13	0.09	0.08	0.20	**0.84**	0.10
On my unit, there is open communication between supervisors and staff (env21).	0.02	0.16	0.09	0.12	0.17	0.14	**0.75**	0.09
H. Patient instructions (n=383, 83%)								
Signs are adequately posted at the entrance of my practice setting (i.e., unit or clinic) instructing arriving patients and those with them to tell staff if they have respiratory infection symptoms (env23).	0.01	0.19	0.14	0.05	0.16	0.00	0.10	**0.76**
My practice setting (i.e., unit or clinic) adequately posts signs that instruct coughing patients in waiting areas to cover their nose/mouth, use tissue, and wash their hands (env24).	0.12	0.11	0.08	0.11	0.07	0.05	0.01	**0.87**
My practice setting (i.e., unit or clinic) has clear procedures on what to do when patients arrive with symptoms of respiratory infection (env25).	0.17	0.14	-0.04	0.06	0.40	0.01	0.20	**0.63**

[1] Principal axis factoring, Varimax rotation with Kaiser normalization
[2] n=the number of subjects who provided a usable response (i.e., a response other than "don't know" or "blank")
[3] %=the percent of respondents of all 440 respondents who provided a usable response

While most factors were calculated based on about 90% or more of all study subjects, factors D (feedback) and H (patient instruction) were calculable only for a smaller subgroup of subjects, 80% and 83%, respectively. Of note, factors D and E originally loaded as one factor in the study by Gershon, et al., who termed it "Feedback and training." These items separated into two factors in the present study.

Factor reliability and independence – Cronbach's alpha coefficients, which are used as a measure of a factor's internal consistency and the amount of expected error measurement (Leske, 1991), were computed for each factor (Table 5-4). Factors A and C had alpha coefficients of less than 0.70 (0.62 and 0.67, respectively). Although not desirable, these factor coefficients are adequate for group comparisons (Leske, 1991). The remaining alpha coefficients ranged from 0.77 to 0.88, indicating respectable to very good factor reliability (DeVellis, 2003). To test discriminant validity, correlations were calculated between the eight factors to examine for factor independence (Table 5-4; Garson, 2006b). All correlations were moderately low, indicating that distinct safety climate dimensions were measured by the factor analysis.

Table 5-4. Safety climate factor correlations and Cronbach's alpha coefficients

	Factor Correlations								Cronbach's alpha coefficients	
Factor	PPE	Support	Hind-rance	Feed - back	Training	Order	Conflict	Instruct	Present study	Gershon[1]
PPE	1.00								.62	.78
Support	.36	1.00							.88	.84
Hindrance	.20	-.19	1.00						.66	.80
Feedback	.18	.42	-.09	1.00					.76	.71[2]
Training	.32	.48	-.13	.33	1.00				.80	
Order	.04	.19	-.13	.23	.20	1.00			.84	.73
Conflict	.06	.27	-.13	.19	.13	.33	1.00		.88	.74
Instruction	.22	.26	-.09	.21	.35	.07	.12	1.00	.84	--- [3]

[1] Cronbach's alpha coefficient of factor items derived by Gershon et al., 2000
[2] Gershon feedback/training factor included items from both feedback and training
[3] Patient instructions is a new factor representing questions added for the present study

Factor interpretation – The factors extracted in the present study were primarily based on previously identified safety climate items (Gershon et al., 2000). Names of previously named factors have been retained (Table 5-2). New or modified factors were named by the investigators following examination of the item concepts. A new factor H, termed "patient instruction", was comprised of three new previously untested questions relating to placement of instructional signs at a clinic's entrance, and instructions to staff on procedures to follow when undiagnosed patients arrive for treatment.

Discussion

This study demonstrated the replicability of the Gershon hospital safety climate measurement instrument when modified to address a different aspect of healthcare worker safety (Gershon et al., 2000). The factors extracted from the tool were generally consistent when the modified instrument was applied to a healthcare worker population in a different geographic location and healthcare setting, and nearly a decade later. The integrity of the factor structure was generally maintained with the modifications and additions that were made to adapt the instrument for studying respiratory rather than bloodborne pathogens.

There are no standardized definitions for safety culture or safety climate, nor for their relationships to organizational culture and climate. Safety culture and climate are commonly viewed as one component of the larger organizational culture and climate. Organizational culture refers to "the norms, values and basic assumptions of a given organization" (Gershon et al., 2000), and organizational climate, the "shared perceptions among members of an organization with regard to organizational policies, procedures, and practices" (Zohar, 2000). While safety climate derives from employee perceptions about safety in their workplace, safety culture reflects "the deeper and less readily accessible core values and assumptions of the organization regarding safety and human resources" (DeJoy et al., 2004), concepts that are much more difficult to measure. Safety climate has also been described as the measurable component of safety culture (Colla et al., 2005), and safety culture as "an organization's norms, beliefs, roles, attitudes, and practices concerned with minimizing exposure of employees to workplace hazards" (Turner, 1991). As such, safety climate has been viewed by different investigators both as a component and a reflection of actual safety culture (Cooper and Phillips, 2004). It is further important to distinguish that some studies of safety climate in health care settings focus on patient safety, and not necessarily worker safety (Makary 2006; Sexton 2006; Thomas 2005).

A recent literature review examined the survey instruments used in twelve quantitative studies of safety climate in healthcare settings (Flin et al., 2006). The studies investigated a variety of outcomes, including self-reported use of Universal Precautions and exposure to bloodborne pathogens (Gershon et al., 2000), perceived adequacy of training for Standard Precautions (McCoy et al., 2001), employee injuries (Vredenburgh, 2002), and handling of medical errors and adverse events (Itoh et al., 2002). Several of these studies included no outcome measure other than safety climate (Woods et al., 2003; Singer et al., 2003; Pronovost et al., 2003). Of the twelve studies, nine used different survey instruments, and three used modifications of the Operating Room Management Attitudes Questionnaire (Schaefer and Helmreich, 1993). The studies variably utilized the terms, safety climate, safety culture, or both, and definitions differed between studies. Most of the studies also failed to identify the conceptual model underlying the hypothesized associations between safety climate and outcome measures. In spite of these differences and shortcomings, the studies commonly examined the same or similar dimensions of safety climate, including safety attitudes and reported behaviors, and perceptions related to management or supervisors, safety systems, personal risks, job demands, reporting or speaking up, communication and feedback, teamwork, personal resources (e.g., stress), and organizational factors (Flin et al., 2006).

Subsequent to the review by Flin and colleagues (Flin et al., 2006), two large healthcare safety-climate studies were published, utilizing the Safety Attitudes Questionnaire (SAQ) (Sexton et al., 2006; Makary et al., 2006). The SAQ differs from the Gershon safety climate instrument in that it focuses primarily on patient safety.

The instrument derives from a questionnaire that was extensively used in commercial aviation, and has since been adapted for use in intensive care units, operating rooms, general inpatient settings and ambulatory clinics. It is comprised of 40 items in six analytically derived safety attitude-related scales: teamwork climate, job satisfaction, perceptions of management, working conditions, stress recognition, and a safety climate scale consisting of seven items.

In one study, the SAQ was administered to 10,843 healthcare workers in more than 200 healthcare locations in New Zealand, the United Kingdom and the United States (Sexton et al., 2006). The investigators conducted a multi-level factor analysis to fit their six-factor model to data collected at the level of the respondent, clinical area, and clinical area levels, and they concluded the instrument is psychometrically sound for application in healthcare settings. The study examined scale reliability using Raykov's ň coefficient, which is a multidimensional test in which each item may measure more than one attribute, rather than the commonly used mono-dimensional Cronbach's alpha coefficient, and thus cannot be compared directly with the measure used in the present study. The SAQ study yielded a large pool of benchmarking (reference) data, which is available in the public domain to gauge performance of the SAQ administered in other settings.

A second study tested the reliability of the "SAQ (OR version)" —Safety Attitudes Questionnaire, Operating Room version, modified for application in surgical settings— when administered to 2,135 healthcare workers at 60 hospitals in 16 US states (Makary et al., 2006). Strong psychometric properties were demonstrated by confirmatory factor analysis. This modified SAQ included a seven-item safety-climate scale; the alpha coefficient for internal consistency of the seven items was 0.76.

Providing another measure of validity, the SAQ was used as an effect measure in a group randomized trial, which demonstrated a beneficial influence of executive walk rounds on nurses' perceptions of safety climate (Thomas et al., 2005).

The present study elected to use a safety climate instrument adapted from the one developed by Gershon and coworkers, because it was based on a credible conceptual model and has proven to be psychometrically valid when applied in studies of healthcare workers' use of Universal Precautions (Gershon et al., 2000). Furthermore, the Gershon safety climate scale, which provided the basis for the present study instrument, was developed specifically to examine the relationship of safe work behavior for protection against transmission of bloodborne, rather than respiratory pathogens. Nominal changes were made to the original survey instrument, to be appropriate for a study of precautions related to respiratory rather than bloodborne hazards. The conceptual model developed by Gershon and colleagues was also modified to include a presumed role for public health awareness (Figure 1-1).

Construct validity of the modified Gershon safety climate scale was established by exploratory factor analysis. Seven dimensions of safety climate were identified, in contrast to six dimensions identified by Gershon and colleagues, and an additional dimension emerged from new questions that were added to the scale (Table 5-2). The six questions comprising the single Gershon "feedback and training" factor extracted to two factors, "feedback" and "training," in the present study. The relatively high number of non-responses on the "feedback" from supervisors on safe practices factor (20% overall) was primarily among physicians (37% non-responses), who may have not responded because they are not directly supervised. Moderately low correlations between the eight factors (Table 5-4) indicated that the factors represented eight relatively distinct concepts. Two pairs of factors (concepts) showed relatively high but acceptable interdependence – "training" and "management support," (r=0.48), and "feedback" and "management support," (r=0.42).

Psychometric properties were strong and comparable to the experience of Gershon and colleagues. The reliability of each factor was examined for internal consistency by Cronbach's alpha coefficient. Five factors had alpha coefficients ranging from 0.71, which is considered acceptable, to 0.84, which is considered to be very good (DeVellis, 2003). Although the internal consistency of two factors was below a desirable alpha coefficient of 0.70, alpha scores in this range are deemed adequate for group comparisons (Leske, 1991). These associations are comparable to those obtained by Gershon and colleagues who extracted six safety climate factors from 46 items, with alpha coefficients ranging from 0.71 to 0.84 (Gershon et al., 2000).

There are potential limitations to this study beyond those described in Chapter 3. Three factors were comprised of only two items (questions). While a factor may be minimally comprised of two questions, at least three or more questions are generally considered desirable for an adequate factor interpretation (Pedhazur and Schmelkin, 1991). Because internal consistency (alpha coefficients) of the two-question factors was judged to be acceptable to adequate for group comparisons, and because Gershon and colleagues' analysis yielded similar factor structures, the two-item factors were retained to examine associations with the present study's outcome measures (Chapter 4). Missing values due to responses of "don't know" or blank responses ranged from 1.3% to 13.0% for some items, with more physicians providing a "don't know" answer than nurses or nurse aides. This differential loss of subjects is a potential source of bias in comparisons between jobs, because factor analysis only includes subjects who provided a response for all items (questions) comprising a factor, and eliminates those who do not. However, any such bias is likely to be small, since complete responses were available for the vast majority of subjects in the occupational group (i.e., 87% of physicians) with the most missing responses.

The present study collected data using a self-report questionnaire, which might have introduced recall bias with over-reporting of desirable responses. Without conducting independent observations, it is not possible to assess the degree of such recall bias; however, there is no reason to expect recall bias to be substantially differential between occupational groups (e.g., physicians reporting behaviors or beliefs more or less favorably than nurses). Furthermore, most previous studies of safety climate have used similar data collection methods, and the findings of the present study are not likely to be any more subject to bias than previous studies. Study generalizability is potentially limited by the sample size and response rate (n=440; response rate=53%, range 39% to 76% at the five medical centers), which was similar to that of Gershon and colleagues (n=789; 60%), but is somewhat small than the SAQ studies of Sexton and colleagues (n=10,443; 67%) and Makary and colleagues (n=2,135; 77%). Nonetheless, the present study sample is not insubstantial and is derived from five diverse healthcare institutions; therefore, it should have a meaningful degree of generalizability.

In conclusion, these findings demonstrate the replicability of a modified version of the Gershon safety climate instrument for establishing dimensions of safety climate in healthcare settings, specific to healthcare workers' use of CDC respiratory infection control practices as the outcome of interest. The instrument demonstrated good psychometric properties in the factor analysis and tests of internal consistency. The tool appears to have sufficient reliability and validity for use by healthcare decision makers as an indicator of employee perceptions of safety in their institution. Further testing of the safety climate tool could examine if the dimensions hold across different and larger healthcare populations, settings, and safety applications over time. Future research should include the evaluation of existing items for temporal changes, as well as the inclusion of additional questions to enhance interpretation and internal consistency of the instrument's dimensions. Investigators should also consider building on the experience of the SAQ which is supported by a large base of evidence. Although the SAQ is primarily focused on patient rather than worker safety, many SAQ items might be suitable for augmenting studies of worker safety to consider dimensions of organizational climate beyond safety climate.

6. Notifiable Condition Reporting Knowledge among Healthcare Workers in First Contact Patient Care Settings

Surveillance is defined as the "systematic ongoing collection, collation and analysis of data and the timely dissemination of information to those who need to know so that action can be taken" (WHO, 2006e). Communicable disease surveillance involves the monitoring of a population's infectious disease burden, where the population may range in scale from international to a single healthcare facility. Information derived through communicable disease surveillance is used to guide interventions to control the spread of infectious agents in susceptible populations. Surveillance may also identify the appearance of emerging or re-emerging infectious diseases both in the community and in healthcare facilities. Communicable disease surveillance is conducted through a variety of systems, including notifiable condition reporting and surveillance within healthcare facilities.

The communicable disease burden of the United States population is tracked through a notifiable condition reporting surveillance system. Notifiable conditions are diseases or conditions of public health importance in which either a case, or in some instances, a suspected case, must be reported to either the local or state public health authority by healthcare providers, medical institutions, clinical laboratories or others. Routine information on notifiable conditions is reported by states to the CDC through either the National Electronic Disease Surveillance System (NEDSS) (CDC, 2006c) or the National Electronic Telecommunications System for Surveillance (CDC, 2006d).

In Washington State, the communicable disease notifiable condition reporting system is mandated by Chapter 246-101 of the Washington Administrative Code (WAC). For healthcare providers, both diagnosed and suspected cases of certain diseases such as measles or pertussis, as well as infectious disease outbreaks and suspected outbreaks, must be reported immediately to the local public health authority (immediately notifiable conditions) so that appropriate control measures can be carried out. Immediate reporting is also required for diseases of suspected bioterrorism origin such as anthrax or smallpox, other rare diseases of public health significance such as SARS during the 2003 outbreak, and unexplained critical illnesses or deaths of suspected infectious origin. In addition, healthcare providers must report other conditions of a less serious public health consequence to public health authorities, typically within three work days of suspected or confirmed diagnosis. A few notifiable conditions such as chronic hepatitis may be reported monthly. Similar reporting must be conducted by healthcare facilities and clinical laboratories, with different sets of diseases reported by each group.

Healthcare workers provide a critical link between patient care and the public health community. In most circumstances, the healthcare provider with primary responsibility for patient diagnosis or treatment is responsible for reporting notifiable conditions to the public health authority. However, other licensed or certified healthcare workers in attendance, such as nurses or nurse aides, may also be responsible for notifiable condition reporting in the absence of the principal provider. Medical settings in which multiple providers care for a patient with a notifiable condition may have a system for assigning reporting. Clinical laboratories also have separate notifiable condition reporting obligations.

In addition to notifiable condition reporting, hospitals and other healthcare facilities must also maintain an effective infection control program to minimize the risk of acquiring and transmitting healthcare-acquired infections among patients, visitors and healthcare staff (JCAHO, 2005). Infection control programs in Washington State are mandated under Chapter 246-320 of the Washington Administrative Code. Hospital accreditation standards call for hospitals to use an epidemiologic approach consisting of surveillance, data collection, and trend identification. Systems must be in place to provide timely information to appropriate staff about healthcare-acquired infections within the medical facility as well as communicable diseases of concern in the greater community.

Despite the need and legal requirement for clinicians to report notifiable conditions, reporting by clinicians remains low (Doyle et al., 2002). Medical institutions should also provide clinicians with surveillance information derived from the reporting system (Lee et al., 1998). Therefore, the aim of this chapter is twofold: 1) to examine healthcare worker knowledge about notifiable condition reporting; and 2) to examine perceptions of healthcare workers about their employers' communicable disease feedback and notifiable condition training programs. This chapter specifically addresses the research questions:

- Does knowledge of notifiable condition reporting among healthcare workers differ by occupation? (Research Question 3a)
- Is knowledge of notifiable condition reporting among healthcare workers associated with training? (Research Question 3b)

Methods

Detailed study methods are presented in Chapter 2. Methods relevant to this chapter are summarized for reader convenience or described in further detail.

During the summer and fall of 2005, healthcare workers were surveyed in primary care and emergency department settings at five medical centers in King County, Washington to assess healthcare worker knowledge and practices regarding notifiable condition reporting, and healthcare worker perceptions about their employer's communicable disease surveillance, data collection, and information reporting systems.

All eligible healthcare workers (1,241) at each of the surveyed medical settings were invited to participate, and 653 surveys were returned for a response rate of 53%. Of those, 630 respondents met the study's eligibility criteria. The other 23 respondents were excluded from the study. Respondents were grouped into categories of physician/practitioners, nurses, nurse aides, allied professionals, and reception/other. The analysis was restricted to healthcare workers involved in direct patient care (physician/practitioners, nurse, nurse aide; Chapter 5, Table 5-1) because of their direct involvement in notifiable condition reporting.

The study questionnaire was developed to examine healthcare worker knowledge of notifiable condition reporting and perceptions of their employer's communicable disease surveillance practices. Questions relating to surveillance knowledge and perceptions were developed with the assistance of the Communicable Disease Control, Epidemiology and Immunization Section of Public Health – Seattle and King County, the infection Control Office of Harborview Medical Center, and the Communicable Disease Epidemiology Section of the Washington State Department of Health. With the exception of one variable measuring hours of training, questions were based on Likert scale responses of "strongly agree," to "strongly disagree." answers of "don't know" were addressed as missing values during analysis.

Factor analysis was conducted on the study instrument's 10 items related to communicable disease surveillance knowledge, using the principal axis factoring method. Factor loadings were examined by varimax orthogonal rotation to identify the two factors (concepts) underlying the construct. Variables with factor loadings of 0.45 or greater were grouped and judgments made on their applicability to an underlying concept. One factor, termed "notifiable condition reporting knowledge" was extracted from six questionnaire items relating to reporting and training (questions surv5 through surv10) as identified in Appendix B. A second factor, termed "employer surveillance feedback" was extracted from two survey questions (surv1 and surv2). Cronbach's alpha coefficients were calculated to estimate the internal consistency of the questions comprising each factor.

Factors were prepared for analysis by dichotomizing each question comprising a factor to indicate agreement (coded "1"), or disagreement (coded "0") with a question (Gershon et al., 1995; Michalsen et al., 1997; McCoy et al., 2001). Agreement was defined by a response of "strongly agree" or "agree." Factor development methods are further described in Chapter 2. A detailed factor analysis of the surveillance knowledge construct is presented in Chapter 7.

Survey respondents were combined into three occupational categories of physician/practitioners (n=187; 41% of respondents), nurses (n=180; 39%), and nurse aides (n=93; 20%) for a total of 460 direct care providers. Within these categories, 88% of physician/practitioners were physicians, 94% of nurses were RNs, and 86% of nurse aides were medical assistants. Four subjects originally categorized as nurse aides were removed from the analysis due to uncertain classification. One hundred seven (66%) physician/practitioners, 33 (19%) nurses and 70 (79%) nurse aides worked in a primary care setting, and 54 (34%) physician/practitioners, 144 (81%) nurses, and 19 (21%) nurse aides in an emergency department. Thirty-four (7%) healthcare providers did not specify a prime work setting. This report uses the abbreviated term, "physician," to refer to the physician/practitioner category. A detailed description of demographic information is provided in Chapter 3.

Results

Approximately three quarters of physicians and about two thirds of responding nurses and nurse aides said they were familiar with Washington State's immediately notifiable condition reporting standards (Table 6-1). Responding physicians tended to be less aware of their practice setting's reporting procedures than nurses or nurse aides, although the difference was not significant. About three quarters of the responding physicians and about half of the nurses knew where to find Washington's notifiable conditions list. Two thirds of responding physicians and fewer nurses knew the diseases to report immediately, and the telephone number to call to report a notifiable condition.

Only about one third of physicians said that their employer provided them with training about notifiable condition reporting (Table 6-1). However, 43% reported that they had received some training on notifiable condition reporting in the year before the survey, indicating training from other sources (Table 6-2). Those who received any training from any source had a 10.0-fold higher odds of being knowledgeable about notifiable reporting requirements than those who did not (95% CI=5.6-17.8, $p<.001$). Odds ratios for physicians, nurses and nurse aides were similar (OR=10.3, 9.9, and 10.2, respectively). In a test of trend, increased hours of training in the year

Table 6-1. Surveillance knowledge, feedback and training

	Physician Practitioner (n=187)	Nurse (n=180)	Nurse Aides (n=97)	p-value[4]
Knowledge				
I am familiar with Washington's immediately notifiable condition reporting requirements (surv5) [1,2,3]	142 (78%) [4]	113 (68%) [15]	59 (70%) [9]	.14
I am aware of my practice setting's procedures for reporting a notifiable condition (surv6)	101 (59%) [17]	113 (69%) [17]	57 (69%) [6]	.16
I know where to find Washington's list of notifiable conditions (surv7)	127 (72%) [10]	92 (57%) [19]	44 (56%) [14]	.007
I know where to find the number to call 24/7 to report an immediately notifiable condition (surv8)	115 (66%) [13]	86 (55%) [23]	39 (50%) [15]	.03
I am aware of what diseases I need to immediately report (surv9)	118 (65%) [5]	99 (60%) [15]	55 (65%) [8]	.61
Employer communication				
My employer provides me with timely information about healthcare-acquired infections in my medical center (surv1)	122 (71%) [16]	127 (76%) [12]	68 (75%) [2]	.65
My employer provides me with timely information about infectious diseases in the greater community (surv2)	110 (61%) [7]	127 (73%) [7]	64 (70%) [1]	.04
Training				
My employer provides me with training about notifiable condition reporting (surv10)	52 (28%) [4]	59 (34%) [10]	41 (47%) [6]	.01
I received training on notifiable condition reporting (from any source) during the past 12 months (surv11)	81 (43%) [0]	80 (44%) [4]	39 (44%) [5]	.92

[1] Number and percent positive responses. A positive response of agreement is a response of either "Strongly Agree" or "Agree." Percent is based on the number of subjects who provided a measurable response to the question
[2] Number of non-responses (subjects who provided a "don't know," or blank response) are shown in square brackets
[3] Complete survey questions are presented in Appendix A. Question numbers (surv) are presented in Appendix B
[4] p-value based on chi square test of homogeneity

preceding the survey were significantly associated with notifiable condition reporting knowledge among all healthcare providers.

About two thirds of respondents also reported that their employer provided timely feedback about infectious diseases in their institution and in the community (Table 6-1). Those who received such feedback had a 5.4-fold higher odds of feeling knowledgeable about notifiable condition reporting than those who did not (CI=2.9-10.2, p<.001). Feedback and training were highly correlated (Cramér's V = 0.80).

Table 6-2. Association of training with notifiable condition reporting knowledge[1]

	n	OR	95% CI	p-value[2]
0 Hours[3]	201	1.0	---	---
<1 Hour	125	7.5	3.8 - 14.7	<.001
1 - 2 Hours	40	20.2	7.3 - 55.8	<.001
> 2 Hours	8	47.9	4.3 - 532.4	<.001

[1] Analysis based on the "notifiable condition reporting knowledge" factor (see Chapter 7)
[2] p-value based on chi square test of homogeneity
[3] Hours of notifiable condition reporting training in the year preceding the survey

Discussion

This study identified gaps in clinicians' knowledge about their role in reporting notifiable conditions both under Washington State's reporting standards and within the healthcare setting where they work. The influence of training upon clinicians' notifiable condition reporting knowledge was pronounced. Those who did not receive training were less likely to understand their responsibilities under Washington State's notifiable condition reporting standards. Those who received feedback from their employer about surveillance data collected within their institution as well as from the community were also more likely to understand the notifiable condition reporting system in general, as well as that of their institution.

Notifiable condition reporting by clinicians has historically been incomplete. Although states legally mandate notifiable condition reporting, this passive surveillance system involves receiving unsolicited case reports from healthcare providers, laboratories and others. A recent literature review examined completeness of infectious disease reporting in 33 studies published in the United States from 1970 to 1999, by comparing reports through conventional public health reporting systems to those identified through one or more additional data sources (Doyle et al., 2002). The proportion of notifiable conditions reported to public health authorities varied from 6% to 99%, depending on the condition being reported. Reporting completeness of tuberculosis, AIDS, and sexually transmitted diseases was significantly higher than all other conditions. While notifiable condition reporting surveillance information may be incomplete, data are useful for monitoring short and long term trends, alerting clinicians and public health officials of changes in trends and emerging conditions (Chorba et al., 1989).

Reasons identified for underreporting by clinicians include unawareness of the legal requirement to report, which diseases to report, or how they should be reported (Doyle et al., 2002). In the present study, although three quarters of physicians reported familiarity with Washington State's notifiable condition reporting requirements, less than 20% of physicians reported knowledge of all six notifiable condition reporting questions of the survey. Overall, only one third of respondents indicated that their employer trained them in notifiable condition reporting. Although US studies are limited, three identified lack of knowledge as a barrier to reporting. A study of 345 physicians in New York found lack of knowledge to be a major factor in underreporting (Konowitz et al., 1984). Consistent with Doyle and colleagues, knowledge significantly varied based on the disease being reported. Furthermore, respondents who believed they understood reporting procedures actually did not when asked detailed reporting-related questions by the investigators. Similarly, in a survey of 139 physicians participating in a physician-based surveillance study in Vermont (38% response rate), 40% indicated that they were unaware that notifiable condition reporting was required, and two thirds assumed laboratories were doing the reporting (Schram et al., 1980). In a study of 582 physicians in Louisiana (58% response rate), almost 20% indicated lack of knowledge about how or where to report, and about half assumed the duty was handled by someone else (e.g., the laboratory)(Ktsanes et al., 1991).

Different medical settings often have different procedures for reporting notifiable conditions, so it is important for clinicians to understand how reporting is conducted where they work. In the present study, only about half of the physicians and about two thirds of nurses and nurse aides were aware of how notifiable condition reporting was conducted in their practice setting. In a study of notifiable condition reporting by emergency room clinicians in 11 hospitals, three types of reporting systems were recognized: an emergency department based system in which, under the direction of an emergency department director, nursing or clerical staff identified cases and reported diseases; a hospital-based system in which either laboratory or infection control staff identified cases and completed reports; and a hybrid system in which emergency department staff identified cases and infection control staff completed and submitted the reports (Kirsch and Shesser, 1990). In a separate study of 192 physicians in Vermont, 42% had single practices and 55% group practices (Schramm et al., 1991). About half responded that they practice reporting unassisted, 17% shared the responsibility with others they work with, and 27% relied entirely on staff for all reporting.

Surveillance data feedback to clinicians originates from sources both internal and external to a facility. Such information can be transmitted in many ways, including electronically as reports or posters, or during staff meetings. It has been suggested that healthcare institutions should integrate a surveillance feedback system to clinicians as part of an overall institutional surveillance program (Lee et al., 1998), yet in the present study, about one third of clinicians reported that their employer did not provide them with timely information about infectious diseases either in their institutions or in the community. Surveillance information reported back to clinicians completes the reporting loop, and can serve as an incentive for participation by encouraging partnerships between clinicians and data collectors, and by providing information useful to their practice (Teutsch and Churchill, 2000). Feedback to clinical staff can also serve as an early warning to adhere to infection control practices. For example, timely surveillance information from provincial public health authorities to hospitals in Vancouver, British Columbia, informing them to be on the alert for individuals returning from China with influenza-like illness, contributed to preventing the spread of SARS in the Pacific Northwest (Hofmann and Turnberg, 2005).

In the present study, the proportion of respondents who reported that their employer provided them with notifiable condition reporting training was less than when the question was reworded without reference to the employer. This inconsistency may be due to training and educational information received from other sources beyond the workplace, such as from local public health agencies. In Washington State, local public health agencies are legally required to notify health care providers, laboratories, and health care facilities about their responsibilities under the notifiable condition reporting system (WAC 246-101-505(3)). Training notification can take the form of educational mailings, posters, or other communication methods, including in-service meetings.

This study suggests that notifiable condition reporting among clinicians practicing in primary care and emergency department settings can be enhanced by training and feedback of surveillance information to clinicians. Training and feedback may originate from both the healthcare employer as well as the local public health community, preferably in a partnership role. Clinicians need to understand their legal responsibilities under the reporting system, as well as the reporting process followed by their institution. Healthcare institutions should actively promote the importance of notifiable condition reporting to clinicians, leading to enhanced participation, and a strengthened relationship between medical institutions, clinicians, and the public health community.

7. Factor Analysis within Constructs of Infection Control Practices, Individual Views, and Public Health Surveillance

This chapter presents details of the factor analysis of groups of survey questions relating to three of the major constructs of the study's conceptual model: respiratory infection control practices, individual views, and public health surveillance (see Chapter 1, Figure 1-1). The psychometric properties of a fourth construct of the model, safety climate, are presented in Chapter 5.

Factor analysis is conducted to achieve parsimony in data analysis by identifying a few items underlying much of the variance associated with a larger set of items (Fabrigar, 1999). This process involves both a statistical examination of the variance among a set of items, as well as a subjective examination of the results to address the question, "Does the statistical grouping of items make sense?" From these groupings the dimensions of the intercorrelated questions are identified.

The purpose of this chapter was to determine the psychometric properties (validity and reliability) of the factors representing underlying concepts within three of the major constructs of the study's conceptual model: use of infection control practices, individual views, and public health surveillance. Once determined, the concepts represented by the factors can then be used in statistical modeling to examine associations with healthcare workers' use of respiratory infection control measures recommended by the Centers for Disease and Control and Prevention (CDC). Knowledge of factors that influence behavior can be used to guide training and intervention decisions to enhance the safety of healthcare workers in medical settings.

Methods

Detailed study methods are presented in Chapter 2.

The study sample is described in Chapter 3. The factor analyses focused on responses from physicians, physician assistants, nurse practitioners, nurses, and nurse aides. Allied professionals and administrative staff, primarily represented by patient receptionists, were excluded because of the marked difference in their duties compared to direct care providers, resulting in numerous "does not apply" and "don't know" responses. Four subjects originally identified as nurse aides were removed due to uncertain categorization.

Data collection and factor analysis methods are presented in Chapter 2. Statistical analysis used the Statistical Package for the Social Sciences, Release 13.0, and Stata, Version 9.0. Missing values were not imputed or otherwise included in the analysis. Questions are labeled in the order and section as they appear in the survey instrument. Questionnaire sections are denoted by the following labels: "icp" (infection control practices), "ind" (individual views), and "surv" (public health surveillance). The survey questionnaire is presented in Appendix A. Survey question labels and question sources are presented in Appendix B.

Results

Infection Control Practices Factors – Infection control recommendations published by the CDC were measured using 18 survey questions (items) as described in Chapter 2.

Item analysis – Each item (infection control practice question) was descriptively examined for its missing values, mean, standard deviation, normality, corrected item-total correlation, and Pearson inter-item correlation. Missing values approached or exceeded 20% for the following five questions: icp10, icp14, icp15, icp16, and icp17 (see Appendix B) . These questions were removed from analysis.

Means and standard deviations were calculated for the remaining 13 items. On a five point Likert scale, with "1" being "almost always" and "5" being "never," means ranged from 1.01 to 3.75, and standard deviations from 0.10 to 1.44. The item icp6 (I remove my disposal gloves promptly after use) had a mean of 1.08 and standard deviation of 0.29, and the item icp8 (I change my gloves before going to another patient) had a mean of 1.01 and a standard deviations of 0.10, indicating little variance from a perfect response, so they were excluded from further analysis.

Corrected item-total correlation coefficients were calculated to compare how each item correlates with the total scale computed from the other items. Coefficients were within acceptable limits, ranging from 0.31 to 0.56 – corrected item-total correlations from 0.20 to 0.70 are generally considered acceptable (Nunnally, 1978).

Factor analysis – The interrelationships between items were examined on a Pearson inter-item correlation matrix to determine whether sufficient numbers of significant correlations existed among the items, and whether the matrix was sufficiently stable to justify extraction of factors (Pett, 2003). The determinant for the matrix for the 11 infection control practices variables was 0.07. A determinant greater than zero indicates that the correlation matrix is not singular, there are no linear dependencies in the data, and the matrix is stable for mathematical operations. The maximum correlation, $r=0.58$, was less than 0.70, indicating the absence of multicollinearity. Significance values for the correlation matrix were also computed testing the null hypothesis of no association between each pair of items in the matrix. An overall alpha of 0.78 was calculated for the remaining 11 infection control items.

Bartlett's test of sphericity (Bartlett, 1950) is a chi-square test that was conducted to test the null hypothesis of no relationship between the items (e.g., that the matrix is an identity matrix with 1's along the diagonal and 0's on the off-diagonal). For the infection control practices matrix, a significant p-value of $<.0001$ was calculated. The null hypothesis that the matrix is an identity matrix was rejected.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) is a test to examine whether the items have enough in common to justify conducting a factor analysis. The test compares magnitudes of correlation coefficients to partial correlation coefficients, and results in values of between 0 and 1. Interpretation of the KMO measure is based on the Kaiser-Meyer-Olkin Measure of Sampling Adequacy Labels (Kaiser, 1974). For the present study, the KMO score for the infection control practices matrix was 0.81, indicating that the matrix is "meritorious" in terms of the items having enough in common to share common factors.

Factor extraction – The principal axis factor extraction method was conducted on the remaining 11 items and compared to determine the best statistical factor solution. An initial estimate of the communality of each item was computed. The communality of an item is the total amount of its variance explained by the factors. Communality values range from 0, in which no variance in the item is explained by the factors, to a value of 1, in which all of the variance in an item is explained by the factors. Initial communality estimates indicated that an acceptable amount of variance is attributed to the common factors, rather than each item's unique variance.

In factor analysis calculations, an eigenvalue represents the variance of all items explained by a given factor. Eigenvalues must be greater than 0 because they represent the explained variance in a set of items comprising a factor. An eigenvalue represents a direct index of how much of the total variance is accounted for by a given factor (Pett, 2003).

The number of factors to be extracted was estimated by examination of the scree plot. In this graph, the extracted factors are plotted against their respective eigenvalues sorted in descending order. The factor solution is interpreted by the number of factors appearing above the break in the curve. The screeplot, calculated for this analysis, in Figure 7-1 suggests a two factor solution.

A goodness of fit of the two factor solution was tested by computing a residuals matrix, which compares differences between the observed correlation coefficient and those estimated from the common factors. A given factor solution is supported by residuals of less than 0.10 (Leske, 1991). Higher residuals indicate that a higher factor solution may exist. In the present study, all residuals were less than 0.10, indicating the adequacy of the two factor model.

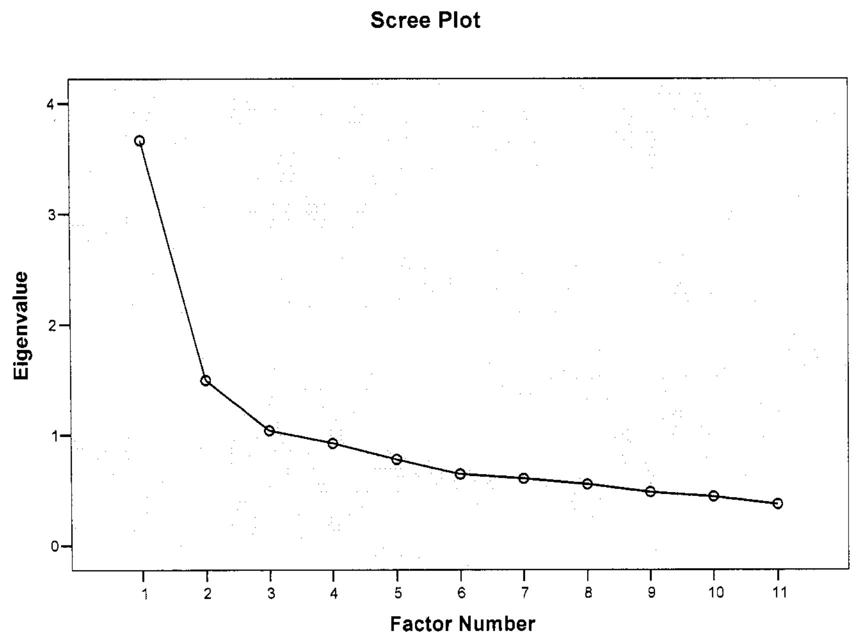

Figure 7-1. Scree plot of infection control practices eigenvalues

Factor rotation – Factor rotation is conducted to find a simple structure by geometrically rotating the model, leading to a more interpretable factor solution. In factor analysis, two rotations are commonly used: orthogonal and oblique. Although each is based on very different approaches and assumptions, both have the common goal of finding a simple structure. The orthogonal rotation assumes that factors are uncorrelated (independent). This is in contrast to the assumption of the oblique rotation that there is some correlation between at least two rotated factors (Pett, 2003).

In the present study, two rotation methods were examined: the orthogonal varimax and oblique direct oblimin. Factor loadings for the two factor model are presented in Table 7-1 for the principal axis factoring method and varimax orthogonal rotation. Only items with loadings of 0.45 or greater were included in the final factor.

Table 7-1. Respiratory infection control practices factor pattern matrix[1]

Items	Factor Loadings	
	Factor 1	Factor 2
Hand hygiene practices (n=425, 92% of 460)		
I practice hand hygiene before having direct contact with a patient (icp1)	<u>**0.46**</u>	0.09
I practice hand hygiene after taking a pulse or blood pressure (icp2)	<u>**0.70**</u>	0.19
I practice hand hygiene after working with a patient who is coughing (icp3)	<u>**0.61**</u>	0.17
I practice hand hygiene after touching items in the immediate vicinity of a patient (icp4)	<u>**0.68**</u>	0.27
I practice hand hygiene immediately after removing my disposable gloves (icp7)	<u>**0.58**</u>	0.20
Respiratory precautions (n=378, 82% of 460)		
I wear disposable gloves when I'm working with a coughing patient with flu-like symptoms (icp5)	0.19	<u>**0.55**</u>
Disposable face masks are offered to coughing patients when they present for care in my practice setting (icp9)	0.09	0.42
instruct patients who I observe coughing or sneezing to cover their mouths and noses, use tissues, and wash their hands (icp11)	0.23	<u>**0.58**</u>
I wear eye protection when caring for patients who are coughing or sneezing (icp12)	0.15	<u>**0.53**</u>
I wear a mask when I'm examining a coughing patient with flu-like symptoms (icp13)	0.14	<u>**0.66**</u>
Patients with respiratory infections are instructed about how to prevent spread to their family and other close contacts (icp18)	0.17	0.44

[1] Principal axis factoring method, varimax orthogonal rotation

Factor reliability and independence – An instrument's reliability is based on an understanding of the extent of measurement error in the instrument. Measurement error is categorized as systemic or nonrandom when it consistently recurs over different tests of the instrument, and as random when the error is not predictable (Pett, 2003). Cronbach's alpha is used as a measure of a factor's internal consistency and as a measure to summarize the amount of measurement error within a group of items (Leske 1991). Alpha interpretations for research scales have been described as follows: below 0.60, unacceptable; between 0.60 and 0.65, undesirable; between 0.65 and 0.70, minimally acceptable; between 0.70 and 0.80, respectable; between 0.80 and 0.90, very good; much above 0.90, one should consider shortening the scale (DeVellis, 2003). It has been suggested that alpha scores of at least 0.50

are adequate for group comparisons (Leske, 1991). In the present analysis, a respectable alpha coefficient of 0.75 was observed for factor 1, and minimally acceptable alpha of 0.68 for factor 2. Correlation was low between the two factors (r=0.24), indicating that each comprised a separate dimension of the construct rather than similar concepts. Ninety-two percent of respondents provided answers to all five hand hygiene practice items (Factor 1) and four respiratory precaution items (Factor 2) each loading above 0.45.

Factor interpretation – Following statistical extraction, items comprising the factors were examined to determine if the groupings were conceptual and logical. The factors were named on the basis of common themes among the items.

Factor 1 was comprised of five items loading above 0.45. Each item involved a common theme, and the factor was named, "hand hygiene practices." Factor 2 consisted of four items loading above 0.45. Three items involved reported use of personal protective equipment (gloves, masks, and eye protection) while examining patients with influenza-like illness. One item involved the practice of providing respiratory precautions instructions to patients who are coughing or sneezing. This factor was named, "respiratory precautions."

Individual Views Factors – The development of questionnaire items addressing individual views is described in Chapter 2.

Item analysis – Fourteen items were examined for potential inclusion in the individual views factor analysis. This included one item (env26) from the survey's "Working Environment" section. Missing values, based on a respondent either not filling in an answer or providing an answer of "don't know" ranged from 0.9% to 8.3% of 460 responses. No items were excluded due to excessive missing values. Item means ranged from 1.40 to 4.00, with an overall mean of 3.10 indicating a general trend toward a response of "disagree." Standard deviations ranged from 0.54 to 1.35.

Corrected item total correlation coefficients were computed for the 14 items. Items ind1, ind2, and ind13 had corrected item total correlation coefficients of less than 0.20 (0.13, 0.04, and 0.04, respectively) indicating insufficient association with the other items (Nunnally, 1978). Therefore, each item was dropped from further analysis.

Factor analysis – The interrelationships between items were examined on a Pearson inter-item correlation matrix. No items were highly correlated at correlations of >0.80 eliminating a concern of multicollinearity. However, several correlations were low at <0.30 indicating a potential lack of correlation for a successful factor analysis.

The determinant of the matrix was 0.02, indicating that the matrix is not a singular matrix. Bartlett's test of sphericity was statistically significant ($p<.0001$) rejecting the null hypothesis that the matrix is an identity matrix. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.80. This was interpreted as "meritorious" for sampling adequacy (Kaiser, 1974). Based on these tests, it was determined that the matrix is suitable for factor extraction.

Factor extraction – The principal axis factor extraction method was conducted on the remaining 11 items. A scree plot of eigenvalues is presented in Figure 7-2 based on the remaining 11 items. The bend in the curve at eigenvalue four suggested a three factor solution.

Factor rotation – Two rotation methods were examined, 1) varimax orthogonal rotation, and 2) direct oblimin oblique rotation; both with Kaiser normalization. Each resulted in the same factor loading pattern. The rotated factor matrix for the principal axis factoring method, varimax orthogonal rotation is presented in Table 7-2.

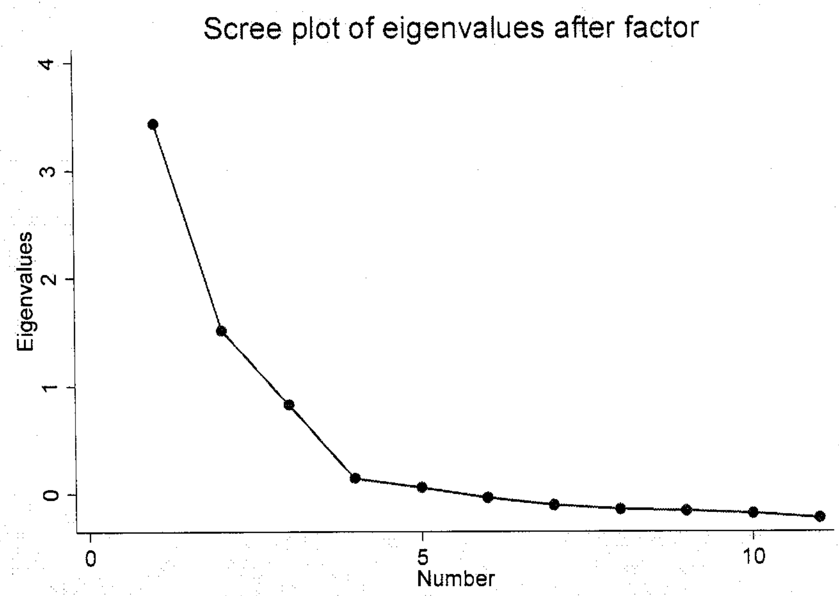

Figure 7-2. Scree plot of individual views eigenvalues

Factor reliability and independence – Factor 1, consisting of six items, had 428 of 460 complete observations (93%), with a Cronbach's alpha coefficient of 0.84 (Table 7-3). Factor 2, comprised of three items, had an alpha score of 0.84 based on 87% of respondents. Factor 3, consisting of two items, had an acceptable alpha score of 0.73 based on 98% of respondents. The overall Cronbach's alpha coefficient for the 11 items in the factor model was 0.80. Correlation was low between the three factors, indicating that each comprised a separate dimension of the major construct.

Factor interpretation – Factor items were reviewed for a common or unifying concept. Factor 1 contained six questions loading above 0.45. Questions included concepts of hindrances to practicing respiratory infection control practices because of patient's needs, job duties, productivity expectations, increased patient severity of illness, lack of information, and interferences between recommended practices and job performance. Four questions were derived from the "conflict of expectations"

Table 7-2. Individual views factor pattern matrix[1]

	Factor Loadings		
	Factor 1	Factor 2	Factor 3
Conflict of expectations (n=428, 93% of 460)			
I can't always follow safe respiratory infection control practices because patients' needs come first (ind3)	**0.60**	-0.07	0.13
Following recommended respiratory infection control practices keeps me from doing my job to the best of my abilities (ind4)	**0.63**	-0.09	0.03
I do not have enough information in order to correctly follow recommended respiratory infection control practices in my work (ind5)	**0.55**	-0.03	0.20
My job duties often interfere with my being able to follow recommended respiratory infection control practices (ind6)	**0.80**	-0.12	0.07
Productivity expectations interfere with my ability to follow recommended respiratory infection control practices (ind7)	**0.77**	-0.14	0.10
Increased patient acuity decreases my ability to follow recommended respiratory infection control practices (ind8)	**0.69**	-0.18	0.20
Sick leave expectations (n=450, 98% of 460)			
I always take sick-leave when I have flu-like symptoms (ind9)	-0.11	**0.75**	0.01
My colleagues expect me to take sick-leave when I have flu-like symptoms (ind10)	-0.12	**0.83**	0.03
My employer encourages me to take sick-leave when I have flu-like symptoms (env26)	-0.13	**0.72**	-0.14
Perception of risk (n=450, 98% of 460)			
I frequently worry about catching a dangerous respiratory infection because of my work (ind11)	0.16	0.02	**0.69**
My risk of becoming infected with a dangerous respiratory infection through my work is high (ind12)	0.13	-0.08	**0.66**

[1] Individual views items, principal axis factoring method, varimax rotation

scale by Gershon and colleagues (Gershon et al., 1995); therefore, Factor 1 was named "conflict of expectations" (Table 7-3). Factor 2 contained three new questions relating to taking sick leave, and it was named "sick leave expectations". Questions comprising Factor 3, modified from Gershon et al., involved fears and risks of catching a dangerous respiratory infection at work (Gershon et al., 1995), and it was named "perception of risk."

Table 7-3. Individual views factor correlations and Cronbach's alpha coefficient

	Factor Correlations			
Factor	Conflict of Expectations	Sick Leave Expectations	Perception of Risk	**Cronbach's alpha coefficient**
Conflict of Expectations	1.00			.84
Sick Leave Expectations	.06	1.00		.84
Perception of Risk	.11	-.04	1.00	.73

Public Health Surveillance Factors – The questionnaire section addressing infectious disease surveillance included 10 newly developed items as described in Chapter 2.

Item analysis – A high frequency of missing values, primarily due to "don't know" responses, was observed for item 3 (37.5%) and item 4 (37.0%). Because the frequency of missing values exceeded 20%, these items were dropped from further analysis. Of the remaining items, missing values ranged from 3.3% to 11.1%. Item means ranged from 2.20 to 3.11, and standard deviations from 0.96 to 1.21.

Factor analysis – All corrected item-total correlation coefficients were within the desired range of 0.20 to 0.80 (Nunnally, 1978). A Pearson correlation matrix was computed to examine correlations between items. The determinant of the matrix was 0.004 indicating that the matrix is factorable. Correlations exceeding 0.70 were examined for redundancy. It was determined that the wording of these items was sufficiently different to retain all items in the factor model. Bartlett's test of sphericity was significant ($p<.0001$), rejecting the null that the matrix is an identity matrix. The Kaiser-Olkin-Meyer measure of sampling adequacy test generated a value of 0.856, which is labeled as " meritorious" based on the Kaiser labeling scheme (Kaiser 1974; Pett, 2003). From this initial matrix examination, it was determined that the matrix is suitable for factor extraction.

Factor extraction – Factors were extracted by the principal axis factoring method. Initial communality estimates indicated that an acceptable amount of variance is attributed to the common factors, rather than each item's unique variance. The scree plot (Figure 7-3) revealed a bend in the curve at eigenvalue three, indicating that the two factor solution is appropriate.

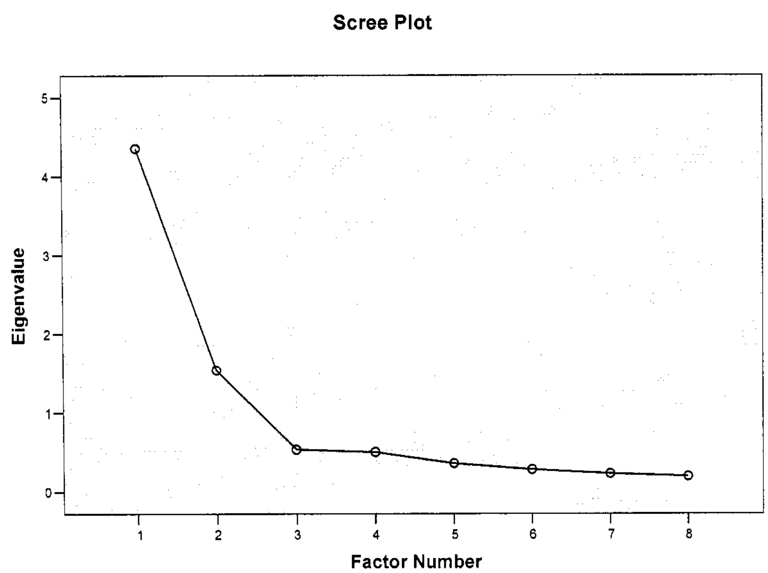

Figure 7-3. Scree plot of public health surveillance eigenvalues

Factor rotation – Two factor rotation methods were used – varimax orthogonal, and direct oblimin oblique. All tests resulted in the same factor loadings. The rotated factor matrix for the principal axis factoring method, varimax orthogonal rotation is presented in Table 7-4.

Factor reliability and independence – Factor 1 consisted of six newly developed items, and Factor 2 of two newly developed items. All items loaded above 0.45. Based on an assessment of internal consistency using Cronbach's alpha coefficients, Factor 1, with 83% of 460 observations, had an alpha score of 0.90, and Factor 2, with 93% observations, an alpha score of 0.86 (Table 7-4). Both alpha coefficient scores are rated as "very good" (DeVellis, 2003). The overall alpha coefficient calculated from all eight items in the model was 0.88. Correlation was low between the two factors (0.28), indicating that each comprised a separate dimension of the public health surveillance construct.

Table 7-4. Public health surveillance factor pattern matrix[1]

	Factor Loadings	
	Factor 1	**Factor 2**
Employer surveillance feedback (n=428, 93% of 460)		
My employer provides me with timely information about healthcare-associated infections in my medical center (surv1)	0.14	<u>0.80</u>
My employer provides me with timely information about infectious diseases in the greater community (surv2)	0.12	<u>0.83</u>
Notifiable condition reporting knowledge (n=377, 82% of 460)		
I am familiar with Washington State's requirements for reporting immediately notifiable conditions (surv5)	<u>0.77</u>	-0.17
I am aware of my practice setting's procedures for reporting a notifiable condition (surv6)	<u>0.66</u>	0.34
I know where to find Washington State's list of notifiable conditions (surv7)	<u>0.84</u>	-0.06
I know where to find the number to call 24/7 to report an immediately notifiable condition (surv8)	<u>0.83</u>	-0.14
I am aware of what diseases I need to immediately report (surv9)	<u>0.80</u>	-0.15
My employer has trained me about notifiable condition reporting (surv10)	<u>0.59</u>	0.35

[1] Principal axis factoring method, varimax rotation with Kaiser normalization

Factor interpretation **–** Factor items were reviewed for a common or unifying concept. Factor 1, consisting of six items, was termed "notifiable condition reporting knowledge." Seventeen percent of respondents answered "don't know" on one or more of the six items. Factor 2, termed "employer surveillance feedback," is comprised of two items addressing an employer's involvement in disseminating infectious disease surveillance information both in-house and from the community to its healthcare staff. Only 7% of respondents reported a "don't know" response to one or both of the items.

Discussion

The factor analyses described for the three constructs in this chapter and for the safety climate construct in chapter 5, yielded factors with good psychometric properties. The extracted factors demonstrated sufficient reliability and validity for use in statistical modeling, as conducted in the present study (chapter 4), to identify possible behavioral characteristics and barriers to the use of CDC recommended respiratory infection control practices.

Factor analysis was used to identify questionnaire items (questions) that could be condensed into single variables (factors), representing underlying dimensions of components (major constructs) of the conceptual model. The factor analyses yielded two factors representing the infection control practices construct, three for the individual views construct, and two for the public health surveillance construct. All items loaded above 0.45 for each factor, which is a common benchmark used to discern the factor structure of the data (Pett, 2003). Discriminant validity was demonstrated by the low correlations observed between the factors (range: -0.04 to 0.28), indicating that the factors represented different dimensions (independent concepts) within each construct (Garson, 2006b). Reliability of each factor was demonstrated to range from a marginally acceptable to very good level of internal consistency for each of the extracted factors (coefficient alpha range: 0.68 to 0.89; DeVellis, 2003).

One goal of factor analysis is to reduce a large number of variables (items) to a number that is easier to manage and also less susceptible to false positive findings caused by conducting multiple tests. Unfortunately, data reduction can come at a cost. For a subject's responses to be included in a factor analysis, all questions that comprise a factor must be answered. Otherwise, the subject is removed from analysis. Data loss occurred in the present study when subjects gave responses of "don't know," "does not apply," blank, or improper responses. To minimize the influence of such data loss, two heathcare worker categories (allied professionals and administrative/reception) were excluded from the factor analysis and from analyses using those factors, due to the higher number of survey questions that did not pertain to their practice. Factor analysis was restricted to the study's 460 direct care providers (physician/practitioners, nurses, and nurse aides) so that each factor retained at least 82% of all subjects. Of the seven factors produced, data loss did not exceed 8% for five factors or 18% for two. The exclusion of workers who were not directly involved in patient care is not a source of bias, as long as the findings of analyses using the derived factors are not generalized to the excluded healthcare occupations. Furthermore, the frequency of missing values for subjects retained in the factor analyses was relatively low and generally not disproportionately distributed across the different healthcare occupations; therefore, this is not likely to be a substantial source of bias. Implications of data loss are further discussed in Chapter 5.

8. Validity and Reliability

Introduction

In research, validity refers to whether a study's measurement tool truly measured what it intended to measure. Reliability of a survey instrument refers to the extent to which instrument scores are free from measurement error (Pett, 2003).

Validity – Two aspects of validity were examined in the present study: content validity and construct validity. Content validity (face validity) examines whether the questions comprising a construct actually measure the intended concept. Construct validity (factorial validity) examines the sensibility and logic of the questions comprising a construct or factor (Garson, 2006b).

Reliability – Three tests of reliability were examined in the present study: internal consistency, test-retest, and situational reliability.

Internal consistency reliability – Internal consistency reliability analysis examines summary variable scales by measuring the homogeneity of different questions that were intended to measure the same concept (Aday, 1996). A scale is internally consistent when its items are correlated. This may be due to 1) the items causally affecting each other, or 2) the items sharing a common cause (DeVellis, 2003). Internal consistency is typically examined via Cronbach's alpha coefficient.

Cronbach's alpha coefficient is used to measure a factor's internal consistency and to summarize the amount of measurement error within a group of items (Leske 1991). One suggested scheme for categorizing alpha ranges for research scales is: less than 0.60, unacceptable; between 0.60 and 0.65, undesirable; between 0.65 and 0.70, minimally acceptable; between 0.70 and 0.80, respectable; between 0.80 and 0.90, very good; much above 0.90, one should consider shortening the scale (DeVellis, 2003). Cronbach's alpha coefficient values below 0.60 indicate that some items in the summary variable scale are not addressing the concept in the same way as do others, or as intended (Aday, 1996). However, factor coefficients above 0.50 are adequate for group comparisons (Leske, 1991).

Test-retest reliability – Test-retest reliability analysis examines the repeatability or temporal stability of measurement on the same subjects responding to the same measurement scale at two points in time (DeVellis, 2003). This test of reliability is based on the assumption that the correlation between two scores has an underlying unobservable true score that is constant and that differences between scores are due to random error (Pedhazur and Schmelkin, 1991). This assumption does not take into consideration biases of the test-retest design. These include real changes in the testing situation, behavior, or attitude of the respondent, or the influence on responses simply because the test is repeated (Aday, 1996; Pett, 2003). Test-retest reliability is also influenced by sample size and the length of time between tests (DeVellis, 2003). Because of potential biases due to the re-sampling design, it becomes difficult to separate an instrument's reliability from its stability (Pedhazur and Schmelkin, 1991). Differences therefore cannot be attributed to measurement error alone, as implied by the test's assumption.

Situational reliability – Situational reliability analysis examines responses when asked from different perspectives within the same questionnaire. In the present study, the strength of the relationship between infection control practice-related questions was explored by asking matched questions from a "general" versus "situation-specific" perspective. The chosen situation was the most recent relevant occasion. Presumably, the effect of recall bias should be lower than reporting usual behavior, because the recalled event is closely proximate in time and the answer does not require integration of multiple events.

Methods

Validity – Methods for examining construct and content validity were as follows:

Construct validity – Factor analysis was conducted to demonstrate statistically how items (questions) in a scale load on one factor. The items comprising a factor were examined for linear dependencies or multicollinearity, which is identified by the presence of excessive intercorrelations (>0.80). Factors were also required to have at least moderate correlations (>0.20) between items (Leske, 1991). Convergence of related scales was evaluated by examining the reproducibility of a safety climate scale published by other investigators (Gershon et al., 2000) when applied to the subjects of the present study. Discriminant validity, as a component of construct validity, was assessed by correlating final factors derived from each major construct of the study's conceptual model (Chapter 1, Figure 1-1) to examine for redundancies of similar concepts of the construct (Garson, 2006b). Tests of construct validity are further described in Chapters 5 and 7.

Content validity – Three techniques were employed to guide the development of the study's survey instrument and maximize content validity: 1) In developing the study questionnaire, questions and scales that had been evaluated in other studies were used whenever feasible, with modifications to meet the purposes of this study; 2) The survey questions and scales were reviewed by experts in the field; and 3) The survey questions and scales were judged during pilot review by a sample (n=15) of healthcare workers and infection control professionals.

Content validity of the dependent variables from the outcome construct "use of recommended infection control practices," was also ensured by basing each questionnaire item on identified CDC recommendations. A matrix that describes sources of questionnaire items related to infection control practices is presented in Appendix B.

Reliability –

Internal consistency reliability – Cronbach's alpha coefficients were calculated for all factors determined by factor analysis as described in Chapters 5 and 7 to determine internal consistency of the questions comprising each factor.

Test-retest reliability – A subgroup of study subjects was recruited for further participation in a study of test-retest reliability. Participants were recruited by including instructions and a contact information sheet (name, mailing address) in the standard survey packets distributed at two medical settings selected by convenience sampling. All 108 eligible healthcare workers at two locations were provided the opportunity to participate in the test-retest study. Interested participants were asked to include a contact information sheet when returning their completed original questionnaire to the researchers in a stamped addressed envelope. Two additional espresso cards were offered as an incentive.

The contact information sheet was returned by 29 (27%) prospective participants. A retest survey packet was mailed back to interested participants approximately 14 days following the date post-marked on the returned survey. The retest mailing included an instructional cover sheet, the retest questionnaire, a stamped return envelope, and the two espresso card incentive.

Of the 29 prospective participants, 25 completed the retest questionnaires (23%, overall). Participants included 3 physician/practitioners, 13 nurses, 7 allied professionals, and 2 "other" providers. The participants worked in primary care setting (n=6), emergency department (n=17), and unspecified settings (n=2). Retest survey packets were mailed to prospective participants from September 24, 2005 to October 20, 2005, and 25 retest packets were received from October 14, 2005 to December 27, 2005. Days between date of receipt of the test questionnaire and the retest questionnaire for 24 surveys ranged from 20 days to 31 days (mean=24, median=23), and for one survey, 91 days.

Two sets of variables were created for each for the15 factors identified in Chapters 5 and 7 to generate variables for test-retest comparison. These included dichotomized factors by methods described in Chapter 2, and means of items comprising each of the 15 factors. Intraclass correlation coefficients, 95% confidence intervals, and p-values were calculated to compare factor item means using SPSS Version 14.0 statistical software, for each factor item pair (Landis and Koch, 1977). A proposed benchmark classification to assist interpreting intraclass correlations is: slight, 0.0 – 0.20; fair, 0.21 – 0.40; moderate, 0.41 – 0.60; substantial, 0.61 – 0.80; and almost perfect, 0.81 – 1.00 (Landis and Koch, 1977).

Following dichotomization, responses to each of the factor pairs were examined for percent concordance to determine the percent change between responses to the same question when asked at least two weeks later. The significance of the associations was also examined by the F-test. Discordant responses were examined for departure from random distribution (i.e., non-equal numbers of yes-no and no-yes pairs), but the sample size and number of discordant pairs was not sufficient to meet assumptions for a statistical test, such as McNemar's test. Statistical analysis was performed using Stata version 9.0.

Situational reliability – The 25 respondents who participated in the test-retest study were also asked to answer an additional eight questions included in the retest survey from the perspective of the following statement: *The last time I worked with a patient with flu-like symptoms who was coughing and sneezing….* Among the 25 respondents in the test-retest study, 22 (88%) completed the situational reliability questions.

The response scale for the general questions ranged from "Almost Always" to "Never," plus a non-response of "Does Not Apply." The response options for the eight recent situation questions were dichotomous ("Yes" and "No"), plus "Don't Remember" and "Does Not Apply." The responses to questions were dichotomized for comparison purposes: "Almost Always" or "Often" were coded as a positive; and "Sometimes," "Rarely," or "Never," were coded as a negative response. For the situational questions, a response of "Yes" was coded as a positive response, and "No" as a negative response. All other responses were coded as missing values.

Percent concordance between responses asked from a general versus recent situation perspective was determined. Cramer's V coefficients were also calculated to provide an additional measure of the relative strength of association between the paired responses. Cramer's V, which is a chi-square-based measure of dichotomous associations, can difficult to interpret, with 1 indicating a strong association (Garson, 2006d).

Results

Validity – Construct validity of the factors was established by determination of the factor loading matrix. All factor items loaded above 0.45 (Table 8-1). Correlations between factors within each construct were relatively low, thereby meeting the test of discriminant validity that factors are not representing the same concept.

Reliability –

Internal consistency reliability – Internal consistency of factor items was demonstrated by the adequate to very good Cronbach's alpha coefficients for all factor scales (Table 8-1).

Test-retest reliability – Intraclass correlation coefficients were determined for the 15 factors identified from the study's four constructs of infection control practices, safety climate, individual views and public health awareness, based on comparison of factor item score means and dichotomized factors (Table 8-2). Coefficients were significant ($p<.001$ to .06). Using the benchmark classifications of Landis and Koch (1977), coefficients ranged from "moderate" to "almost perfect" for those calculated by comparing means of factor items as well as those comparing the dichotomized factors. Percent concordance between test and retest responses ranged from 71% to 95%, indicating association between responses.

Situational reliability – Percent concordance of responses to questions addressed from a general versus recent situation perspective was high, ranging from 81% to 100% (Table 8-3). Of the five question pairs that did not include a constant response,

Table 8-1. Summary of construct psychometric properties (validity and reliability)

Construct and factors	# Items[1]	Factor loadings[2]	Factor correlations[3]	Cronbach's alpha[4]
Infection control construct	18		.25	.80
Hand hygiene	5	.46 - .70		.76
Respiratory precautions	6	.46 - .66		.68
Excluded items	7			
Safety climate construct	25		.19 - .48	.91
Personal protective equipment	2	.51 - .81		.62
Management support	4	.62 - .70		.88
Absence of job hindrances	2	.59 - .66		.66
Feedback	2	.48 - .66		.76
Training	3	.46 - .69		.80
Cleanliness/orderliness	3	.46 - .91		.84
Minimal conflict/good communication	3	.75 - .84		.88
Patient instructions	3	.63 - .87		.84
Excluded items	3			
Individual views construct	14		.04 - .11	.75
Conflict of expectations	6	.55 - .77		.84
Sick leave expectations	3	.72 - .83		.84
Perception of risk	2	.66 - .69		.73
Excluded items	3			
Public health awareness construct	10		.28	.89
Notifiable condition reporting	6	.59 - .84		.86
Employer surveillance feedback	2	.80 - .83		.90
Excluded items	2			

[1] Number of questions in constructs and factors
[2] Measure of construct validity
[3] Measure of discriminant validity (presented as a range of correlations for construct factors
[4] Estimate of internal consistency reliability
[5] Estimate of test-retest reliability

Cramer's V coefficients ranged from 0.45 to 0.89 (p<.001 to .05), indicating significant association between paired responses. The number of discordant pairs was small; however, there was no evidence of bias toward yes or no responses on the general questions, compared to the situational (last time) questions.

Table 8-2. Test-retest reliability intraclass coefficients and percent concordance

	Intraclass correlation (mean)[1,2]	**p-value[3]**	**Rating[4]**	**Percent concordance**
Infection control dimensions				
Hand hygiene	.83	<.001	Almost perfect	78%
Respiratory precautions	.71	.002	Substantial	90%
Safety climate dimensions				
Personal protective equipment availability	.81	<.001	Almost perfect	82%
Management support	.85	<.001	Almost perfect	82%
Absence of job hindrances	.76	<.001	Substantial	79%
Feedback	.64	.008	Substantial	76%
Training	.83	<.001	Almost perfect	76%
Cleanliness/orderliness	.80	<.001	Substantial	79%
Minimal conflict/good communication	.88	<.001	Almost perfect	75%
Patient instructions	.52	.04	Moderate	83%
Individual views dimensions				
Conflict of expectations	.49	.06	Moderate	95%
Sick leave expectations	.61	.01	Substantial	84%
Perception of risk	.85	<.001	Almost perfect	83%
Surveillance knowledge dimensions				
Employer surveillance involvement	.85	<.001	Almost perfect	71%
Personal surveillance knowledge	.84	<.001	Almost perfect	88%

[1] Intraclass correlation coefficient, average measures, two-way mixed, consistency, split-half model
[2] Comparison based on mean item scores of each factor
[3] F-test with true value 0
[4] Benchmark classifications based on Landis and Koch, 1977

Table 8-3. Association between questions asked from a "general" versus "recent situation" perspective[1]

Question	n	Cramer's V (n=23)	p-value[1]	Percent concordance
Practice hand hygiene before working with a patient	18	.45	.05	83%
Practice hand hygiene after working with a patient[2]	20	---	---	95%
Wear disposable gloves	21	.61	.005	81%
Remove disposable gloves[2]	15	---	---	100%
Practice hand hygiene after removing disposable gloves	14	.83	.002	93%
Change gloves before going to another patient[2]	16	---	---	100%
Wear eye protection	18	.89	<.001	94%
Wear a face mask	16	.67	.008	88%

[1] p-value based on chi-square test
[2] No statistics could be computed because icp measure was a constant for one or both questions

Discussion

The tests of validity and reliability used in this study provide assurance that the survey items and the factors derived to represent the study's four constructs are meaningful and robust, and have good psychometric properties. Previously tested scales were used when available, and modified to address respiratory infection control practices. Examination of the draft instrument by experts in the field, both during one-on-one review as well as comments during pilot-testing of the survey provided professional input into question content and wording. The factor analyses demonstrated adequate or better internal consistency for all factors derived for the study, with little correlation between factors representing the same construct. The test-retest reliability study provided added assurance about the stability of the survey instrument. Further assurance was provided based on similarity of responses to questions presented from a general versus a recent situation perspective based on a high percent concordance of responses, Cramer's V coefficients indicating strength of associations, and chi square values indicating significance of the associations. The overall evaluation of test-retest and situational reliability was limited by small sample size. Additional findings and discussion about validity and reliability of the study constructs are presented in Chapters 4, 5, 6 and 7.

9. Conclusions

This study found that many of the CDC guidelines for healthcare workers confronting patients with undiagnosed respiratory infections are not used routinely in primary and emergency care first-encounter settings. There were shortcomings in healthcare workers' knowledge or awareness of first-encounter practices at their institution, and frequent deficiencies in their reported individual use of recommended practices. Lapses were observed in use of recommended practices across all healthcare worker occupations, although nurses tended to be more observant of recommended practices than workers in other occupations. Historically understudied healthcare workers, particularly reception and administration and technical staff who routinely interact with patients in first-contact settings, frequently received no training on infection control procedures and were often not familiar with practices that are potentially applicable to their work situation. Those in emergency department settings were also more likely to report using CDC guidelines than those in primary care clinics. Building on a conceptual model developed for studies of precautions for bloodborne pathogens in hospital settings, this study found that the use of respiratory precautions is related to a number of variables representing individual views, organizational safety climate, and public health surveillance. Some of these findings warrant further investigation or confirmation in other settings, but some also represent potential opportunities for interventions to improve use of respiratory precautions.

Essential CDC respiratory infection control recommendations were addressed. The CDC recommendation for clinics to display visual alerts instructing patients to inform healthcare staff of their respiratory symptoms upon arrival, and providing basic respiratory infection control instructions is relatively new. While most physicians and nursing staff reported that visual alerts were adequate in their practice setting, fewer administrative staff working in front-desk reception areas agreed, indicating a need for improved visual alerts at clinic entrances.

The patient's role in preventing the spread of infection to others can be strengthened by personal instruction from their healthcare providers. In the present study, nurses were much more likely to instruct patients personally about how to prevent the spread of respiratory infections than physicians or other workers who have patient contact in technical or reception roles. Responses from all occupations were lower when asked about information that was actively conveyed by the worker, rather than passively conveyed by the institution. This may indicate a perception by healthcare staff that, because patient instruction is done by others in their practice setting, personal involvement is less important.

The CDC recommends that patients with respiratory symptoms be encouraged to sit three feet from others in waiting areas to prevent spread of respiratory agents to others, particularly during periods of increased respiratory illness in the community. This was rarely done, and almost half did not know if spatial separation was practiced in their setting. However, while evidence suggests that spatial separation can reduce the spread of droplet-transmissible infections, implementation in a crowded waiting room can be challenging and may be unrealistic without sufficient planning and physical resources.

Only about half of direct care providers reported placing coughing patients with influenza-like illness (ILI) in a private examination room when available. Patient separation was reported more commonly in emergency rooms than primary care settings, which may reflect differences in physical capacity relative to patient volume and turnover. Separating ILI patients into private examination rooms or cubicles is good practice from an infection control perspective, but will undoubtedly be difficult or impossible because of space limitations during flu seasons.

The CDC recommends offering a surgical or procedure mask to coughing patients to contain the spread of infected droplets, particularly during periods of high respiratory illness in the community. In the present study, most respondents reported offering masks to coughing patients, although nurses and administrative staff were more likely to do so than physicians, nurse aides, or technical staff, and 7% of all respondents reported not knowing if masks were offered at all.

Use of recommended hand hygiene practices was mixed. Most workers reported practicing hand hygiene before and after direct contact with a patient. However, fewer did so immediately after touching items near a patient with ILI symptoms, or after having direct contact with patients' skin while checking a pulse or blood pressure. This may be partly due to a perception that touching intact healthy-appearing skin does not warrant hand hygiene, even though there is a strong theoretical rationale for this recommendation. The use of some but not all recommended practices was also evident in the use of personal protective equipment. Almost all workers who were directly involved in patient care reported removing disposable gloves after use, and changing gloves before going to another patient. Only about three quarters of nurses and allied professionals reported using gloves when caring for patients with ILI – however, physicians were much less likely to do this. Furthermore, few healthcare workers in any occupation reported wearing eye protection or a disposable mask when examining an ILI patient who is sneezing or coughing. These basic practices were judged necessary to control SARS but clearly they are not routinely implemented outside of unusual circumstances.

Overall, training in respiratory infection control and personal protection practices reported by respondents during the previous year was low. One quarter of physicians, 15% of nurses, nurse aides and allied professionals, and 40% of administrative staff reported no training, and 40% overall reported having less than one hour of training during the previous year. Furthermore, about one quarter of all respondents said their practice setting did not have clear written procedures on infection control actions to take when confronted by an undiagnosed patient presenting with respiratory infection symptoms, and 20% of physicians did not know. This study identifies gaps in clinicians' knowledge about their role in reporting notifiable conditions both under Washington State's reporting standards and within the healthcare setting where they work. The influence of training upon clinicians' notifiable condition reporting knowledge was pronounced. Those who did not receive training were less likely to understand their responsibilities under Washington State's notifiable condition reporting standards. Those who received feedback from their employer about surveillance data collected within their institution as well as from the community were also more likely to understand the notifiable condition reporting system in general, as well as that of their institution.

Personal and workplace characteristics associated with HCW use of respiratory infection control measures were identified through statistical modeling. Training showed a particularly strong association with respiratory infection control practices. Reported use differed by occupation, with nurse aides more likely to follow practices compared to physicians. Those in emergency departments were also more likely to follow practices than those in primary care clinics. Safe practices were associated with cleanliness and orderliness of the workplace, supervisory status, and those with infants, small children or elderly adults at home, although this association was limited to nurses, and was not seen among physicians regardless of gender. Nurses who reported understanding their responsibilities under Washington State's notifiable condition reporting rules were also more likely to report use of the recommended infection control measures. However this association was not observed among physicians. These personal and worksite characteristics should be considered by infection control staff to guide and prioritize intervention strategies.

Respiratory infection control practices recommended by the CDC are designed to prevent infection among healthcare workers and their patients, provided that they are used. However, in spite of theoretical grounds for recommended practices, it may not be realistic to expect them to be fully implemented at all times, because of practical constraints such as limited available resources and space, job and productivity demands, and human nature. Physical constraints may be compounded by the expanded influx of patients during outbreaks, forcing need to consider alternative and otherwise less desirable strategies such as cohorting patients with similar illness. For this reason, feedback from public health surveillance and provider alerts can play a potentially critical role to ensure maximal use of recommended practices in outbreak circumstances, and can serve as a cue to action for healthcare workers to be even more careful than usual.

Changing safe practice behaviors among HCWs who are slow to adopt well-accepted practices poses a serious challenge to any clinic or healthcare organization. Because interventions that only target modifying behavior of individuals may be unsuccessful or short-lived, it has been suggested that interventions must also include an examination of the organizational culture of an institution as well (Larson, et al., 2000). Therefore, future research should examine the influence of organizational climate on infection control practices measured at baseline and post-intervention, with clinical setting as the unit of analysis and specific training programs and methods as a component of safety climate. Training should probably address individual views, including personal risk. Consideration should be given to conducting additional research to examine the organizational safety climate tool evaluated in this study to determine its stability across different and larger healthcare populations, settings, and safety applications over time. Investigators should also consider building on the experience of the Safety Attitudes Questionnaire (Sexton et al., 2006). This organizational climate measurement tool includes a large pool of benchmarking data collected from hospitals to gauge performance in relation to other settings, although the primary use of this instrument to date has been to study patient safety.

In conclusion, this study identified shortcomings in the knowledge and use of most respiratory infection control measures by HCWs, including how the recommendations are practiced within their clinical setting. Additional training should be considered to increase HCWs' awareness of this relatively new CDC approach to respiratory infection control in first-contact healthcare settings, as well as clinician's notifiable condition reporting responsibilities within their practice setting. However, interventions should address shortcomings in organizational climate and practices, and not just individual behavior. The findings of this study could be used to target future changes or corrective interventions in national and institutional policies, worker training strategies, and institutional facilitation of recommended practices by healthcare workers.

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Appendix A. Survey Instrument

University of Washington
School of Public Health
and Community Medicine

Survey of Respiratory Infection Control Practices among Healthcare Workers in Primary, Urgent and Emergency Care Settings

To begin we want to ask some questions about your healthcare setting and occupation. Please place an "X" in only one circle for each question.

A. Are you currently working at least one day per week in a primary, urgent, or emergency care setting?

O Yes　　O No

B. Of these settings, please identify the medical setting where you work the most often (mark only one):

- O Primary care setting
- O Urgent care setting
- O Emergency care setting
- O None of the above. I work in ______________________

Please complete this questionnaire from the viewpoint of the primary, urgent, or emergency care setting where you work the most often.

C. Do you have routine interaction with patients either during reception or patient care?

O Yes　　O No　　[*If "No" to this question, please do not proceed with this questionnaire*]

D. Please identify the response that best describes your present occupation (mark only one):

- O Physician
- O Physician Assistant
- O Nurse Practitioner
- O Registered Nurse
- O Licensed Practical Nurse
- O Nursing Aide
- O Phlebotomy Technician
- O Radiology Technician
- O Respiratory Therapist
- O Medical Assistant
- O Medical Technician
- O Receptionist
- O Other (please specify): ______________

DEMOGRAPHIC INFORMATION

We will start by asking about your demographic information. Please place an "X" in only one circle for each question.

1. Identify the medical center or hospital where you work the most often (mark only one):

- O Enumclaw Community Hospital
- O Harborview Medical Center
- O Northwest Hospital & Medical Center
- O Overlake Hospital Medical Center
- O Swedish Medical Center
- O University of Washington Medical Center
- O Virginia Mason Medical Center
- O Other (please specify): ____________________

2. What is your gender?

O Male O Female

3. How old are you? ________ Years

4. Do you have infants, young children or adults over 65 years old living with you at home?

O Yes O No

5. What is your educational background?

- O Some high school / high school grad / GED
- O Associate's degree (2 yrs)
- O College graduate (4 yrs)
- O Post graduate work (masters / doctoral / MD)

6. How long have you worked for your current healthcare institution?

- O Less than 6 months
- O 6 to 12 months
- O 1 to 2 years
- O 3 to 5 years
- O 6 to 10 years
- O More than 10 years

7. How many hours do you normally work per week, including overtime?

- O Less than 20 hours per week
- O 20-40 hours per week
- O 41-50 hours per week
- O 51-60 hours per week
- O More than 60 hours per week

8. How long have you worked in your present occupation?

- O Less than 1 year
- O 1 to 2 years
- O 3 to 5 years
- O 6 to 10 years
- O 11 to 20 years
- O More than 20 years

9. How long have you been working in healthcare?

- O Less than 1 year
- O 1 to 2 years
- O 3 to 5 years
- O 6 to 10 years
- O 11 to 20 years
- O More than 20 years

10. Are you a supervisor with front-line responsibility for a group of workers?

O Yes O No

11. Do you receive an annual influenza vaccination whenever it is available?

- O Always or almost always
- O More than half the time
- O About half the time
- O Less than half the time
- O Never or almost never

12. How would you describe your race?

- O Asian
- O Black or African American
- O Native American or Other Pacific Islander
- O White
- O Other (Please write your answer) __________
- O I would rather not answer this question

INFECTION CONTROL PRACTICES

The next 18 questions concern infection control practices on a typical work day in your practice setting. Please place an "X" in only one circle for each question.

1. I practice hand hygiene (i.e., hand washing with soap and water or use of antiseptic hand rubs) before having direct contact with a patient

O	O	O	O	O	O
Almost Always	Often	Sometimes	Rarely	Never	Does Not Apply

2. I practice hand hygiene after taking a pulse or blood pressure

O	O	O	O	O	O
Almost Always	Often	Sometimes	Rarely	Never	Does Not Apply

3. I practice hand hygiene after working with a patient who is coughing

O	O	O	O	O	O
Almost Always	Often	Sometimes	Rarely	Never	Does Not Apply

4. I practice hand hygiene after touching items in the immediate vicinity of a patient

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

5. I wear disposable gloves when I'm working with a coughing patient with flu-like symptoms

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

6. I remove my disposable gloves promptly after use

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

7. I practice hand hygiene immediately after removing my disposable gloves

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

8. I change my gloves before going to another patient

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

9. Disposable face masks are offered to coughing patients when they present for care in my practice setting

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

10. Patients or visitors who have flu-like symptoms with cough are requested to sit at least 3 feet from others

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

11. I instruct patients who I observe coughing or sneezing to cover their mouths and noses, use tissues, and wash their hands

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

12. I wear eye protection when caring for patients who are coughing or sneezing

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

13. I wear a mask when I'm examining a coughing patient with flu-like symptoms

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

14. Patients with flu-like symptoms are placed in a private examination room or cubicle as soon as possible

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

15. A surgical mask is placed on patients who may have the measles or chickenpox as soon as the diagnosis is suspected

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

16. Patients who may have measles or chickenpox are placed in an airborne infection isolation room if available as soon as the diagnosis is suspected

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

17. I wear a fit-tested or power air-purifying (PAPR) respirator when entering the room of a patient with suspected infectious pulmonary tuberculosis

O Almost Always O Often O Sometimes O Rarely O Never O Does Not Apply

18. Patients with respiratory infections are instructed about how to prevent spread to their family and other close contacts

O Almost Always O Often O Sometimes O Rarely O Never O Don't Know

WORKING ENVIRONMENT

The next 27 questions address your working environment. Please place an "X" in only one circle for each question.

1. Disposable face masks are readily available in my work area

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

2. Disposable gloves are readily available in my work area

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

3. Eye protection is readily available in my work area

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

4. The protection of workers from occupational exposures to respiratory infections is a high priority with management where I work

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

5. On my unit, all reasonable steps are taken to minimize hazardous job tasks and procedures

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

6. Employees are encouraged to become involved in employee safety and health matters

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

7. Managers on my unit do their part to insure employee protection from occupational respiratory infections

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

8. My job duties often interfere with my being able to follow Standard Precautions (*Standard Precautions are a group of infection prevention practices that apply to all patients regardless of diagnosis or presumed infection status*)

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

9. I have enough time in my work to always follow Standard Precautions

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

10. I usually have too much to do to always follow Standard Precautions

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

11. On my unit, unsafe work practices are corrected by supervisors

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

12. My supervisor often discusses safe work practices with me

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Does Not Apply

13. I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

14. Employees are taught to be aware of and to recognize potential health hazards at work

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

15. On my unit, I know how to access information about clinic safety

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

16. My work area is kept clean

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

17. My work area is not cluttered

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

18. My work area is not crowded

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

19. There is minimal conflict within my department

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

20. The members of my unit support one another

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

21. On my unit, there is open communication between supervisors and staff

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

22. In my job, there are clear written procedures on infection control actions to take based on signs and symptoms of infection, before the diagnosis is made

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

23. Signs are adequately posted at the entrance of my practice setting (i.e., unit or clinic) instructing arriving patients and those with them to tell staff if they have respiratory infection symptoms

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

24. My practice setting (i.e., unit or clinic) adequately posts signs that instruct coughing patients in waiting areas to cover their nose/mouth, use tissue, and wash their hands

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

25. My practice setting (i.e., unit or clinic) has clear procedures on what to do when patients arrive with symptoms of respiratory infection

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

26. My employer encourages me to take sick-leave when I have flu-like symptoms

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

27. In the past 12 months, about how many hours of training did you receive specifically on respiratory infection control and personal protection practices?

- O 0 hours
- O Less than 1 hour
- O 1-2 hours
- O 3-5 hours
- O 6 or more hours

INDIVIDUAL VIEWS

These next 13 questions focus on your individual views. Please place an "X" in only one circle for each question.

1. I can reduce my risk of getting sick by using recommended personal protective measures and respiratory infection control practices when working with a coughing patient with flu-like symptoms

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

2. I can reduce my risk of catching the flu by receiving an annual influenza vaccination

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

3. I can't always follow safe respiratory infection control practices because patients' needs come first

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

4. Following recommended respiratory infection control practices keeps me from doing my job to the best of my abilities

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

5. I do not have enough information in order to correctly follow recommended respiratory infection control practices in my work

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

6. My job duties often interfere with my being able to follow recommended respiratory infection control practices

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

7. Productivity expectations interfere with my ability to follow recommended respiratory infection control practices

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

8. Increased patient acuity decreases my ability to follow recommended respiratory infection control practices

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

9. I always take sick-leave when I have flu-like symptoms

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

10. My colleagues expect me to take sick-leave when I have flu-like symptoms

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

11. I frequently worry about catching a dangerous respiratory infection because of my work

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

12. My risk of becoming infected with a dangerous respiratory infection through my work is high

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

13. There is no medical risk for me to receive an annual influenza vaccination

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

INFECTIOUS DISEASE SURVEILLANCE

The last 11 questions address infectious disease surveillance and notifiable condition reporting. Notifiable conditions are those diseases of public health importance that must be brought to the attention of the local or state health officer.

1. My employer provides me with timely information about healthcare-associated infections in my medical center

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

2. My employer provides me with timely information about infectious diseases in the greater community

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

3. My employer has a system for collecting information about respiratory infectious diseases in employees at my workplace

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

4. My employer has dependable procedures in place to notify my facility's infection control staff 24 hours per day, 7 days per week about possible infectious diseases

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

5. I am familiar with Washington State's requirements for reporting immediately notifiable conditions

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

6. I am aware of my practice setting's procedures for reporting a notifiable condition

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

7. I know where to find Washington State's list of notifiable conditions

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

8. I know where to find the number to call 24/7 to report an immediately notifiable condition

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

9. I am aware of what diseases I need to immediately report

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

10. My employer has trained me about notifiable condition reporting

O Strongly Agree O Agree O Neutral O Disagree O Strongly Disagree O Don't Know

11. In the past 12 months, about how many hours of training did you receive specifically on notifiable condition reporting?

- O 0 hours
- O Less than 1 hour
- O 1-2 hours
- O More than 2 hours

Thank-you for completing this questionnaire. Please return it to the research team in the enclosed stamped addressed envelope.

University of Washington
School of Public Health
and Community Medicine

Appendix B. Questionnaire Item Labels and Sources

DEMOGRPHIC INFORMATION VARIABLES

Item#	Question	Source/Comment
intro1	Are you currently working at least one day per week in a primary, urgent, or emergency care setting	*Eligibility question, developed by the investigators
intro2	Of these settings, please identify the medical setting where you work the most often	*Developed by the investigators to identify respondent's "first contact" setting
intro3	Do you have routine interaction with patients either during reception or patient care	*Eligibility question, developed by the investigators
intro4	Please identify the response that best describes your present occupation	1. Gershon et al., 2000 (Modified)
dem1	Identify the medical center or hospital where you work	*Developed by the investigators to identify respondent's medical center
dem2	What is your gender	1. Gershon et al., 2000
dem3	How old are you	1. Gershon et al., 2000
dem4	Do you have infants, young children or adults over 65 years old living with you at home	*Developed by the investigators to address risks associated with infecting household contacts
dem5	What is your educational background	1. Gershon et al., 2000
dem6	How long have you worked for your current healthcare institution?	1. Gershon et al., 2000
dem7	How many hours do you normally work per week, including overtime	1. Gershon et al., 2000
dem8	How long have you worked in your present occupation	2. Gershon et al., 1995
dem9	How long have you been working in healthcare	1. Gershon et al., 2000, modified to address time in healthcare
dem10	Are you a supervisor with front-line responsibility for a group of workers	1. Gershon et al., 2000
dem11	Do you receive an annual influenza vaccination whenever it is available	*Developed by the investigators to address influenza vaccination
dem12	How would you describe your race	**General

INFECTION CONTROL PRACTICES CONSTRUCT

Item#	Question	Source/Comment
icp1	I practice hand hygiene before having direct contact with a patient	2. CDC Hand Hygiene in HC Settings, Part II 1C
icp2	I practice hand hygiene after taking a pulse or blood pressure	2. CDC Hand Hygiene in HC Settings, Part II 1F
icp3	I practice hand hygiene after working with a patient who is coughing	6.CDC, DRAFT Isolation Precautions, IIIA1 (New Standard Precautions:Resp Hyg/Cough (p56)
icp4	I practice hand hygiene after touching items in the immediate vicinity of a patient	2. CDC Hand Hygiene in HC Settings, Part II 1I
icp5	I wear disposable gloves when I'm working with a coughing patient with flu-like symptoms	6.CDC, DRAFT Isolation Precautions, III (Standard Precautions) B2bi(Gloves)(p 67) 8.CDC, Interim Guidance for Use of Masks to Control Influenza Transmission
icp6	I remove my disposable gloves promptly after use	3. CDC, II (Standard Precautions), B (Gloves)
icp7	I practice hand hygiene immediately after removing my disposable gloves	2. CDC Hand Hygiene in HC Settings, Part II 1J
icp8	I change my gloves before going to another patient	3. CDC, II (Standard Precautions), B (Gloves)
icp9	Disposable face masks are offered to coughing patients when they present for care in my practice setting	3. CDC, II (Droplet Precautions), B (Mask) 4. CDC, Supp I, B (Masking and separation) 8.CDC, Interim Guidance for Use of Masks to Control Influenza Transmission
icp10	Patients or visitors who have flu-like symptoms with cough are requested to sit at least 3 feet from others	3. CDC, II (Droplet Precautions), A (Patient Placement) 4. CDC, Supp I, B (Masking and separation) 5. CDC, Influenza Resp Hyg/Cough, 3 (Masking) 8.CDC, Interim Guidance for Use of Masks to Control Influenza Transmission
icp11	I instruct patients who I observe coughing or sneezing to cover their mouths and noses, use tissues, and wash their hands	4. CDC, III (IC in HC Facilities), B (Respiratory hygiene/cough etiquette) 5. CDC, Influenza Resp Hyg/Cough, 3 (Masking)
icp12	I wear eye protection when caring for patients who are coughing or sneezing	6. CDC, DRAFT Isolation Precautions, Part IV, Section IVD, All Precautions, p.76

INFECTION CONTROL PRACTICES CONSTRUCT (Cont.)

Item#	Question	Source/Comment
icp13	I wear a mask when I'm examining a coughing patient with flu-like symptoms	3. CDC, II (Standard Precautions), C (Mask, Eye Protection, Face Shield) 3. CDC, II (Droplet Precautions), B (Mask) 4. CDC, Supp I, B (Droplet Precautions) 8.CDC, Interim Guidance for Use of Masks to Control Influenza Transmission
icp14	Patients with flu-like symptoms are placed in a private examination room or cubicle as soon as possible	3. CDC, II (Droplet Precautions), A (Patient Placement)
icp15	A surgical mask is placed on patients who may have the measles or chickenpox as soon as the diagnosis is suspected	6. CDC, DRAFT Isolation Precautions, Part IV, Section IVD, All Precautions, p.77
icp16	Patients who may have measles or chickenpox are placed in an airborne infection isolation room if available as soon as the diagnosis is suspected	3. CDC, II (Airborne Precautions), B (Patient Placement)
icp17	I wear a fit-tested or power air-purifying (PAPR) respirator when entering the room of a patient with suspected infectious pulmonary tuberculosis	3. CDC, II (Airborne Precautions), B (Respiratory Protection)
icp18	Patients with respiratory infections are instructed about how to prevent spread to their family and other close contacts	5. CDC, Influenza Resp Hyg/Cough (General) 9. WAC 246-101-105(7)

SAFETY CLIMATE CONSTRUCT

Item#	Question	Source/Comment
env1	Disposable face masks are readily available in my work area	1. Gershon et al., 2000 (Modified)
env2	Disposable gloves are readily available in my work area	1. Gershon et al.
env3	Eye protection is readily available in my work area	1. Gershon et al., 2000 (Modified)
env4	The protection of workers from occupational exposures to respiratory infections is a high priority with management where I work	1. Gershon et al., 2000
env5	On my unit, all reasonable steps are taken to minimize hazardous job tasks and procedures	1. Gershon et al., 2000
env6	Employees are encouraged to become involved in employee safety and health matters	1. Gershon et al., 2000
env7	Managers on my unit do their part to insure employee protection from occupational respiratory infections	1. Gershon et al., 2000
env8	My job duties often interfere with my being able to follow Standard Precautions	1. Gershon et al., 2000
env9	I have enough time in my work to always follow Standard Precautions	1. Gershon et al., 2000
env10	I usually have too much to do to always follow Standard Precautions	1. Gershon et al., 2000
env11	On my unit, unsafe work practices are corrected by supervisors	1. Gershon et al., 2000
env12	My supervisor often discusses safe work practices with me	1. Gershon et al., 2000
env13	I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures	1. Gershon et al., 2000 (Modified)
env14	Employees are taught to be aware of and to recognize potential health hazards at work	1. Gershon et al., 2000
env15	On my unit, I know how to access information about clinic safety	1. Gershon et al., 2000 (Modified)
env16	My work area is kept clean	1. Gershon et al., 2000
env17	My work area is not cluttered	1. Gershon et al., 2000
env18	My work area is not crowded	1. Gershon et al., 2000
env19	There is minimal conflict within my department	1. Gershon et al., 2000
env20	The members of my unit support one another	1. Gershon et al., 2000

SAFETY CLIMATE CONSTRUCT (Cont.)

Item#	Question	Source/Comment
env21	On my unit, there is open communication between supervisors and staff	1. Gershon et al., 2000
env22	In my job, there are clear written procedures on infection control actions to take based on signs and symptoms of infection, before the diagnosis is made	*Developed by the investigators to address "first contact" infection control practices
env23	Signs are adequately posted at the entrance of my practice setting (i.e., unit or clinic) instructing arriving patients and those with them to tell staff if they have respiratory infection symptoms	*Developed by the investigators to address "first contact" infection control practices
env24	My practice setting (i.e., unit or clinic) adequately posts signs that instruct coughing patients in waiting areas to cover their nose/mouth, use tissue, and wash their hands	*Developed by the investigators to address "first contact" infection control practices
env25	My practice setting (i.e., unit or clinic) has clear procedures on what to do when patients arrive with symptoms of respiratory infection	*Developed by the investigators to address "first contact" infection control practices
env27 [(a)]	*In the past 12 months, about how many hours of training did you receive specifically on respiratory infection control and personal protection practices?*	*1. Gershon et al., 2000 (Modified)*

[(a)] Item "env27" was not included in the factor analysis of the safety climate construct.

INDIVIDUAL VIEWS CONSTRUCT

Item#	Question	Source/Comment
ind1	I can reduce my risk of catching the flu by receiving an annual influenza vaccination	*Developed by the investigators to address respiratory infection prevention practices
ind2	I can reduce my risk of getting sick by using recommended personal protective measures and respiratory infection control practices when working with a coughing patient with flu-like symptoms	2. Gershon et al., 1995 (modified)
ind3	I can't always follow safe respiratory infection control practices because patients' needs come first	2. Gershon et al., 1995 (modified)
ind4	Following recommended respiratory infection control practices keeps me from doing my job to the best of my abilities	2. Gershon et al., 1995 (modified)
ind5	I do not have enough information in order to correctly follow recommended respiratory infection control practices in my work	2. Gershon et al., 1995 (modified)
ind6	My job duties often interfere with my being able to follow recommended respiratory infection control practices	2. Gershon et al., 1995 (modified)
ind7	Productivity expectations interfere with my ability to follow recommended respiratory infection control practices	2. Gershon et al., 1995 (modified by the investigators to address productivity expectations)
ind8	Increased patient acuity decreases my ability to follow recommended respiratory infection control practices	2. Gershon et al., 1995 (modified by the investigators to address effects of patient acuity)
ind9	I always take sick-leave when I have flu-like symptoms	*Developed by the investigators to address respiratory infection prevention practices
ind10	My colleagues expect me to take sick-leave when I have flu-like symptoms	*Developed by the investigators to address respiratory infection prevention practices
ind11	I frequently worry about catching a dangerous respiratory infection because of my work	2. Gershon et al., 1995 (modified)
ind12	My risk of becoming infected with a dangerous respiratory infection through my work is high	2. Gershon et al., 1995 (modified)
ind13	There is no medical risk for me to receive an annual influenza vaccination	*Developed by the investigators to address respiratory infection prevention practices
env26 [(b)]	My employer encourages me to take sick-leave when I have flu-like symptoms	*Developed by the investigators to address respiratory infection prevention practices

[(b)] Item "env26," from the "Working Environment" section of the survey instrument (Appendix A), was included in the factor analysis of the individual views construct.

PUBLIC HEALTH SURVEILLANCE CONSTRUCT

Item#	Question	Source/Comment
surv1	My employer provides me with timely information about healthcare-associated infections in my medical center	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv2	My employer provides me with timely information about infectious diseases in the greater community	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv3	My employer has a system for collecting information about respiratory infectious diseases in employees at my workplace	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv4	My employer has dependable procedures in place to notify my facility's infection control staff 24 hours per day, 7 days per week about possible infectious diseases	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv5	I am familiar with Washington State's requirements for reporting immediately notifiable conditions	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv6	I am aware of my practice setting's procedures for reporting a notifiable condition	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv7	I know where to find Washington State's list of notifiable conditions	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv8	I know where to find the number to call 24/7 to report an immediately notifiable condition	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv9	I am aware of what diseases I need to immediately report	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv10	My employer has trained me about notifiable condition reporting	*Developed by the investigators to address communicable disease reporting awareness/perceptions
surv11[c]	*In the past 12 months, about how many hours of training did you receive specifically on notifiable condition reporting?*	*1. Gershon et al., 2000 (Modified)*

[a] Item "surv11" was not included in the factor analysis of the surveillance knowledge construct.

Key:

*Questions developed by the investigators, specific to the present study (see Chapter 2, Methods)

[1] Gershon R, Karkashian C, Grosch J, Murphy L, Escamilla-Cejudo A, Flanagan P, Bernacki E, Kasting C, Martin L. 2000. Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *Am J Infection Control*, 28:211-21.

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[3] Centers for Disease Control and Prevention. 2002b. Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APOC/IDSA Hand Hygiene Task Force. MMWR, 51(RR16):1-44.

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[5] Centers for Disease Control and Prevention. January 8, 2004b. Severe Acute Respiratory Syndrome, Supplement I: Infection Control in Healthcare, Home, and Community Settings.

[6] Centers for Disease Control and Prevention. November 4, 2004c. Respiratory Hygiene / Cough Etiquette in Healthcare Settings – Fact Sheet.

[7] Centers for Disease Control and Prevention. 2004. Draft CDC Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Closed for public comment on August 13, 2004.

[8] Centers for Disease Control and Prevention. August 8, 2005a. Interim guidance for the use of masks to control influenza transmission: Guidelines and recommendations.

[9] WAC 246-101-1-5(7) of the Washington Administrative Code [Duties of the Healthcare Provider]