SPECIAL ARTICLE

Protecting healthcare workers in an acute care environment during epidemics: lessons learned from the SARS outbreak

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Abstract

During the 2002-2003 the SARS outbreak resulted in 8,450 illnesses and 812 deaths. Out of these documented cases 1706 were among healthcare workers (HCWs)The purpose of this paper is to focus on and examine the details of infection control (IC) measures and which of these measures appear to be the most effective in stopping disease spread. Historically, HCWs have had poor compliance with the use of IC measures prior to the SARS outbreak. A number of lessons were learned from the SARS epidemic that should be incorporated into healthcare institutions policies and procedures. They include the following: an emphasis on the correct and immediate use of IC measures; an increased focus on HCWs recognizing early perceived threats; healthcare institutions should mandate routine in-house education with periodic updates on IC measures; administrators need to acknowledge and encourage role models among staff; engineering controls should be put in place to protect staff from pathogens; and finally, there should be clear and constant communication between administration and staff.

Keywords: SARS lessons, infectious disease control, acute care and infectious disease control, acute care and SARS.

Introduction

In 2002-2003, a novel coronavirus caused a Severe Acute Respiratory Syndrome (SARS) epidemic that began in China and spread to over 29 countries, resulting in 8,450 illnesses and 812 deaths (WHO, 2003). Twenty-one percent of the cases of SARS were among nurses and other healthcare workers (HCWs) including physicians, respiratory therapists, and other ancillary staff (A. Ho, Sung, & Chan-Yeung, 2003). Studies identifying reasons for such a high rate of infection included: 1) lack of education regarding the use of infection control (IC) measures, 2) an absence of basic infection control infrastructure, 3) the unavailability of personal protective equipment (PPE), 4) confusing and frequently changing infection control policies during the epidemic and 5) attitudes and behaviors of individual HCWs toward IC measures. As a result the HCWs were unsure of what was the most effective method for controlling SARS transmission (Chan, et al., 2005; A. Ho, et al., 2003; P.-L.

Ho, Tang, & Seto, 2003; Moore, Gamage, Bryce, Copes, & Yassi, 2005a; Murphy, 2006).

Although formal infection control programs were introduced in the United States and other industrialized countries over three decades ago, in countries with poor resources fundamental infection control policies are often absent. As a result infection control standards vary from country to country causing haphazard and ineffective disease control (DeJoy, Searcy, Murphy, & Gershon, 2000; Murphy, 2006). Due to the severity and international consequences of SARS, the World Health Organization (WHO) became the main organization in disseminating information on infection control measures and surveillance during the SARS outbreak (Lee, 2009; Murphy, 2006). The WHO worked with the public health agencies of individual countries as the disease outbreak proved to be fluid and dynamic with controversy on several measures especially the use of quarantine and when to employ IC measures. This epidemic highlighted the need for acute care institutions to be prepared for new and emerging infectious diseases (Murphy, 2006; WHO, 2003).

Purpose and Rationale

The purpose of this paper is to review and examine a small sample of healthcare institutions in some of the countries affected by the SARS outbreak. This paper will focus on the details of infection control methods and which measures appeared to be the most effective in stopping the spread of disease. Finally, this paper reviews what lessons were learned and how they could be applied to the next epidemic or pandemic to protect patients, nursing staff and other HCWs.

A review of the literature was conducted utilizing the following databases Medline, PUBMED, Cumulated Index of Nursing and Allied Health Literature (CINAHL), and EBSCO. Key words were SARS, infection control measures, personal protective equipment, knowledge, attitudes and practice of IC measures, nurses, HCWs. Criteria included articles written in English, focusing on HCWS use of infection control measures, and the dates were from 1995-2010.

Background

HCWs and infection control policies

Infection control measures are defined as policies and procedures designed to minimize spread of infection in and out of healthcare facilities. It includes such methods as barrier precautions, hand hygiene, immunization programs, environmental engineering and management of health and safety programs (Bolyard, et al., 1998; Siegel, Rhinehart, Jackson, Chiarello, & Committee, 2007).

Although, all HCWs are at occupational risk for acquiring airborne infectious disease, nurses have the most risk due to their prolonged close contact with patients while rendering care (Maunder, et al., 2004; Tzeng, 2005). Nurses have always assumed a high occupational risk of encountering biological, chemical, physical, ergonomic, or psychosocial hazards. Therefore, it is important that policies and procedures are in place to protect them.

Infection control polices should include the use of barrier precautions and hand hygiene. Barrier precautions include the use of personal protective equipment (PPE). PPE includes all clothing and other work accessories or devices that an individual may wear for protection against a biological or man-made hazard. PPE may range from a simple set of earplugs to a complete self-contained breathing apparatus (SCBA), an item of body gear with oxygen provision for first responders (Deshmukh, 2006). In health care most PPE consists of masks (either N 95 or surgical masks), gloves, gowns, hair covers, shoe covers, and/or goggles (Preston, Forti, & Kassab, 2002; Siegel, et al., 2007). Hand hygiene is considered the single most effective means of reducing the transmission of infectious agents. Most, if not all healthcare institutions, have policies regarding consistent hand washing before and after rendering patient care.

Environmental engineering controls include negative pressure isolation rooms, general ventilation, and filtration to reduce the transmission of contaminants. Isolation rooms should have negative pressure, through which air is exhausted from that room to the outside

environment versus contaminated air staying in the room or entering the air circulation of the institution and spreading to other patients' rooms or wards. Filtration utilizes high efficiency particulate absorbing (HEPA) filters, which are highly effective in removing small contaminated particulates. Building temporary facilities next to a healthcare institution is a relatively inexpensive way to control contaminates without investing in too many resources. A structure as simple as a tent can suffice as a place to assess, treat and triage infectious patients without exposure to the main institution (Thorne, Khozin, & McDiarmid, 2004).

The safety climate of the institution is a variable that exerts a powerful influence on the HCWs perception of how safe their work environment is. This is important because health institutions with strong safety climates consistently report fewer workplace injuries. Studies have shown that healthcare institutions that place a strong emphasis of adherence to safe work practices such as complying with infection control policies have more employees that are likely to comply because of the influence peers have on one another. An example of this is the HCWs ability to follow isolation precautions when caring for infectious patients. HCWs, especially those in positions of influence and power who fail to follow IC measures, can influence younger and less mature HCWs not to follow these measures (Gershon, et al., 2000).

Studies have documented that historically HCWs have poor compliance rates with the use of IC measures prior to the SARS outbreak (Gershon, et al., 1995). One study revealed that HCWs working in an emergency room had inadequate knowledge of pathogen infection risk, under reported exposures, and underused personal protection equipment during trauma cases. These authors concluded that "experienced trauma care HCWs were cavalier regarding blood borne disease exposure risks" (Madan, Rentz, Wahle, & Flint, 2001). Another study examined nurses' intention or acceptance of hand washing as a protective behavior. Nurses' beliefs and values directly affected how compliant they were toward hand washing policies. The more value placed on the protective effect the more likely the nurse would utilize hand washing appropriately (Whitby, et al., 2007).

Several studies examined institutional factors that affect the HCWs use of IC policies. Dejoy et al. (2000) conducted a study to examine the individual, organizational and environmental factors of non-compliance in utilization of PPE by nurses. This study concluded that three antecedents 1) individuals' beliefs, attitudes and values, 2) environmental controls and 3) reinforcing factors that reward or punish behavior were needed to increase the nurses' utilization of PPE.

The physical and psychological impact of SARS on HCWs

At the peak of the SARS epidemic an unprecedented number of HCWs caring for SARS patients became ill and several died from the disease. In addition, infected HCWs infected other patients and co-workers within the institution in which they were working. Out of the 8,450 documented SARS infections worldwide, 1706 occurred among HCWs (Chan, et al., 2005; Chia, et al., 2005; Moore, et al., 2005a; Shaw, 2006; Yassi, et al., 2005). Vietnam (57%) had the highest proportion of HCWs infected, followed by Canada (51%) (P.-L. Ho, et al., 2003; Koh, et al., 2005; Moore, Gamage, Bryce, Copes, & Yassi, 2005b). Singapore reported that among the 32 dead from SARS 5 were HCWs (Tan, Goh, & Lee, 2006). Hong Kong and Hanoi reported that 46% and 63% of their SARS cases respectively had been acquired by HCWs' exposure to SARS patients (Twu, et al., 2003). A hospital in Taiwan, reported that 16 HCWs (5 doctors, 9 nurses and 2 respiratory therapists) were among the infected and subsequently a total of 6 of these individuals died during treatment (Chong, et al., 2004).

Three studies focused on the psychological impact of nurses and other hospital workers caring for SARS patients in Toronto. One study noted that, ***"Nurses form the single largest occupational group in most hospitals and are directly and intensively involved in patient care."*** The authors' concluded that

nurses and other healthcare workers who had contact with SARS patients experienced a more intense acute traumatic stress response than those who had cared for no SARS cases (Maunder, et al., 2003; Maunder, et al., 2004). One variable that decreased the stress load included the use and availability of PPE and other IC measures. Stress levels were reduced when PPE was available and nurses were educated and encouraged to use them along with other IC measures such as hand washing.

However, Maunder (2003) noted, ***"staff were observed to be not fully complying with infection control procedures."*** It was not determined whether this was due to inadequate communication (because of frequently changing guidelines), technical difficulty, or because of psychological responses such as ***"denying risk or simple rebelliousness."*** (p. 1247).

One study surveyed the psychological effects of SARS on hospital staff and reported that, ***"Wearing a mask was the precaution most frequently cited as most bothersome and the most commonly cited difficulty with the mask was physical discomfort"*** (Nickell, et al., 2004).

Infection Control by HCWs during SARS

Professionalism and beliefs in the effectiveness of infection control guidelines were identified as important influences on an HCW's willingness to utilize PPE during the SARS outbreak. Yassi et al. (2005) examined the HCWs' use of PPE during the SARS epidemic in Toronto, Canada. One study examined variables in family physicians' utilization of PPE during the SARS outbreak in Singapore. Although the participants reported feeling helpless while caring for SARS patients, a few reported skepticism regarding the effectiveness of utilizing PPE. Another study examined the variables of appropriate use of PPE among HCWs in healthcare settings in Singapore and concluded that there was significant lack of knowledge of correct use of PPE and other IC measures by physicians and nurses (Chia, et al., 2005).

Hand washing is considered a critical component of IC measures. One study focused on the hand washing practices of medical students before and after the SARS epidemic in Hong Kong. Prior to the SARS outbreak, a survey of medical students revealed that only 35.2% washed their hands prior to contact with patients and 72.5% after contact with a patient. After the SARS epidemic another survey was conducted in 2004. It was noted that 60.3% of medical students washed their hands prior to contact with patients and 100% washed their hands after contact. Despite the SARS epidemic only 51% were aware of the WHO's infection control guidelines regarding hand washing practice. Role modeling appeared to increase compliance with hand washing guidelines as students who washed their hands before examining patients had observed their peers practice proper hand washing techniques (Wong & Tam, 2005).

Confusing infection-control measures relating to the correct use of PPE led to an increase of SARS cases in HCWs. For example in one hospital in Hong Kong, at the end of March 2003, had identified areas that were classified according to risk for exposure to patients with SARS. High risk areas such as intensive care units and wards dedicated to SARS patients were supplied with masks, gloves, gowns, caps, goggles and shoe covers and employees were instructed to discard after a single use. Medical and pediatric wards were given the same materials but were told to use the same equipment for an entire shift. In hospital areas identified as low-risk, HCWs were just given one mask for an entire 8-hour shift. Unfortunately several SARS cases presented atypically and were misdiagnosed and these patients were placed in low risk areas. These patients not only spread contagion to the HCWs caring for them but the infected HCWs became vectors and amplifiers for the disease (A. Ho, et al., 2003).

In a study of nurses who cared for SARS cases in Hong Kong the following quote poignantly points out how difficult is was to adequately care for patients during the SARS outbreak (Chung, Wong, Suen, & Chung, 2005).

"Because the disease was so new, information continued to change . . . modification and updating of the infection control procedures and recommendations day-by-day, and even hour, by, hour, increased the frustration and uncertainty. The perception of personal danger was exacerbated by this uncertainty…" (p. 514).

Another nurse reported her frustration in working with colleagues who were not using IC measures appropriately. **"…It was hard to work with those colleagues who were not prepared to be assigned to SARS wards by denying risk or by simply being rebellious. These efforts were complicated by their incomplete knowledge about the actual risk . . .They believed whatever they heard from the media, other colleagues and friends. I was frustrated when staff was observed to be not fully complying with infection control procedures…"** (p. 513).

These quotes illustrate the multiple variables that decreased the HCWs ability and willingness to correctly implement IC measures. Lack of communication, lack of resources and confusing and rapidly changing policies all led to staff not trusting that IC measures were effective in controlling SARS. One medical student who failed to use a mask while taking a patient history became infected with SARS and subsequently died (Lau & Chan, 2005; Wong & Tam, 2005).

In contrast to the examples of poor compliance or poor institutional support, Tseng et al. (2005) conducted a survey at one hospital in Taiwan that managed to stay open and provided all services during the SARS outbreak. Even though some of the nurses did contract SARS, none died. The authors investigated variables that encouraged this hospital to stay open and continue to provide most if not all services during the SARS epidemic. One of the main themes identified was the hospital's ability to maintain its supply of protective equipment such as masks, gloves, protective gowns, goggles, shoes and hats. These were obtained by the hospital during the early stages of the epidemic and all staff were trained and encouraged to wear them correctly. **"...Speedy supply of protective materials, environmental protection, preventive protocols, and route control were implemented procedures that helped the success ratio. The implementation was strictly supervised and duly recorded. All in all, the actions, including planning, preparation, implementation, supervision, verification, recording, and improvement, had to be carried out rigorously and carefully…"** (p. 62).

In addition, nurses were on key committees making key decisions on infection control measures. Education on correct use of PPE was done on a daily basis. Effective communication between management and staff was instituted.

"…In this study, fast and frank communication was characteristic of the selected hospital. "…The chief executive instructed all house staff that every major decision must be discussed with the nursing department in advance for hospital-wide stability" (p. 62).

During the SARS crisis nurse administrators met twice daily to discuss the evolving situation. All resolutions were communicated by e-mail to all staff, including those working in quarantined wards whose staff members had to stay at the hospital throughout the epidemic. Educating nurses daily increased the use of IC measures throughout the hospital (Tseng, Chen, & Chou, 2005). This hospital exemplifies a hospital with a strong safety climate. It is probably due to this hospitals commitment to the safety of its staff and patients that the outcomes and the potential devastation of SARS were markedly reduced.

Discussion

A number of lessons about being prepared for any biodiasaster were learned from the SARS epidemic. The first is that correct and immediate use of IC measures, with clear communication to all of the HCWs giving direct care, is associated with a dramatic decline in nosocomial-acquired cases. The HCWs who wore PPE (masks, goggles, gloves, and gowns) and practiced good hand hygiene were less likely to develop SARS than those

who did not. Hospitals in Beijing, Hong Kong, Taiwan, Singapore and Toronto all reported a dramatic decrease in SARS cases once staff were supplied and correctly used all IC measures (Chan, et al., 2005; Chia, et al., 2005; P.-L. Ho, et al., 2003; Shaw, 2006; Twu, et al., 2003; Varia, et al., 2003; Yassi, et al., 2005). Confidence that HCWs had in the ability of IC measures to protect them against the coronovirus occurred only after successful termination of the disease was attributed toward consistent and correct use (Tan, et al., 2006).

Second, there needs to be an increased focus on ensuring that all of the HCWs, including nurses, recognize a perceived risk or threat and are able to implement IC measures in a correct and timely way (Kim, et al., 1999; Madan, et al., 2001). For example, medical students who had an increased emphasis on the use of IC measures were more likely to use these in their practice (Wong & Tam, 2005). It would be reasonable to expect that this would be the same for nursing education; emphasis on the use of IC measures and why these measures should be utilized should be continued throughout the course of their study.

Third, hospitals and other health care institutions should have routine mandatory in-house education on the correct and appropriate use of IC measures, with periodic updates simulating an infectious disease outbreak or bioevent. These policies and procedures need to be part of a facility's policy. The more comfortable the HCWs including nurses are in training for epidemics, pandemics, or biodisasters, the more confidence they have in their skills to mange these events (Crane, 2005; Maunder, et al., 2003; Thorne, et al., 2004).

Fourth, institutions need to acknowledge and encourage role models especially among senior medical and nursing staff. Nurses need to be empowered to initiate the use of IC measures, including when and where to utilize PPE, based on their knowledge and education. Use of PPE should not be based on the hospital administrators' attempts to economize. If changes need to be made, nurses should be part of the decision making process. Nurses should also be key members of any hospital's safety committee (Moore, et al., 2005a; Tzeng, 2004).

Fifth, healthcare institutions need to ideally have in place engineering controls such as the use of isolation, negative pressure rooms, general ventilation, local ventilation, high efficiency particulate aerosol (HEPA) filtration, anterooms with neutral or negative pressure ability. In areas where cost is a factor something simple such as a tent adjacent to treatment facilities can successfully decrease the spread of disease (Thorne, et al., 2004).

Finally, during a bioevent, clear and constant communication between administration and direct care staff is critical. Updating information as it becomes available reduces stress and increases effectiveness of the HCWs ability to give care during stressful situation such as the SARS epidemic (Moore, et al., 2005a; Tseng, et al., 2005). Today we have such technology as computers, smartphones, PDAs and other technology making communication rapidly available as a situation evolves. This is not only desirable but in many instances necessary. Having reliable and instant communication from public health departments and other reliable sources such as the WHO allows for better decision-making and for rapid response as a critical situation evolves.

Conclusion

This paper validates the importance that healthcare institutions be prepared for any eventuality such as emerging/remerging infectious diseases or other biodisasters. It has been shown that institutions that were prepared had better outcomes than those that were not. These findings highlight the need for updating all staff regarding correct utilization of IC measures, including the correct use of PPE and handwashing. I the past, the consequences of the HCWs not utilizing IC measures were devastating to them and the patients they cared for. Unfortunately, even after the SARS epidemic, the willingness to use IC measures correctly by nurses remains low (Shaw, 2006). In light of current and future epidemics and pandemics this is cause for grave concern.

Future research needs to examine the nurses' and nursing students' attitudes, beliefs, barriers and acceptance towards IC measures. In addition hospital administrators' education and attitudes towards IC measures should also be examined since the institutions emphasis on the importance of IC measures directly impacts the HCWs compliance with those measures.

Both inpatient an outpatient health care facilities must be prepared in advance in order to manage large scale infectious disease outbreaks including those caused by emerging or reemerging pathogens such as SARS, Tuberculosis, Norovirus and influenza epidemics and pandemics (Thorne, et al., 2004). In addition schools of nursing have a duty to teach nursing students how to utilize IC measures and explain the necessity for using them.

Nursing curriculum should advance the idea of empowering nurses in decision-making especially toward self-protective behavior.

All institutions should keep foremost that the safety of their staff is critical in ensuring nurses' ability to give safe and effective bedside care under trying conditions. We cannot afford to lose our nurses to deadly pathogens. All of the above interventions can reduce the danger of working with deadly pathogens. Education, practice, communication, decision-making and available resources increases the nurses' ability to correctly utilize IC measures under difficult situations.

References

Bolyard, E., Tablan, O., Williams, W., Pearson, M., Shapiro, C., Deitchman, S., et al. (1998). Guideline for infection control in health care personnel, 1998. *American Journal of Infection Control, 26*, 289-354.

Chan, S., Leung, G., Tiwari, A., Salili, F., Leung, s., Wong, D., et al. (2005). The Impact of work-related risk on nurses during the SARS outbreak in Hong Kong. *Community Health, 28*(3), 274-287.

Chia, S., Koh, D., Fones, C., Qian, F., Ng, V., Tan, B., et al. (2005). Appropriate use of personal protective equipment among healthcare workers in public sector hospitals and primary healthcare polyclinics during the SARS outbreak in Singapore. *Occupationa Environmental Medicine, 62*, 473-477.

Chong, M.-Y., Wang, W.-C., Hsieh, W.-C., Lee, C.-Y., Chiu, N.-M., Yeh, W.-C., et al. (2004). Psychological impact of severe acute respiratory syndrome on health workers in a tertiary hospital. *British Journal of Psychiatry, 185*, 127-133.

Chung, B., Wong, T., Suen, E., & Chung, J. (2005). SARS: caring for patients in Hong Kong. *Journal of Clinical Nursing, 14*, 510-517.

Crane, J. (2005). Assessment of the community healthcare providers' ability and willingness to respond to a bioterrorist attack in Florida. 1-141

DeJoy, D., Searcy, C., Murphy, L., & Gershon, R. (2000). Behavioral-diagnostic analysis of compliance with universal precautions among nurses. *Journal of Occupational Health Psychology, 5*(1), 127-141.

Deshmukh, A. (2006). Product evaluation and process improvement guidelines for the personal protective equipment manufacturers based on human factors, NIOSH guidelines and system safety principles (pp. 1-160). Blacksburg: Virginia Polytechnic Institute and State University.

Gershon, R., Karkashian, C., Grosch, J., Murphy, L. R., Escamilla-Cejudo, A., Flanagan, P., et al. (2000). Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *American Journal of Infection Control, 28*, 211-221.

Gershon, R., Viahov, D., Felknor, S., Vesley, D., Johnson, P., Delclos, G., et al. (1995). Compliance with universal precautions among health care workers at three regional hospitals. *American Journal of Infection Control, 23*, 225-236.

Ho, A., Sung, J., & Chan-Yeung, M. (2003). An outbreak of severe acute respiratory syndrome among hospital workers in a community hospital in Hong Kong. *Annals of Internal Medicine, 139*, 564-567.

Ho, P.-L., Tang, X.-P., & Seto, W.-H. (2003). SARS: hospital infection control and admission strategies. *Respirology, 8*, S41-S45.

Kim, L., Evanoff, B., Parks, R., Jeffe, D., Mutha, S., Haase, C., et al. (1999). Compliance with universal precautions among emergency department personnel: Implications for prevention programs. *American Journal of Infection Control, 27*, 453-455.

Koh, D., Lim, M., Chia, S., Ko, S., Qian, F., Ng, V., et al. (2005). Risk perception and impact of severe acute respiratory syndrome (SARS) on work and personal lives of healthcare workers in Singapore. What can we learn? *Medical Care, 43*(7), 676-682.

Lau, P. Y., & Chan, C. W. (2005). SARS (severe acute respiratory syndrome): reflective practice of a nurse manager. *J Clin Nurs, 14*(1), 28-34.

Lee, K. (2009). *The World Health Organization*. London and New York: Routledge Taylor and Francis Group.

Madan, A., Rentz, D., Wahle, M., & Flint, L. (2001). Noncompliance of health care workers with universal pecautions during trauma resuscitations. *Southern Medical Jouranl, 94*(3), 277-280.

Maunder, R., Hunter, J., Vincent, L., Bennett, J., Peladeau, N., Leszcz, M., et al. (2003). The immediate psychological and occupational impact of the 2003 SARS outbreak in a teaching hospital. *Canadian Medical Association Journal, 168*(10), 1245-1251.

Maunder, R., Lancee, W., Rourke, S., Hunter, J., Goldbloom, D., Balderson, K., et al. (2004). Factors Associated with the psychological impact of severe

acute respiratory syndrome in nurses and other hospital workers in Toronto. *Psychosomatic Medicine, 66*(938-942).

Moore, D., Gamage, B., Bryce, E., Copes, R., & Yassi, A. (2005a). Protecting health care workers from SARS and other respiratory pathogens: Organizational and individual factors that affect adherence to infection control guidelines. *American Journal of Infection Control, 33*, 88-96.

Moore, D., Gamage, B., Bryce, E., Copes, R., & Yassi, A. (2005b). Protecting health care workers from SARS and other respiratory pathogens: organizational and individual factors that affect adherence to infection control guidelines. *Am J Infect Control, 33*(2), 88-96.

Murphy, C. (2006). The 2003 SARS outbreak: global challenges and innovative infection control measures. *Online J Issues Nurs, 11*(1), 6.

Nickell, L., Crighton, E., Tracy, C., Al-Enazy, H., Bolaji, Y., Hanjrah, S., et al. (2004). Psychosocial effects of SARS on hospital staff: survey of a large tertiary care institution. [Researc]. *Canadian Medical Association Journal, 170*(5), 793-798.

Preston, D., Forti, E., & Kassab, C. (2002). Profiles of Rural Nurses' Use of Personal Protective Equipment: A Cluster Analysis. *Journal of Association of Nurses in Aids Care, 13*(6), 34-45.

Shaw, K. (2006). The 2003 SARS outbreak and its impact on infection control practices. *Public Health, 120*, 8-14.

Siegel, J., Rhinehart, E., Jackson, M., Chiarello, L., & Committee, t. H. I. C. P. A. (2007). Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings 2007. from http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf

Tan, N. C., Goh, L. G., & Lee, S. S. (2006). Family physicians' experiences, behavior, and use of personal protection equipment during the SARS outbreak in Singapore: do they fit the Becker health belief model. *Asia Pacific Journal Public Helath, 18*(3), 49-56.

Thorne, C., Khozin, S., & McDiarmid, M. (2004). Using the hierarchy of control technologies to improve healthcare facility infection control: lessons from severe acute respiratory syndrome. [Fast Track Article]. *Journal of Occupational and and Environmental Medicine, 46*(7), 613-622.

Tseng, H.-C., Chen, T.-F., & Chou, S.-M. (2005). SARS: Key factors in crisis management. [Qualitative Research]. *Journal of Nursing Research, 13*(1), 58-65.

Twu, S.-J., Chen, T.-J., Chen, C.-J., Olsen, S., Lee, L.-T., Fisk, T., et al. (2003). Control measures for severe acute respiratory syndrome (SARS) in Taiwan. *Emerging Infectious Diseases, 9*(6), 718-720.

Tzeng, H.-M. (2004). Nurses' professional care obligation and their attitudes towards SARS infection control measures in Taiwan during and after the 2003 epidemic. *Nursing Ethics, 11*(3), 277-289.

Tzeng, H.-M. (2005). Promoting a safer practice environment as related to cccupational tuberculosis a nursing care quality issue in Taiwan. [Descriptive]. *Journal of Nursing Care Quality, 20*(4), 356-363.

Varia, M., Wilson, S., Sarwal, S., McGeer, A., Gournis, E., Galanis, E., et al. (2003). Investigation of a nosocomial outbreak of severe acute respiratory syndrome (SARS) in Toronto, Canada. [Research]. *Canadian Medical Association Journal, 169*(4), 285-292.

Whitby, M., Pessoa-Silva, C. L., McLaws, M. L., Allegranzi, B., Sax, H., Larson, E., et al. (2007). Behavioural considerations for hand hygiene practices: the basic building blocks. *J Hosp Infect, 65*(1), 1-8.

WHO. (2003). Severe Acute Respiratory Syndrome. Manila: World Health Organization.

Wong, T.-W., & Tam, W. (2005). Handwashing practice and the use of personal protective equipment among medical students after the SARS epidemic in Hong Kong. *American Journal of Infection Control, 33*, 580-586.

Yassi, A., Moore, D., FitzGerald, J., Bigelow, P., Hon, C.-Y., & Bryce, E. (2005). Research gaps in protecting healthcare workers from SARS and other respiratory pathogens: an interdisciplinary, multistakeholder, evidence-based approach. *Journal of Occupational and and Environmental Medicine, 47*, 41-50.