THE UNIVERSITY OF CALGARY

Needlestick Injuries:

Blame The System, Not The Health Care Worker

by

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Abstract

This purpose of this study was to determine what factors within a health care organization relate to the occurrence of needlestick injuries (NSIs) among Health care workers (HCW). To do this a systems approach was taken. The overall hypothesis was that factors external to the HCWs were related to the occurrence of NSIs and, therefore, the focus of NSI prevention should be taken off the individual. A mail-out questionnaire was completed by 209 Alberta nurses. From the data generated, a structural equation model was tested which examined factors at many levels of a health care organization as well as those associated with HCWs which may be predictive of the occurrence of NSIs. There was support for the hypothesis that organizational factors, not individual ones, account for the most variance in unsafe behaviors and NSIs. Discussion centers on the specific factors found to be most related to NSIs and possible human factors interventions.

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Dedication

I dedicate this thesis to my parents, Guy and Sally James, in recognition of their never-ending support, love, and faith in me.

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Overview

Individuals who work in the health care industry such as doctors, nurses, lab technicians and paramedics, are constantly exposed to situations, materials, and clients that may be contaminated with infectious diseases. Thus, for health care workers (HCWs), the possibility of becoming infected at work is a potent and dangerous reality. Occupationally acquired disease is also a risk to the many others who work alongside HCWs such as housekeeping, laundry and dietary staff. While there are a number of different threats in the environment in which HCWs and the support staff work, one of the most common mechanisms by which infectious diseases are transmitted is through needlestick injuries (NSIs) (Stringer, 1993). A needlestick injury occurs when a person's skin is unintentionally broken by a sharp object (known as 'sharps') that is contaminated with blood or other body fluids. NSIs can result from many different 'sharps' including, but not limited to, needles, scalpel blades, guide wires, lancets, and broken glass which have become contaminated[1]. These types of injuries are serious for the HCW if the needle puncture occurs after the needle was used on a patient infected with a transmittable blood borne disease.

More than 800,000 NSIs are estimated to occur among HCWs annually in the United States (Berry & Greene, 1992; Millam, 1990; Owens-Schwab &

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[1] For the remainder of the paper, the term 'needle' will be used to refer to all 'sharps'.

Fraser, 1993). There is no organization which keeps NSI statistics for Canadian HCWs but the Canadian rates are expected to be similar in magnitude once the relative size of the populations is taken into account. Despite the use of ergonomically designed equipment (equipment that is designed specifically to increase safety and decrease the number of NSIs) and policies outlining safe handling procedures for contaminated needles, the number of reported needlestick injuries and occupationally acquired diseases via NSIs appears to be escalating (Rowe & Giuffre, 1991). As well, the morbidity and mortality from these injuries is significant (Kopfer & McGovern, 1993) due to the severity of the diseases which they can transmit.

There has been a surge of interest in needlestick injuries within the past 10 to 15 years due to the increased incidence of Acquired Immunodeficiency Syndrome (AIDS) and the corresponding fear HCWs have of acquiring the disease occupationally. AIDS, however, is not the only serious blood borne pathogen that can be transmitted via needlestick injuries and, actually, has a relatively low transmission rate. Blood transmitted to a HCW from an infected patient as a result of an accidental puncture wound has been attributed as the cause for serious infections such as viral hepatitis, herpetic whitlow, streptococcal sepsis, staphylococcal sepsis, tuberculosis, Varicella-Zoster, Rocky Mountain spotted fever, malaria, and the human T-cell lymphotropic virus type III (HTLV-III) (Kramer, Sasse, Simms, & Leedom, 1993; McCormick & Maki,

1981; Weiss, Saxinger, Rechtman, Grieco, Nadler, Holman, Ginzberg, Groopman, Goedert, Markham, Gallo, Blattner, & Landesman, 1985). In total, there are 57 known infectious blood borne diseases, 22 of which have been documented to be transmittable via needlestick injuries. Documented transmission of additional blood borne diseases is likely to occur as the epidemiological case work is performed. In addition, a number of diseases that are normally transmitted through direct contact or airborne particles have been found to be transmittable via needlesticks (e.g., tuberculosis and herpes) (Berry & Greene, 1992; Burman, 1995; Dekker & Robson, 1992). Transmission of a disease can occur after a single needlestick incident (Stryker, Coates, DeCarlo, Haynes-Sanstad, Shriver, & Makadon, 1995) and the risk of becoming infected after an NSI depends on the type of disease. Chances are greatest of developing Hepatitis B with 25% to 43% of exposures to the disease via a needlestick injury ersulting in transmission (Baxter, 1990; Berry & Greene, 1992; McCormick & Maki, 1981; Weiss, et al., 1985). In light of the severity of transmittable diseases, the relatively high incidence of transmission, and the lasting implications for the individuals involved it is clear that an attempt must be made to discover the underlying causes of NSIs so that an attempt can be made to reduce them.

Devices and Procedures Associated with NSIs

There are a variety of ways in which NSIs can occur. It is important to note that the common causes of NSIs are not uniform and vary across types of facilities and even across departments within facilities (Dekker & Robson, 1992). There are, however, a number of key factors associated with the risk of sustaining an NSI independent of the type of facility or department. These are: the type of procedure, the amount of patient blood loss, the duration of the procedure, the use of needles and other sharp objects, the HCWs exposure rate to needles, type of needle, use of gloves, the body fluid involved, the severity of exposure, host susceptibility, and lack of compliance with universal precautions (a set of safety regulations to be followed in situations involving blood or body fluids; see Appendix A) (Berry & Greene, 1992; Gershon, Karkashian, & Felknor, 1994; Hibbard, 1995). Therefore, when attempting to reduce the incidence of needlestick injuries, the types and frequencies of procedures carried out as well as the devices used must be taken into account. More in depth analyses have been conducted on the relative frequencies of NSIs associated with different medical devices and procedures. This research is summarized in the following section.

Devices

A review of the literature reveals that certain types of equipment have higher rates of NSIs associated with them due to their design, frequency of use,

and the procedures associated with them. For example, scalpel blades have relatively high NSI rates associated with them for a number of reasons: most have no protective covering, they must be reused after initial contamination has occurred, and procedures require passing the contaminated scalpel between the doctor and other individuals while the doctor's attention may be directed toward the patient and not the person to whom the scalpel is being passed or received from. The types of needles cited as having the three highest incidences of NSIs associated with them are also cited as the most common types of needles associated with transmitting HIV (Jagger, Cohen, & Blackwell, 1994). Therefore, the needles that HCWs poke themselves with most often are the ones that pose the highest risk of transmission of HIV. Further, when exposure rates are controlled for, the incidence of injury has been found to be five times higher for equipment that requires disassembling than equipment that does not (Jagger, Hunt, Brand-Elagar, & Pearson, 1988). For example, a disposable injection needle may be thrown out as a whole unit with the syringe whereas a suture needle must be disassembled from the needle driver before disposal. Unfortunately, while necessary, the removal and sterilization process is an opportunity for an NSI to occur.

Three studies were found that indicated the incidence of NSIs associated with different medical devices. A summary of them is provided in Table 1. All three of the studies in Table 1 report NSIs to all HCWs in hospitals. Jagger, et

al. (1988) base their results on a 10 month period in a single hospital with both safety and conventional equipment. Gershon, Karkashian and Felknor, (1994) report the NSIs for two hospitals over a six month period also including both safety and conventional equipment. Jagger, Cohen, and Blackwell (1994) present results of a six month period for nine hospitals. Only conventional devices were included in their sample. Overall, the trend indicates that the highest incidence of injuries results from the use of disposable needles and syringes which are used for injections, intravenous tubing and needle assemblies, followed by pre-filled cartridge syringes used for administering medications, and phlebotomy needles which are used for drawing blood.

Table 1
Percentage Of Needlestick Injuries Occurring By Medical Device

Needle type	Gershon, Karkashian & Felknor (1994) (N=229)	Jagger, Cohen, & Blackwell (1994) (N=1016)	Jagger, et al. (1988) (N=326)	Average
Disposable needles and syringes	44.9	38.4	35.0	37.5
I.V. needles, tubing and assemblies	1.3	9.8	33.0	13.4
Prefilled cartridges	3.9	3.4	12.0	4.8
Phlebotomy needles	7.8	4.6	5.0	5.5
Catheter stylets	2.6	3.7	2.0	2.6
Scalpel	7.8	6.2	--	6.9
Suture needle	13.5	10.6	--	12.5
Lancet	1.3	3.6	--	1.9
Glass	2.2	2.7	--	2.4
Other devices	14.3	17	13.0	14.3

Notes: Not all categories were included in all of the studies summarized. In cases where a category was not used, "--" is entered into the table and this data was not used in the calculation of the average. In all cases, N refers to the number of NSIs in total for that study. The final column indicates the average percentage across all studies. To compute the average, the harmonic mean was used to take into account different sample sizes across studies.

Procedures

Only a modest proportion of the injuries occurred while the devices were actually being used. A large number of NSIs occurred while the needle was being prepared for disposal, during the disposal process itself, or as the result of the needle being put into an inappropriate disposal container. While many studies do not include the breakdown of the actions being performed when NSIs occur, a number of them have done so. This data is summarized in Table 2. While the specific action categories (e.g. inserting into skin) were not exactly the same, the broader categories (e.g. during use) were consistent across studies and were therefore used in the table. All seven of the studies presented in this table sampled a wide range of HCWs within hospital settings, with the exception of Hersey and Martin (1994) who only sampled doctors and nurses. The time frame sampled in the studies presented ranges from ten months to four years. Four of the studies sampled from one hospital, one sampled from nine hospitals, one sampled from 34 hospitals, and one took a random sample from a provincial nursing association.

Table 2

Percentage Of NSIs Associated With Different Procedures Summarized Across Studies.

Activity	Dekker & Robson (1992)	Hersey & Martin (1994) (nurses/doctors)	Jagger et al.(1988)	Jagger, Cohen, & Blackwell (1994)	McCormick & Maki (1981)	Wright & Farrer (1990)	Wright & Farrer (1993)	Avg
	(N=677)	(N=1113/157)	(N= 326)	(N=742)	(N=316)	(N=124)	(N=67)	
Before use	*	--	--	1.7	--	--	--	1.7
During use	43.1	34.8 / 71.0	17.0	24.3	37.7	8.0	10.4	33.0
Between steps	--	7.0 / 6.0	--	12.0	--	--	--	7.7
Disassembling	*	8.0 / 0.0	--	9.6	--	6.0	4.5	6.5
Recapping	10.3	25.0 / 20.0	--	7.4	12.0	8.0	9.0	11.8
Other after use- before disposal	12.4	16.0 / 9.0	70.0	23.7	--	45.0	43.3	22.0
Putting into disposal container	9.2	--	13.0	8.6	23.7	--	--	8.0
Protruding from disposal container	--	6.0 / 0.0	--	2.2	--	7.0	10.5	5.2

Table 2 (continued)
Percentage Of NSIs Associated With Different Procedures Summarized Across Studies.

Procedure	Dekker & Robson (1992)	Hersey & Martin (1994) (nurses/doctors)	Jagger et al. (1988)	Jagger, Cohen, & Blackwell (1994)	McCormick & Maki (1981)	Wright & Farrer (1990)	Wright & Farrer (1993)	Avg
Inappropriate disposal container (waste, food tray, linen)	8.3	6.0 / 2.0	--	0.9	16.1	15.0	17.9	6.5
Other person	--	8.0 / 11.0	--	--	--	2.0	--	2.9
Other/ indeterminate	16.7	26.0 / 18.0	--	9.8	10.5	6.0	4.5	12.4

Notes: All numbers given are in percentages. Not all categories were included in all of the studies summarized. In cases where a category was not used, "--" is entered into the table. Entries followed by "*" indicate that the category was lumped together with the other/indeterminate category in that study. The final column indicates the average percentage across all studies (entries with "--" were not included in this calculation). To calculate the average, the harmonic mean was used in order to take into account differences in sample sizes across studies.

The overall trends that can be extracted from this table are that the highest incidence of NSIs occur during use and after use before the needle is disposed. Two other categories had relatively high incident rates: recapping and putting into the disposal container. An interesting point to note is the large number of NSIs that occur between finishing using the needle and disposing of it. After use and before disposal, an NSI can occur as a result of recapping, disassembling, or just being handled. While the actions of recapping and disassembling used needles are considered dangerous, together they only account for approximately 18% of NSIs. The category of just handling needles before disposal accounts for approximately 37% of all NSIs. This suggests that, while dangerous, recapping used needles may actually reduce the chances of sustaining an NSI. One last point to note is the relatively high rate of NSIs (≈7%) caused by needles disposed in the garbage, on food trays, and in linen.

The Incidence of NSIs and Disease Transmission

NSIs account for more than one third of all work related injuries to health professionals (Berry & Greene, 1992; McCormick & Maki, 1981). Studies that have looked at preventing such injuries have found annual rates ranging from 7.5 to 16 NSIs per 100 persons working in hospital settings (McCormick & Maki, 1981; Ruben, Norden, Rockwell, & Hruska, 1983). The results of a study that looked at NSIs in Alberta (Baraniecki, 1993) found that 50% of nurses had sustained one or more NSIs during the preceding year. Of those who reported having sustained an NSI, the number of injuries occurring to any one nurse

ranged from one to fifteen; 51% had sustained one, 43% had sustained two to four, and 6% had sustained five or more. The number of NSIs involving AIDS tainted blood is also high. Studies in the U.S. have found rates as high as 24 NSIs per institution that resulted in the exposure of a HCW to AIDS-tainted blood in less than a two year period (Wormser, Joline, Duncanson, & Cunningham-Rundles, 1984). Similarly, Weiss et. al. (1985) found that 15% of house staff (those working with patients) and 10% of laboratory staff in their study had reported a percutaneous (through the skin) exposure to blood of a confirmed AIDS patient. Therefore, even when increased care is taken with needles because confirmed AIDS patients are being treated, the NSI incident rate is alarmingly high (Gershon, Karashian, & Felknor, 1994).

With the incidence of NSIs being so high, there is a real danger of transmission of disease to HCWs. To outline the severity of this problem Berry and Greene (1992) calculated that for a period covering 5000 hospital days with 10 HIV infected patients there will be an average of 10 NSIs to HCWs with a 3% probability that one will contract the disease. Other studies have indicated that one out of every 200 NSIs that involve the blood or other body fluids of a confirmed AIDS patient will result in transmission of the disease to the injured person (Jemmott, Freleicher, & Jemmott, 1992). In 1990 alone, there were 136 cases of occupationally transmitted HIV to HCWs in the U.S. and 191 further cases still under investigation at the time the study was published. There are approximately 12,000 Hepatitis B infections in HCWs annually in the U.S. as a

result of occupational exposure (Yiasemides Handelman, 1992). Of these, 400 to 440 HCWs require hospitalization and 100 to 200 die from acute Hepatitis B infection (Berry & Greene, 1992; Hersey & Martin, 1994; Yiasemides Handelman, 1992). The NSI incidence rates remain high even though, in many cases, the HCW is aware that the patient is infected with a potentially fatal blood borne disease. Therefore, even having prior knowledge of the patient's condition and the corresponding personal threat to health does not appear to reduce the incidence of NSIs.

The Reporting Of NSIs

The figures reported thus far are based on reported NSIs. There is a great deal of evidence, however, indicating a serious problem of under-reporting. Baraniecki's study (1993) revealed that only 34% of the nurses who sustained an NSI reported some or all of the incidents. Further, only one third of the incidents were reported at the time of the injury. This indicates that there may be approximately 66% more NSIs in Alberta that go unreported. Other studies on needlestick injuries have found similar results with the estimates of unreported NSIs ranging from 40% to 99% of all NSIs (Berry & Greene, 1992; Choudhury & Cleator, 1992; Evans, 1994; Gershon, Karkashian, & Felknor, 1994; Hersey & Martin, 1994; Presswood, 1982).

There are a number of reasons why hospital staff do not report NSIs. Commonly, an incident involving an NSI is not thought by the HCW to be important enough to report. Often, NSIs are not reported unless the patient on

whom the needle had been used is known to have AIDS or Hepatitis B and the HCW believes that the needle was contaminated at the time of the NSI (Dekker & Robson, 1992; McCormick & Maki, 1981). The danger in this is that these two diseases, while being the most dreaded and most commonly transmitted via NSIs respectively, are far from being the only diseases transmitted in this manner. Believing that the needle is not contaminated is often a common and dangerous misconception. For example, the needles and syringes used for injections into I.V. administration sets can be contaminated by blood despite the presence of check valves and without the presence of visible traces of blood (Berry & Greene, 1992). Physicians and nurses will commonly either treat themselves or seek the treatment of a colleague after an NSI. Reasons cited for this treatment procedure include embarrassment at committing a mistake that is often attributed to carelessness or lack of skill and the desire to avoid going through the often long and cumbersome procedures surrounding reporting NSIs. These procedures include having to leave the floor be examined in the emergency room or occupational health department, being tested for a number of diseases, filling out long and complicated forms, taking medications in an attempt to prevent seroconversion, and not being allowed to continue to work (e.g., Dekker & Robson, 1992; McCormick & Maki, 1981). Other reasons for not reporting NSIs include: having completed the Hepatitis B vaccine series and therefore feeling 'safe', not being aware of reporting procedures, fear of reprimand, being too busy to report the incident, being unclear about the details

surrounding the incident, and having no available reporting mechanism at the place of employment (Dekker & Robson, 1992). The most common reasons for not reporting an NSI varies according to the position of the employee and the workplace setting. For example, a nurse in an intensive care unit is more likely to state "being too busy" as his/her primary reason and physicians are more likely to avoid reporting an NSI due to embarrassment. In sum, although the incidence of NSIs appears to be high according to incident reports, the actual frequency of NSIs may be considerably higher (Berry & Greene, 1992; Choudhury & Cleator, 1992; Evans, 1994; Gershon, Karkashian, & Felknor, 1994; Hersey & Martin, 1994; Presswood, 1982).

Unsafe Practices and Noncompliance to Warnings

The majority of nurses report they engage in practices which increase the risk of needlestick injuries (e.g., Dekker & Robson, 1992; Ruben, Norden, Rockwell, & Hruska, 1983). For example, a study which looked at the behaviors of Alberta nurses (Dekker & Robson, 1992) revealed that during the previous year over 73% of nurses admitted to having recapped at least one needle and 53% reported having used their fingers rather than the proper equipment to disassemble a needle from a syringe or a needle driver. As well, 26% continue to bend, break, or cut needles, 17% continue to carry contaminated needles and syringes in their pockets or nursing bags, 8% use their fingers to cork needles, and 6% use their fingers to remove scalpel blades. Similar surveys in the United States have found that approximately 50% to 90% of patient care staff recap

needles regularly and only 43% follow universal precautions (Chia, Koh, Chong, & Jeyaratnam, 1994; Hersey & Martin, 1994; Tait & Tuttle, 1994). In addition, Moss, Clarke, Guss & Rosen (1994) found that the user, another person, or both were exposed to excessive risk of an NSI due to unsafe behaviors in as many as 28% of all needle usages. In many cases, the nurses are aware these are unsafe practices which may lead to NSIs. The incidence of risky behaviors and noncompliance with universal precautions has been found to vary with the type of facility and department in which the HCW works. Compliance to safety practices and universal precautions is low amongst HCWs with paramedics having the lowest compliance rate of 8%. Overall, it has been estimated that only 44% of HCWs working in hospitals follow universal precautions (Gershon, Karkashian, & Felknor, 1994).

Failure to comply with safety warnings and procedures is a common finding in many domains and the health care field is no exception (e.g., DeJoy, 1994; Horst, McCarthy, Robinson, McCarthy, & Krumm-Scott, 1994; Parry, Harries, Beeching, & Rothburn, 1991). Often, NSIs occur when a HCW does not follow correct procedures or ignores safety warnings. In what follows, a set of factors which have been found by a number of researchers (e.g. DeJoy, 1994; Horst, McCarthy, Robinson, McCarthy, & Krumm-Scott, 1994) to be associated with workers not complying to safety warnings and procedures are summarized. Safety warnings written on familiar items are often not salient. Because HCWs continuously handle needles, it is unlikely that any warnings present on these

objects or their packages will even be noticed. Similarly, it was found that warnings associated with low probability events will often be ignored. This occurs because repeated benign experiences with the 'hazardous' item tend to reduce the credibility of the warning and increase a person's perception of his or her own competence in being able to avoid injury. To remind HCWs about the hazards, posters and training materials within hospitals are frequently aimed at informing HCWs that NSIs may result in contracting debilitating and fatal illnesses. These warnings are based on the fallacy that information about potential injury or death is uniquely effective to change behavior. In reality, people base judgments of safety on what they perceive the risk to actually be. Therefore, these messages, if heeded at all, tend to have a temporary effect which is re-adjusted by subsequent experiences which reinforce risky behaviors. As a result, safety warnings for NSIs should focus on informing HCWs about the actual incidences and severity of NSI transmitted diseases rather than issuing a warning about improbable possible death. Two other factors associated with compliance are the perceived effectiveness of the preventative behavior and the cost of compliance. It has been found that in health care settings HCWs often think the costs of compliance to safety procedures (e.g., time, distance traveled, non-conformity to social norms) are too high and the perceived effectiveness of these procedures is low. When the cost of complying is perceived to be high, such as having to leave a needy patient to dispose of a needle or finding it uncomfortable to wear latex gloves all the time, compliance rates go down.

Additionally, the perceived cost of complying tends to increase as the perceived effectiveness of the safety procedure decreases (Dingus, Hathaway, & Hunn, 1994; Dingus, Hunn, & Wreggit, 1994; Godfrey, Rothstein, & Laugery, 1994; Wolgalter, McKenna, & Allison, 1994).

The safety environment of the organization is another determinant of compliance to safety procedures such as universal precautions. For example, if other people in the setting think a threat is real an individual is more likely to heed warnings. This is a problem in health care settings where the seriousness of NSIs is often not recognized by either the HCWs or the administration. This is evidenced by the low rates of HCWs reporting and seeking treatment for NSIs and the finding that relatively high NSI rates are accepted as inevitable by hospital administrators (Treloar, Malcolm, Sutherland, Berenger, & Higginbotham, 1994). Gender (males have higher non-compliance rates of heeding safety warnings), perceiving a patient's needs as high, and risk-taking personality have also been found to be correlated with non-compliance in hospital settings. Alternatively, compliance to safety procedures in hospital settings has been found to be correlated with the following: high levels of knowledge regarding the actual risk of HIV infection and the routes of transmission in the health care setting, tolerant attitudes toward HIV/AIDS patients, low levels of work stress, belief in the efficacy of the preventative compliance behaviors, and the safety environment in the hospital (e.g., whether others follow safety procedures, whether the administration is perceived as

thinking NSIs are serious, where the blame for an NSI is laid) (Gershon, Karkashian, & Felknor, 1994; Hersey, & Martin, 1994).

HCWs Attitudes Toward NSI Preventability

One general factor which may influence the safe and unsafe practices of health care workers are the opinions these individuals have about their ability to prevent an NSI from occurring. Dekker and Robson (1992) looked at Alberta nurses' perceptions of their susceptibility to NSIs and occupationally acquired disease. Ninety-five percent of the nurses in their study indicated they considered themselves to be informed on how to prevent needlestick injuries. Their findings indicate that the majority of nurses feel they are aware of both the most common mechanisms for sustaining an NSI as well as the dangers associated with NSIs. The results of the study have two important implications. Firstly, there may be factors other than knowledge of risks which influence the occurrence of these injuries. Secondly, the high rate of perceived self competence and knowledge about NSIs may produce a false sense of security which may result in carelessness or risky behaviors. These results must be considered carefully, however, because the questions asked were too ambiguous to give a clear picture of the nurses' knowledge. For example, while 56% of the nurses in this study acknowledged that a health care worker is more likely to acquire Hepatitis B at the workplace than from other lifestyle behaviors, there is no way of knowing if they are aware that the transmission rate after a contaminated needlestick injury ranges from 25% to 43%. The opinions about

the hazards associated with NSIs and the corresponding behaviors of HCWs are most likely determined by a more complex set of ideas, values, and knowledge base than is indicated by the responses found by Dekker and Robson (1992).

Recapping

The most common 'risky' behavior studied in health care settings is the recapping of used needles. In fact, the majority of studies have proposed that the most effective way to prevent NSI injuries is to focus attention on training HCWs not to recap, or to use ergonomically designed needles that do not allow for recapping (see, e.g., Fisher, 1994; McCormick & Maki, 1981; Millam, 1990; Ruben, Norden, Rockwell, & Hruska, 1983; Wormser, Joline, & Duncanson, 1984; Wright & Farrer, 1990; Wright & Farrer, 1993). A number of studies, however, have indicated that while recapping is an unsafe procedure, HCWs often feel that it is necessary in order to decrease the danger of an NSI while walking to a centrally located sharps container. Less than one third of facilities surveyed have adequate sharps containers at the point of use (Jagger, Hunt, Brand-Elnagar, & Pearson, 1988). This increases the amount of time and space across which exposed needles must be handled as well as complicating the disposal procedure. Another reason given for recapping was to be able to continue with a procedure that does not allow them to leave and dispose of a needle properly (Berry & Green, 1992; Choudhury & Cleator, 1992; Dalton, Blondeau, Dockerty, Fanning, Johnson, LeFort & MacDonald, 1992; Dekker & Robson, 1992). In such situations, the HCW is faced with a choice to either

recap or walk to a sharps container. Recapping allows the HCW to continue working with a patient and neutralizes the danger of an exposed needle. Thus, the proximity of a sharps container to where patients are located is critical. Not having enough time to follow safety procedures and to take proper precautions was also a commonly cited reason for engaging in such unsafe behaviors as recapping (Choudhury & Cleator, 1992; Dekker & Robson, 1992; Gershon, Karashian, & Felknor, 1994). The underlying inference is that when time allows the HCWs to pay adequate attention to what they are doing and when the facilities are set up in a safe manner needlestick injuries are less likely to occur. Therefore, it is apparent that the unsafe behavior of recapping is being practiced not out of habit or disregard for safety, but rather, HCWs are constrained to certain actions based upon the situations and environments in which they work. These situations are the result of errors committed by the administrators and policy makers in the design procedures and work environments as well as in the equipment supplied.

Considerable research and educational emphasis has been placed on eliminating recapping behaviors. Evidence from a couple of studies suggests that whether or not a HCW recaps does not affect the likelihood of sustaining an NSI. In fact, studies which have compared the incidence of NSIs in HCWs who recap to those who do not have found that 'recappers' may be correct in their beliefs that recapping is an appropriate course of action. These studies have not been able to find convincing evidence indicating that refraining from recapping a

needle after use significantly reduces the risk of an NSI (Choudhury & Cleator, 1992; Berry & Greene, 1992).

Berry and Greene (1992) found that while the educational programs aimed at eliminating recapping behaviors did reduce the amount of recapping they did not reduce the number of NSIs. This trend may explain other studies' findings that educational programs aimed at reducing recapping generally have little or no effect on NSI rates (e.g. Fisher, 1994; Sanborne, Luttrell, & Hoffmann, 1988). That is, while the recapping behaviors decrease, the increase in NSIs resulting from dealing with exposed needles keeps the NSI rates stable. As well as finding no significant difference between recappers and non-recappers, Choudhury and Cleator (1992) also found a high incidence of recapping amongst medical students. Recapping may be the result of a number of things ranging from inadequate training to HCWs reacting as safely as they can to the situation in which they are placed. Thus, while recapping a needle is hazardous, these studies indicate recapping may be no more hazardous than handling an exposed needle. Further, although many researchers claim recapping is the single highest cause of NSIs and efforts should be focused in this area, a look at the data indicates this may not actually be the case. The summary provided by Table 2 clearly indicates recapping is far from being the only cause of NSIs. In fact, handling used needles before disposing of them had a higher rate of NSIs than recapping.

Recommendations in the Literature

In general, the recommendations that have been made to date are based on studies that focus mainly on the actions and behaviors of the HCW. The few studies that do recommend actions at other levels within the organization (e.g. Dekker & Robson, 1992; McCormick & Maki, 1981) have not systematically addressed which factors at different levels of the health care organization influence NSI rates and how these factors interact. As a result, while well intentioned, many of the recommendations are quite vague, difficult to interpret, and, thus, difficult to implement. For example, one recommendation that has been made is to develop a needlestick prevention committee. The problem for implementation is that what the committee's objectives and mandates should be, what they are supposed to do and how they are supposed to influence the HCWs' practices are not specified. Another recommendation is to provide inservice training sessions. However, training objectives are conspicuously missing. As well, how frequently the sessions should be held, who should attend, if they should be mandatory, and the evaluation of their effectiveness are also not mentioned. In addition, many of the recommendations are not economically feasible in today's climate of funding cuts (Canada) and cost-benefit analyses (US). This is especially true in small facilities and rural hospitals where fiscal constraints are often more salient.

Many studies recommend that ergonomically designed equipment be used which are needles and other sharp equipment that are specially designed

so that the possibility of sustaining an NSI is reduced. Examples of these are devices that allow for a one-handed technique to recap used needles and syringes that automatically resheath IV stylets upon their removal from the patient. While the results vary, many studies have reported significant drops in the incidences of NSIs when ergonomically designed equipment and needleless equipment are used (e.g., Bohoney, 1993; Dauleh, Irving, & Townell, 1994; Jagger, Cohen, & Blackwell, 1994; Wolfrum, 1994; Wright & Farrer, 1993).

A Summary of the Problems with the Current Approach

It is evident that while NSIs are the result of a number of different factors which interact in a complex manner past research has tended to focus on the recapping problem. As there are many other social, contextual, and procedural factors which affect the incidence of NSIs the current approach is inherently flawed. The main problems with the current approach are the focus on recapping, problems associated with ergonomic equipment, a lack of understanding of the external influences on NSIs, and the vagueness of the proposed solutions. These problems are discussed in what follows.

While recapping needles is a major source of NSIs it is far from being the only source. Many studies have broken down the steps involved in using needles and looked at the rates of NSIs associated with each step. A compilation of these results indicates that recapping is only one of many actions that result in NSIs (see Table 2). Further, previous literature suggests that the action of recapping appears to be the result of a subconscious risk analysis. This

suggests more complex underlying reasons for errors that result in NSIs than HCWs carelessly engaging in unsafe behaviors. In addition, results of past efforts to reduce NSIs through reducing recapping has indicated that this approach is ineffective. Therefore, it is probable that efforts at reducing NSIs should be focusing on the causes of recapping and other unsafe acts and not just on reducing the acts themselves.

A second problem inherent in the current approach is that there are a number of issues surrounding the use of ergonomic solutions. The decrease in NSI rates due to ergonomically designed equipment range from 0% to 93% depending on the study and the type of device used (Berry & Greene, 1992; Bohoney, 1993; Jagger, 1994; Jagger, Cohen, & Blackwell, 1994; Smith, Eisenstein, Esrig, & Godbold, 1992). While NSI rates have dropped due to the introduction of ergonomically designed equipment in some cases, there are some negative findings associated with the use of such products. Many of the products are not tested by the users at the facilities before they are purchased. As a result, products are often bought that are poorly designed and offer little or no improvement and sometimes actually increase the incidence of NSIs (Berry & Greene, 1992; Roberts & Scharf, 1986). Further, it has been suggested that there is a much higher risk of patient infection when needleless I.V. systems are used as the ports for administering medications become unsterile (Berry & Greene, 1992). This may result in a decrease in HCWs confidence in ergonomic equipment as well as a reluctance among administrators to continue to look for

ergonomic solutions. The new ergonomic and needleless devices are two to 20 times more expensive than traditional equipment (Owens-Schwab & Fraser, 1993). This poses an additional financial burden on the institution and may be unrealistic for small and rural facilities. Additionally, there are many different types of needles that may be used for a single procedure. Ergonomically designed equipment can only work if used. It is not reasonable to assume that all HCWs will like the ergonomically designed needles or that those who do will necessarily use them all the time. As well, there are a large number of situations in which needlestick injuries occur that are not amenable to ergonomic controls. For these reasons ergonomic solutions can only be truly effective if implemented along with procedures and changes addressing the causes behind NSIs.

One of the most serious problems with the current approach is that neither the ergonomic equipment nor the education programs proposed address factors external to the HCW. This is important as all of the HCWs' actions occur within a larger setting which will influence behaviors and attitudes. Only when the context in which the NSIs occur is considered will a better understanding of the underlying causes result. A final weakness is the recommendations which have been made are very vague and, therefore, difficult to implement. Further, they are often too costly not only for small and rural facilities but also for larger facilities facing budgetary constraints. In conclusion, it is unrealistic to assume that the solutions currently proposed in the literature will have a significant effect on reducing the NSI problem.

The Current Study

Research conducted on NSIs have resulted in a set of recommendations that are often contradictory or too narrowly focused. Reviews of NSI literature are limited and have failed to systematically examine the efficacy of recommendations, compare studies, generate an understanding of the causes of NSIs or theoretically frame empirical findings. The lack of compliance by HCWs to universal precautions and other safety practices is more often than not cited as the cause of NSIs, thus placing the blame on the health care workers themselves. As a result, attempts at reducing NSIs have traditionally focused on changing the behavior of the health care worker through education and ergonomically designed equipment.

This approach of blaming the front line worker is common in studies of human error as errors committed by the front line operators are the most visible and, therefore, the easiest ones to lay blame upon (Reason, 1990). When front line operators (nurses, doctors, laboratory technicians) commit an error while handling a needle the effects are felt immediately; an NSI or a near miss occurs. Such an error is termed an active error and this is where most of the attention in NSI research has focused. To truly understand why the active errors are occurring, however, it is often necessary to look at errors in the design of the equipment, policies, and workstation layout. Such errors are generally removed in space and time from the actual active error and are called latent errors. Latent errors are committed by those who are not directly affected by the negative

consequences of the error (such as designers, administrators, and managers) and are much harder to detect because they are separated by time and distance from the active error causing the NSI (Reason, 1990). As well, there is often a large time delay between when the latent error is committed and when the actual injury occurs. The difficulty in detecting latent errors and the large delay between the error and its consequences has resulted in a tendency to blame the worker and not look further to determine factors that may have lead up to the HCW's actions.

A large body of research has been done that describes error behavior or accidents that lead to NSIs. What is missing, though, is an underlying theory of human error that attempts to explain and understand why such behaviors are being performed and look for latent errors in the system. What is needed for a successful NSI prevention program is a systems level approach that is based on theories of human error. Such an approach would take the focus off the active errors committed by HCWs and attempt to discover underlying latent errors that may be associated with NSIs. By correcting latent errors inherent in the design of equipment, workstation layout, policies, and needle procedures hopefully the number of active errors committed by front line workers will also decrease. In order to find the latent errors in the system a theory which takes into account not only factors associated with the HCWs (e.g., experience and knowledge), but also the equipment (e.g., ergonomic designs), administration (e.g., procedures

and programs), and interpersonal factors (e.g., peer pressure and employee - supervisor relations) within the organization is needed.

The Systems Approach

An effective solution to the problem of NSIs will most likely be at the systems level. That is, the individuals, policies, and procedures at many levels of the organization will have to be taken into account. This is necessary because although it is the individual HCWs who sustain NSIs, they do so in the larger context of the whole organization. Factors at levels apparently remote to the HCW can profoundly affect their behaviors and attitudes. While previous studies have made recommendations aimed at organizational policies and practices, the impact of these recommendations to each other within the system has not been determined. Nor has it been determined how high-level decisions, policies, and procedures may affect the front line HCW. It is essential not only to look at changes that must be made at each level, but also to look at the effects that these changes will have on each other and the effect that actions at each level will have on the behavior of individual HCWs. For example, providing inservice training about the risks of NSIs to nurses may have little effect if the safety environment in their department is low and the procedures they must engage in to comply with safety regulations conflict with patient care. By looking at factors at many levels of the organization, both latent and active errors and the way in which they interact may be addressed.

In an extensive look at human error in medicine Moray (1994) stresses the importance of a systems approach when looking at medical human error. He notes that the emphasis and blame has to be taken off the individual. The organization as a whole should be thought of as a complex system and the prevention of NSIs should be at the level of the design of this organization system. In this sense, the organization should be thought of as a collection of components, both human and non-human, with specific relationships between them. The components in this system must be brought together to achieve a well defined goal or purpose. In a systems approach to the prevention of NSIs, then, the source of errors are not only with the individual but also with the design of objects, activities, procedures, and policies.

A look at the individuals affected by NSIs strongly points to the need to examine the health care organization as a whole. Table 3 lists a number of different occupations that have high levels of NSIs associated with them. While the percentage of NSIs sustained by HCWs varies as a function of exposure to needles, it is apparent that personnel in a vast array of occupations working in different areas and at different levels of the organization are affected by NSIs.

Table 3
Percentage Of NSIs By Occupation

Occupation	Jagger, Cohen, & Blackwell (1994) (N=1024)	McCormick & Maki (1981) (N=316)	Ruben, et al. (1983) (N=579)	Avg.
Nurse	51.3	59.6	48.1	50.8
Housekeeping / kitchen / laundry personnel	3.3	17.4	14.8	6.98
Laboratory personnel	2.9	14.9	13.2	6.67
M.D.	15.3	-	13.2	13.3
Medical / nursing Student	2.8	-	7.3	4.0
Respiratory Therapist	2.2	-	-	2.2
Attendant	6.4	-	-	6.4
Phlebotomist / Venipuncture / I.V. team	3.9	-	-	3.9
Non-lab technician	6.6	-	3.5	4.6
Dentist	0.5	-	-	0.5
Dental hygienist	0.8	-	-	0.8
Miscellaneous personnel	3.8	39	-	6.9

Notes: All numbers given are in percentages. Avg. = average. All categories were not included in all of the studies summarized. In cases where a category was not used, an "-" is entered into the table. In all cases N refers to the number of NSIs in total. The final column indicates the average percentage across all studies (entries with an "-" were not included in this calculation). To calculate the average, the harmonic mean was used in order to take into account different sample sizes across samples.

Two of the studies summarized in this table are longitudinal in nature and one is cross sectional. The cross sectional study (Jagger, Cohen & Blackwell, 1994) sampled nine hospitals over one year. The other two studies (McCormick

& Maki, 1981; Ruben, Norden, Rockwell, & Hruska, 1983) each took four year longitudinal data from a single hospital.

While most of the NSI research is directed toward people in front line occupations such as nurses, physicians, and laboratory technologists, this list indicates a number of other departments within the health care facility that are also affected. Other departments include kitchen, housekeeping and maintenance staff, as well as house officers, x-ray technicians, security personnel, and nurses' assistants. Interestingly, in the three studies summarized, doctors and laboratory technicians have similar rates as the support staff (housekeeping, kitchen, laundry personnel). Unfortunately, for many of the support staff populations the mechanisms of injury are direct results of other people's carelessness, such as leaving uncapped needles on food trays or in garbage cans. Tragically, some studies have found that transmission of infectious disease via needlestick injury among personnel in these departments (housekeeping, dietary) are actually the most common (McCormick & Maki, 1981). Individuals in other occupations who are not based solely in hospitals, such as paramedics and home care workers, are also at risk of NSIs (Klontz, Gunn, & Caldwell, 1991). At a more abstract level, administrators are also affected as each NSI has a financial and personnel cost. Therefore, the prevention of these injuries is of interest either directly or indirectly to people at all levels of the organization.

The cost-benefit question of whether to implement strategies in an attempt to reduce NSIs is a complicated one encompassing many levels within the health care system. Front line HCWs advocate that no expense should be spared. Administrators, however, often believe that the cost of implementing prophylactic measures outweighs the benefits. One reason for this may be the tendency of administrators to underestimate the incidence of NSIs (Treloar, Malcolm, Sutherland, Berenger, & Higgnbotham, 1994) therefore underestimating the actual costs. Minimum estimates of the cost to the facility per NSI reported are $54 (U.S. funds). This figure does not include costs of immunization and work hours lost by the affected HCW. Costs per NSI, which include treatment cost and work hours lost are about $500 (U.S. funds) (Berry & Greene, 1992; Laufer & Chiarello, 1994; Owens-Schwab & Fraser, 1993; Ruben, Norden, Rockwell, & Hruska, 1983; Sherlock & Mildon, 1994). These costs increase if psychological counseling is required, if the HCW develops a disease as a result of the NSI, or if litigation ensues. However, many recommendations aimed at reducing NSIs require a large output of funds by the facility, often over extended periods of time. For example, hiring additional staff to run NSI prevention programs, purchasing the more expensive ergonomic equipment, and paying for the personnel hours required to evaluate and change hospital procedures often seem to vastly outweigh the savings in NSI prevention and treatment costs. In fact, many ergonomic safety recommendations are seen as "largely altruistic, with no significant, or even tangible, returns on investment" (Simpson & Mason,

1990; pp. 798). This is especially true if NSI reporting and treatment costs are spread out and often hidden under the titles of generic occupational health and safety costs. Additionally, there is the ethical issue of what is the value of a human life. The question here is: Is it worth while for a hospital to invest considerable sums of money to save a single HCW? These questions are very difficult to answer and administrators are often much more calculating in their evaluations of human worth than the front line workers (Fischhoff, Lichtenstein, Slovic, Derby, & Keeney, 1981, Simpson & Mason, 1990). Unfortunately, the cost of prevention programs is often what influences safety decisions and not safety or longer term cost-benefit analyses.

A Systems Approach to NSIs

A generic hierarchical systems oriented approach previously used to describe medical human error (Moray, 1994) is adapted to needlestick injuries (see Figure 1). Each box, or level, represents different aspects of the healthcare system or context in which NSIs occur.

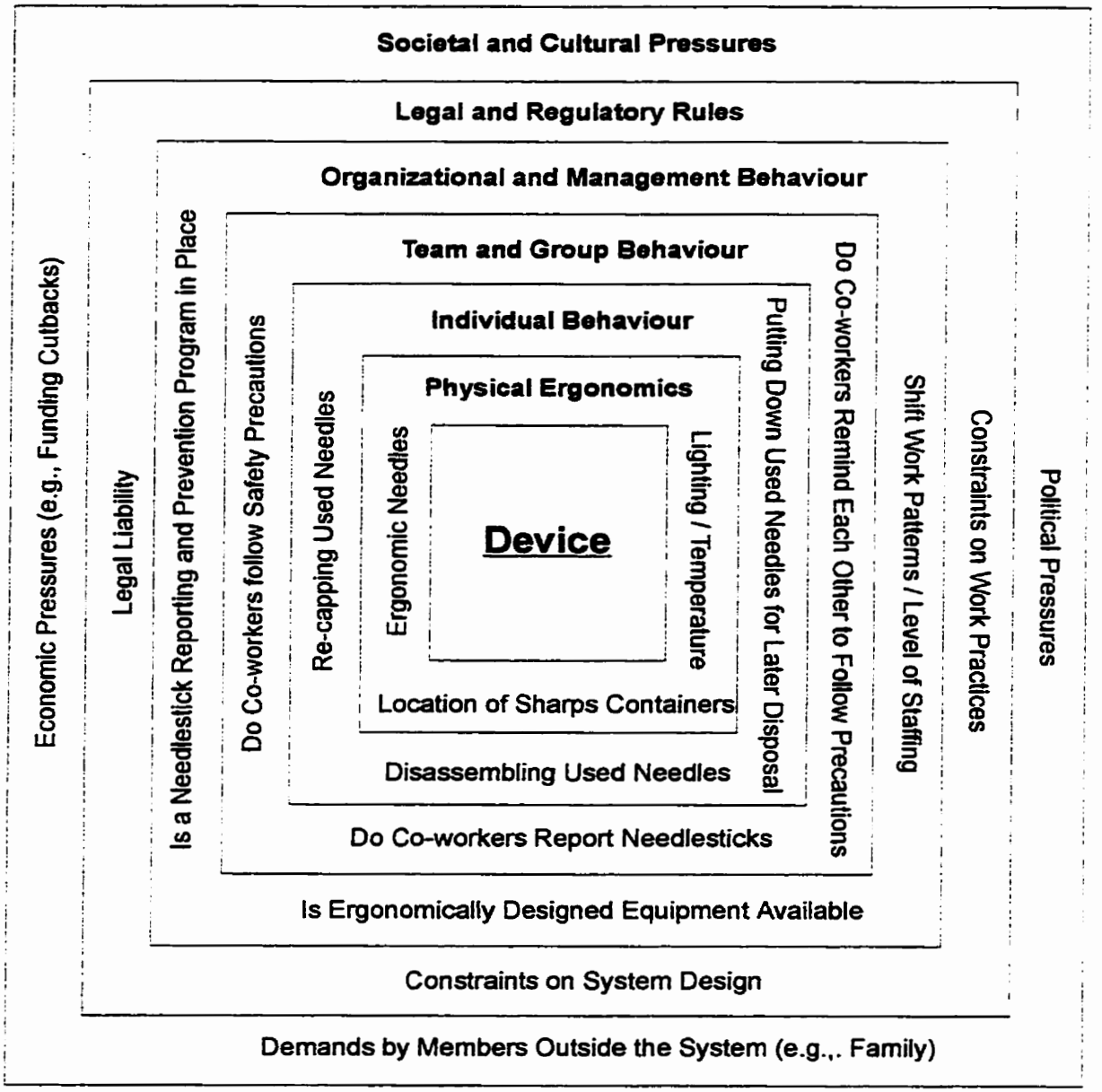


Figure 1. A systems Level Approach to NSIs. (Adapted from Moray, 1994)

The center box in the model represents the physical device which ultimately causes the needlestick injury. The next level is physical ergonomics which addresses the design of equipment and the immediate work environment. Within this level there are factors such as the location of sharps containers and environmental factors such as lighting, temperature, and sound. These factors can influence how a person acquires and uses information. These perceptual sources of information pose constraints on patterns of thought and behavior. Individual behavior is represented by the next box and refers to the errors caused by actions performed by individual HCWs. Included are factors such as recapping needles, disassembling needles, and improper disposal of needles. Here, the limits of human processing and decision making come into play to affect the occurrence of errors. Team and group behavior comprise the next level. Although errors are made by individuals, aspects of the team in which the individual works will affect the types and frequencies of errors. With regard to NSIs, aspects that may affect errors are the other team members' use of safety precautions and reporting practices as well as whether feedback is given by supervisors as to the importance of taking precautions. Constraints at the team and group behavior level that may affect errors are social dynamics such as peer pressure, hierarchical patterns of authority, and folklore about the best ways of doing things passed from experienced HCWs to novice ones. Above the team and group behavior level is the level of the organization and its management. The organization and management level affects errors in more global ways.

Factors including whether ergonomic equipment is available, the presence of an NSI reporting and prevention program, shift work patterns and level of staffing are all included at this level. The organization and management level imposes a lot of constraints that will directly affect the individual workers such as creating the safety environment in the organization and the standards to which the individual members are expected to adhere. The last two levels are legal and regulatory rules and societal and cultural resources. Legal and regulatory rules include things such as who is legally liable for NSIs should illness occur, constraints on system design such as mandatory safety procedures outlined by governing bodies such as OSHA, and constraints on work practices. These factors will affect an individual's behavior especially if hospitals fear litigation from individual workers. Economic pressures such as funding cutbacks, demands by members outside of the system such as friends and family of HCWs and political pressures are societal and cultural resources. This level will affect the options considered by the individual, the choices that will be made, and the level of risk that will be tolerated. These two levels are remote from the individual worker who is making the error, but the effects are still powerful as both decision making and overt behavior can be distorted by the requirements of society (Bogner, 1994). From this model it is apparent that an individual error, in this case a needlestick injury, can be affected by many factors at different levels and that all of the factors interact.

Human Error

In almost all cases, NSIs are the result of a HCW committing an error. What has not been addressed thus far in the literature are the kinds of errors that may lead to an NSI. As Table 2 indicates, NSIs occur while HCWs are performing a large number of different tasks. Within each category of tasks, many situations and circumstances influence why the error is committed. In order to determine what factors are affecting NSIs the nature of the errors being committed must be addressed. Once the types of errors that lead to NSIs are determined the factors leading up to and influencing them can be addressed at both a systems and an individual level. Therefore, the first step in finding a solution for eliminating NSIs is an in depth understanding of the nature of errors as well as why and how they occur.

The G.E.M.S. Model of Human Error

The generic error modeling system (GEMS) is a conceptual framework that was designed to determine the basic human error types (Reason, 1990). It was created in an attempt to integrate two areas of error research: slips and lapses, which are the result of execution or storage failures, and mistakes and violations in which the plan of action is flawed (e.g., also see Norman, 1981). The GEMS approach integrates knowledge from a variety of theories and models (e.g. Norman, 1981; Rasmussen, 1986; Rouse, 1981) and is the first to attempt to achieve an integrated model of error mechanisms operating at all three levels of performance: skills, rules, and knowledge based. Slips and lapses are

classified as skill-based (SB) and are mainly associated with failures in monitoring during performance. Mistakes and violations are considered problem solving failures and are further divided and classified into rule-based (RB) and knowledge-based (KB) categories. RB actions rely on applying a set of previously stored rules to a new situation. KB actions occur when no known rules are applicable to the situation and problem solving must occur based upon the information contained in the environment. SB components, and to a lesser extent RB actions, are involved in virtually all adult actions, even those that are directed by KB processes (Rasmussen, 1983). SB errors greatly exceed other types of errors, followed by RB errors and even fewer KB errors, because of their relative involvement in human performance. However, even though the absolute numbers of SB errors are higher, the relative ratios of the SB, RB, and KB errors show a reversal in pattern, with KB errors being the most frequent and SB errors being the least. It is important to note that the three classifications are neither mutually exclusive nor meant to function in a linear manner. A person can cycle through the levels as needed when attempting to perform an action.

The three basic error types can be distinguished among a number of dimensions. The key distinction, task type, is based upon Rasmussen's (1983) performance levels. The distinction is made by looking at whether the person is problem solving at the time of the error. SB slips generally precede the detection of a problem, whereas RB and KB mistakes arise during attempts to find a solution to a problem. Focus of attention to the task at hand is another important

dimension. Attentional capture, associated with either a distraction or preoccupation, moves attention away from the task and is a necessary condition for a slip or lapse to occur. However, for both RB and KB mistakes it is assumed that the attentional focus will not have strayed from some feature of the problem configuration. Another essential factor in distinguishing the different types of errors is the control mode. Performance at both the SB and RB levels is characterized by feedforward control which emanates from stored knowledge structures (such as motor programs and schemata). Control at the KB level however, is primarily of the feedback kind where effortful reasoning is required. Thus, problem solving, attentional focus, and control mode are essential features for distinguishing the error types. The way in which slips, lapses, mistakes, and violations relate to SB, RB, and KB actions is summarized in Figure 2 (this model is adapted from one outlined in Reason, 1990).

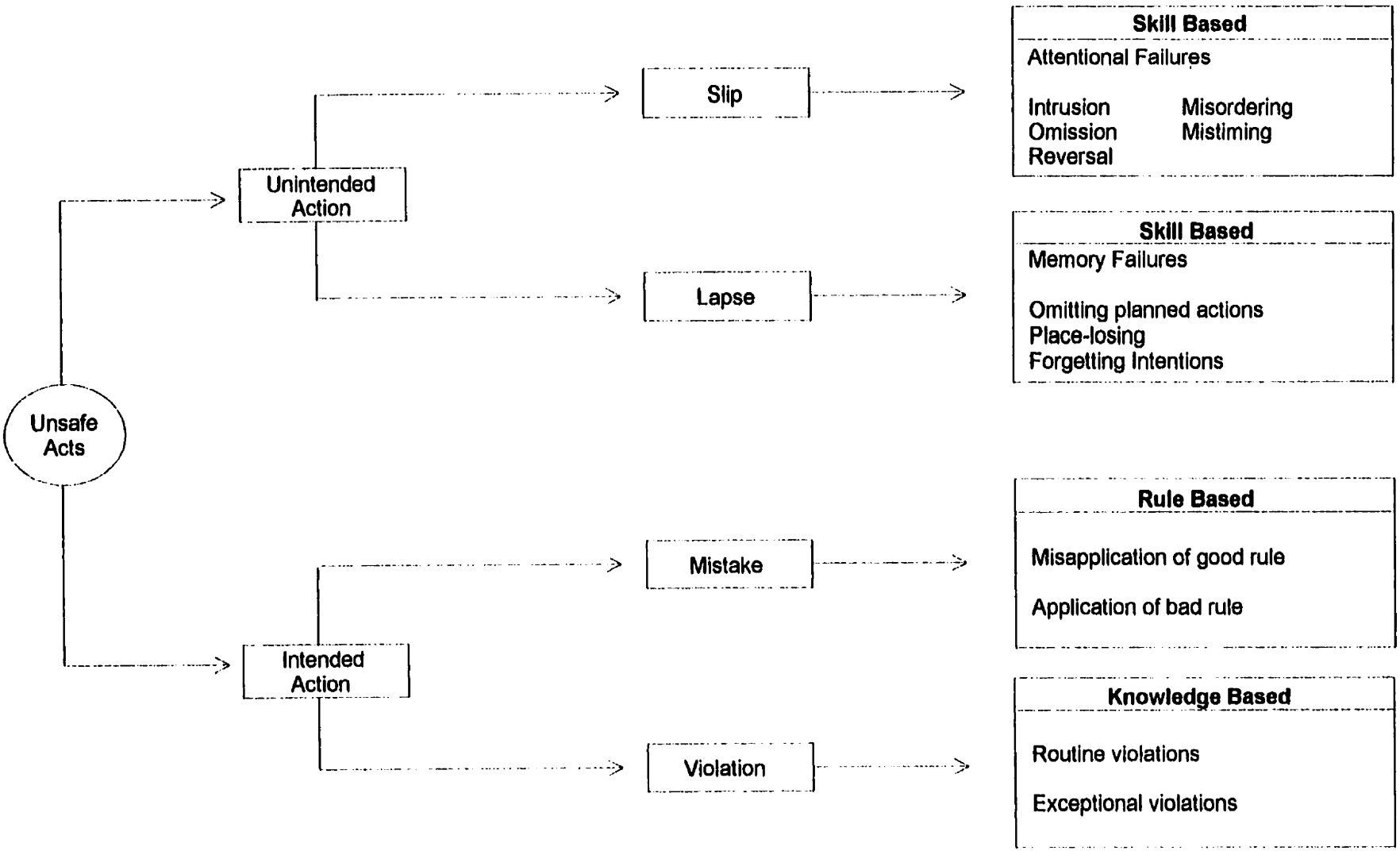


Figure 2. A summary of the psychological varieties of unsafe acts, classified first according to whether the act was intended and then according to whether it was skill, rule, or knowledge based. (Adapted from Reason, 1990)

Types of Errors Associated with NSIs

The first step in determining which factors are highly correlated with needlestick injuries is to examine the types of errors being committed when an NSI occurs. Grounded in the work of Reason (1990), Norman (1981), and Rassmussen (1986), a detailed taxonomy of errors specific to the domain of NSIs is proposed. In accordance with a systems level analysis, this theory addresses factors at all levels of the health care organization (administrative, departmental, individual, and equipment), the ways in which they interact, and the situational context of the NSI.

There are many different ways of classifying errors depending on the underlying goal of the taxonomy. Historically, the focus of taxonomies in the medical and health care domains have been to outline blame and accountability for legal purposes and damage control programs (Leape, 1994). This approach is completely inefficient when the goal is to determine the underlying causes of NSIs. To achieve this goal, a different taxonomy which addresses causal factors at all levels of errors is needed. The author proposes a taxonomy specific to NSIs which is based on the different underlying determinants of the three main types of errors (from Norman, 1981; and Reason, 1990). Factors proposed to be underlying determinants in the taxonomy are grounded in past research in the area of NSIs as well as past findings in the areas of error, safety, social psychology, injuries in health care settings, and warnings. As well, information gained during focus groups and interviews with experienced nurses in phase one

was used in the development of the taxonomy. The resulting taxonomy is outlined in Figure 3.

At the top of the taxonomy is the outcome: NSIs. The first division is between external and internal causes. External causes are taken here to mean those over which the individual has no control. Examples of these include sustaining a needlestick injury from a contaminated needle thrown into a garbage can by another person, or receiving an accidental poke as someone else is moving by you with a contaminated needle. Internal causes are those over which the individual has some control. An example here would be where the person is in the process of disposing of a needle when the injury is sustained. Internal causes are further broken down into slips/lapses, mistakes, and violations. Slips and lapses are errors in action. The intention of the actor is correct but in the process of carrying out the behavior an error occurs (Norman, 1981; Reason, 1990). There are many different types of slips (Norman, 1981, Reason, 1990). This taxonomy collapses them all into one category. An example of a slip would be a nurse sustaining an NSI because her attention was distracted from the disposal procedure by an unruly patient. The slips category is broken down into those resulting by stressors (e.g. fatigue), and poorly designed equipment. Mistakes are errors in intention. With a mistake, the action is carried out as planned, but the intention itself is flawed (Norman, 1981; Reason, 1990). An example here would be a nurse sustaining an NSI while using unfamiliar equipment due to using an incorrect disposal procedure that was thought to be

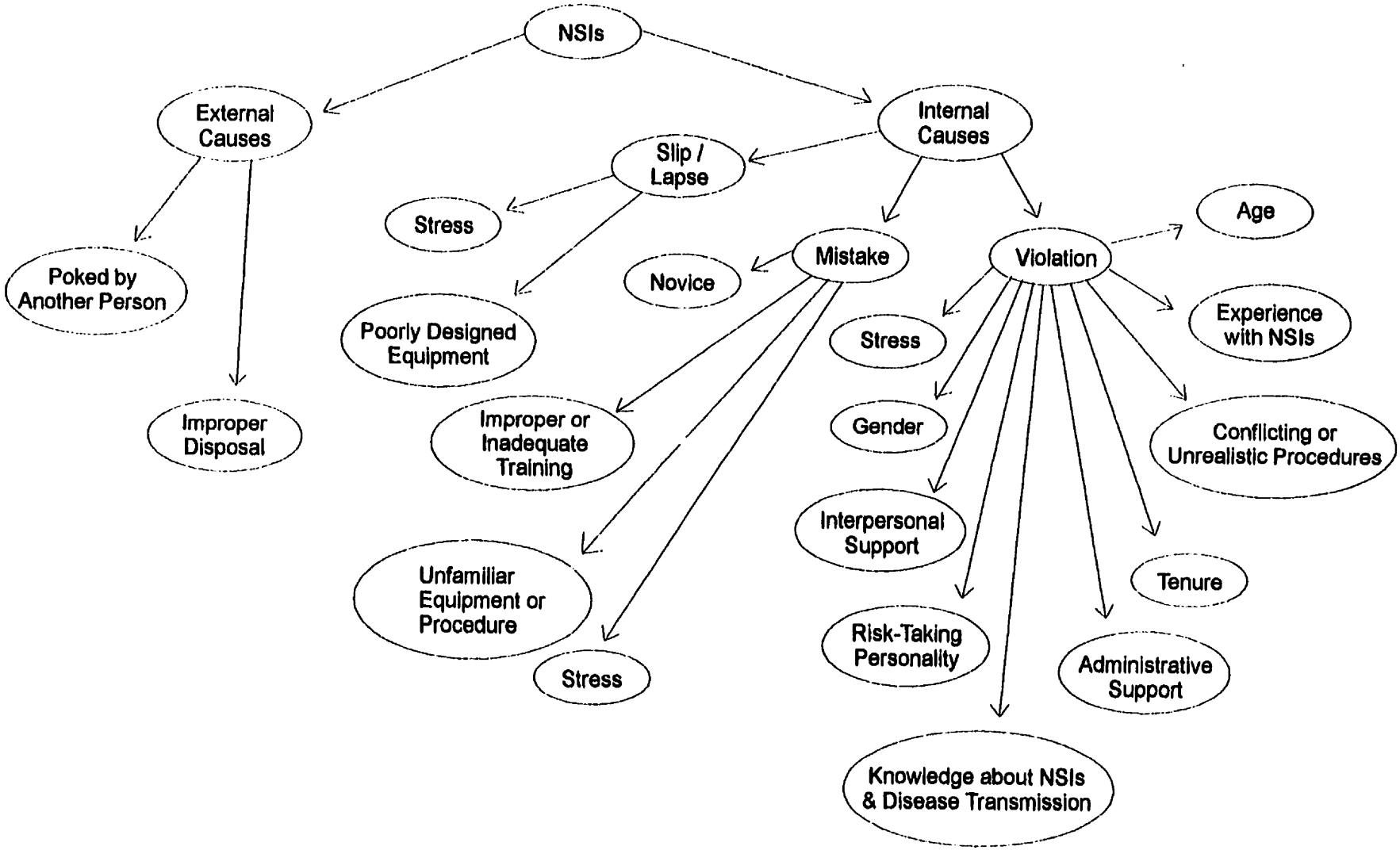


Figure 3. Taxonomy of NSIs categorized first by internal & external factors and then by error type & their predisposing factors.

correct. The mistakes branch is broken down into three categories. Mistakes can result from inexperienced or novice users having inappropriate or inadequate knowledge, as the result of improper or inadequate training, and due to stressors. Violations are deliberate choices to act in a non-standard way such as violating safety procedures or universal precautions. Reasons for committing violations are broken down into: stressors, gender, interpersonal support, risk-taking personality, knowledge about disease transmission, administrative support, tenure, conflicting or unrealistic procedures, experience with NSIs, and age. An example would be a HCW sustaining an NSI as the result of purposely not following a safety procedure because of the belief that it interferes with proper patient care. It should be noted that the categories of violations, slips/lapses, and mistakes are not meant to be mutually exclusive. For example, the act of performing a violation or a mistake may lead a HCW to make a slip.

The NSI Taxonomy and G.E.M.S.

The distinction between violations, mistakes, and slips/lapses in the G.E.M.S. model (Reason, 1990) is of central importance to the NSI taxonomy. Violations represent errors at the KB level. At this level, the action chosen is not the result of routinized behavior or rules. Rather, it is the result of a problem solving decision being made based on higher level knowledge structures. The HCW consciously chooses a violation as he or she perceives it to be the best plan of action in a particular circumstance. Errors at the RB level are represented by mistakes. Here, the wrong or inappropriate rules are applied by the HCW. As

the taxonomy indicates, this can be the result of inexperience, unfamiliarity, or inadequate knowledge. SB errors are represented by the slips/lapses category. In this case, the right rules are applied but an error occurs during the execution of the action. Just as in the larger G.E.M.S. framework, a person can cycle through the different levels during the actions leading up to an NSI. As well, an action can move from the violation to the mistake category if the situation leading to it occurs on a frequent basis. For example, when presented with conflicting operating procedures a HCW may violate a safety procedure in order to solve the problem. This decision initially is at the knowledge based level. If the HCW continues to be confronted with the same conflicting procedures, the individual may establish an informal rule as to what should be done in that instance. In this case, the action moves to the rule based level. Using the G.E.M.S. model of human error within the domain of NSIs, it is proposed that these injuries occur as a result of violations, mistakes, and slips/lapses each with their own specific underlying factors.

In order to test this taxonomy, it can be turned into a causal model in which the various factors are hypothesized to lead into each other and eventually into the ultimate outcome of a needlestick. Figure 4 outlines the path model which is derived from the NSI taxonomy. In order to transform it into a path model, the taxonomy was turned on its side with the proposed flow of causality going from left to right. Relationships between factors are indicated with arrows where the factor on the left is predicted to account for variance in the factor on

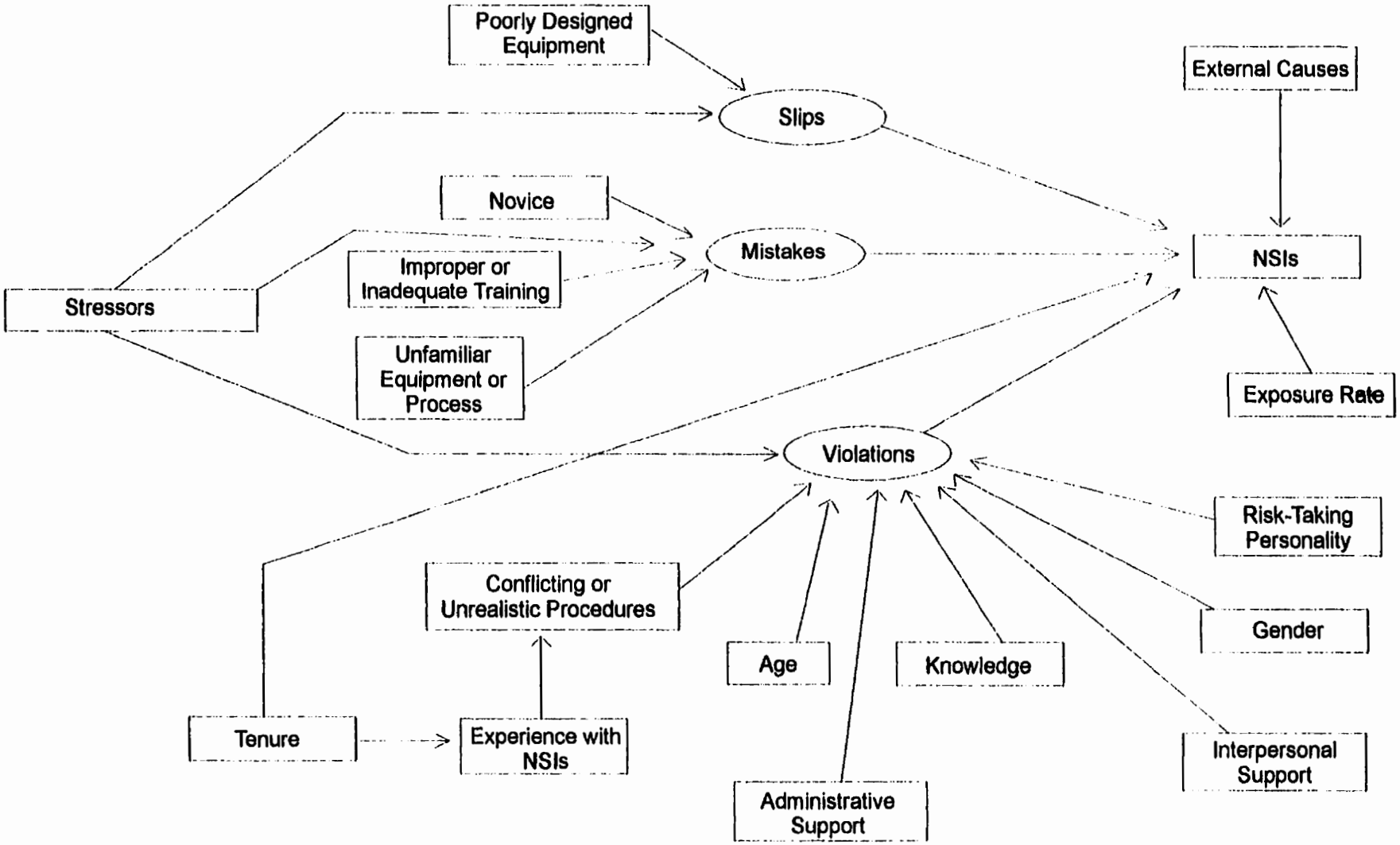


Figure 4. The taxonomy of NSIs represented as a causal model. Relationships between predisposing factors of the error types are included. Latent variables are represented with circles, measured variables are represented by rectangles.

the right. Within the path model, exposure rate is added as a factor leading to NSIs in an attempt to account for higher numbers of NSIs amongst those health care workers who deal regularly with needles as compared to their counterparts. The resulting path model is a testable systems level hypothesis about the underlying factors that influence the likelihood of an NSI occurring.

Proposed Causal Model of NSIs

The model outlined in Figure 4 examines all three types of errors that may lead to an NSI. While NSIs affect many HCWs only nurses will be looked at in this study. Nurses are a population of HCWs who deal with needles frequently and sustain the highest number of NSIs per year of all HCWs (see Table 3). As well, for the purposes of this study only the 'violation' branch will be examined. At this stage, violations are renamed 'critical behaviors' in order to make the model more specific and testable. Critical behaviors are those actions performed by a HCW that are considered risky and are highly associated with the occurrence of NSIs. They are violations of explicit and implicit safety procedures for handling needles. By operationally defining violations in this way, the construct is now measurable as opposed to being a latent variable. The resulting model that will be looked at is shown in Figure 5.

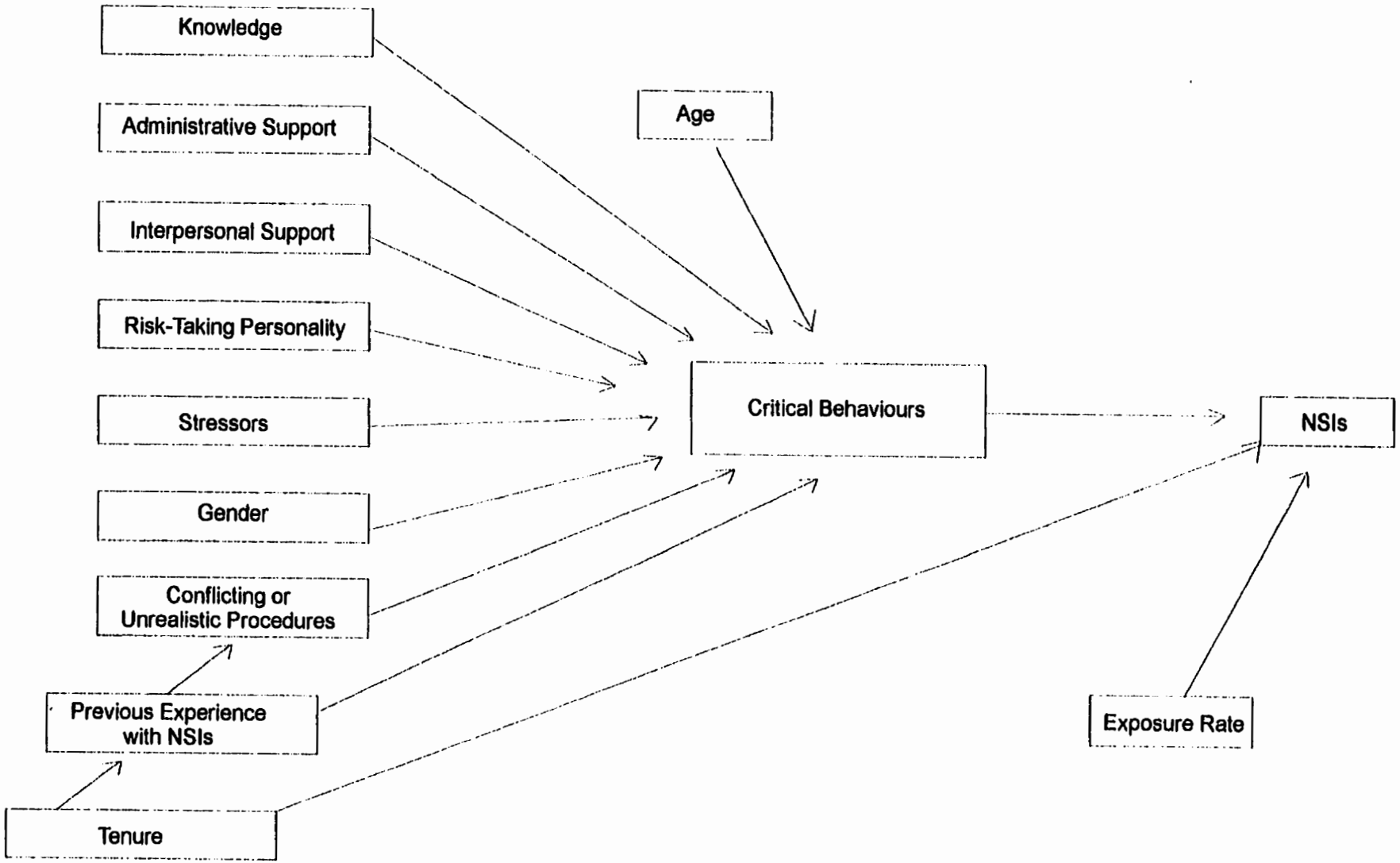


Figure 5. Causal model representing the violations branch of the larger model. Violations are called critical behaviours and measured directly. The 'Exposure Rate' & 'Age' variables from the larger model are included.

There are a number of reasons for choosing to look only at violations. A questionnaire approach was taken which constrained the types of factors that could be assessed. Slips, lapses and mistakes that do not result in NSIs often go unnoticed and therefore are very difficult to measure with a questionnaire. As well, slips, lapses and mistakes are generally not remembered, especially in a busy or stressful situation, unless they result in injury. Therefore, the majority of incidents involving slips, lapses and mistakes would go unreported in a questionnaire survey. On theoretical grounds, there is more utility in studying why violations occur. Slips and lapses happen unintentionally, and are often the result of motor coordination mistakes and lapses of memory or attention. In contrast, violations involve the intentional breaking of safety rules or engagement in unsafe behaviors. If an understanding is achieved of why violations are made, training, workspaces, equipment, policies and procedures can all be altered in an attempt to prevent these unsafe actions from occurring. It is hoped that by decreasing the number of unsafe behaviors that HCWs engage in a large number of NSIs can be eliminated.

Factors That Are Controlled For And Not In The Model

Age

The trend in the warning and safety literature is that people 40 years old and above are more likely to take precautions in response to warnings (Laughery & Brelsford, 1994). Additionally, this population tends to perceive consequences as more serious (Leonard, Hill, & Karnes, 1994). However, the results in the

occupational injury literature are equivocal. An in depth study on occupational injuries in the health care setting found that the highest injury rates were for people between the ages of 25 and 34. Persons falling both above and below this range had lower rates (Wilkinson, Salazar, Uhl, Koepsell, DeRoos, & Long, 1992). Other studies have found that the youngest employees have the highest incidence rates (Yiasemides Handelman, 1992). However, it has also been found that younger workers are more likely to take safety precautions such as being vaccinated against Hepatitis B (Mundt, 1992). Because previous findings have not reached a consensus from which conclusions can be drawn, it is the hypothesis of this study that older nurses will have more NSIs simply as a result of having worked as a nurse longer and, therefore, having more exposure to needles. This hypothesis is, therefore, dependent upon the relationship between tenure and NSIs. As a result, age will be dropped from the analysis as it is significantly correlated with tenure ($\underline{r} = 0.82$, $\underline{p} \leq 0.00$).

Exposure To Needles

There is a wide variation in the amount of needle use amongst nurses in different specializations. It is believed that the number of NSIs will vary as a function of how often an individual nurse has to use needles. It is hypothesized that those who handle needles more often will experience more needlestick injuries. As there are a large number of specializations within the nursing profession it would be difficult to accurately quantify the amount of needle handling done by nurses in each one. Therefore, it was decided to control for

this variable by only including nurses in specializations that have high usage of needles. The two specializations chosen were emergency room nurses and critical care nurses. These two populations use needles more frequently than most other nurses and about equally with respect to each other. As a result of controlling for this variable, it was dropped from the model to be tested.

Factors Included In the Model

The factors included in the path theory are: knowledge about disease transmission via NSIs, administrative support, interpersonal support, risk-taking personality, stressors, gender, conflicting or unrealistic procedures, experience with NSIs, tenure, and critical behaviors (violations). The dependent measure in the model is the number of NSIs sustained over the entire career plus the number of close calls in the previous five years. The following section consists of an explanation of each of these factors and their importance based on the previous literature in the areas of NSIs, safety, warnings, medical human error, social psychology, and injuries in the health care setting. In keeping with a systems level analysis, many aspects of the organization, as well as the context in which the HCWs are using needles are addressed in this theory in addition to factors addressing individual differences (see Figure 5).

Needlestick Injuries

Generally, NSIs are a rare occurrence. Therefore, it is predicted that the number of career NSIs will be low in the sample. As a result of expecting the majority of nurses in the sample to have few NSIs, it is also predicted that the

variance on this factor will be small. For this reason, the number of close calls with NSIs over the past five years will be added to career NSIs to create the dependent variable. Close calls are defined as an instance where a contaminated needle touched the skin but did not break it or came close to puncturing the skin but missed. Close calls are expected to occur more frequently, and, due to the nature of a close call, the predisposing factors that affect a close call will be the same as those which affect the occurrence of an NSI. This composite dependent variable is referred to as NSIs in the structural model.

Tenure

Tenure will be measured by the number of years an individual has worked as a nurse in a hospital setting. It is predicted that the number of needlestick injuries sustained will increase with the number of years the individual has worked as a nurse.

Hypothesis 1: There will be a positive relationship between tenure, as measured by years an individual has worked as a nurse, and the number of NSIs.

Hypothesis 1b: It is also hypothesized that tenure will be indirectly related to both the number of NSIs and the occurrence of critical behaviors through previous experiences with NSIs (see Figure 5).

Tenure is also predicted to be related to the amount of experience nurses have with NSIs. The amount of experience with NSIs is predicted to increase as tenure increases.

Hypothesis 2: The amount of experience with NSIs will increase as tenure increases.

Critical Behaviors

Critical behaviors are defined as those which were found to be highly related to NSIs, or near misses, either to the HCW working directly with the needles or to others around them. They include such actions as recapping used needles, putting a contaminated object down for later disposal, and improper disposal of a contaminated sharp object (see Table 4).

Table 4
List of Critical Behaviors Found to be Highly Associated with NSIs

1. Giving a needle to an unruly patient without assistance.
2. Using unfamiliar needles or sharp equipment without asking about proper techniques and procedures.
3. Looking at the patient, I.V. bag, monitor, medicine tray, etc. while withdrawing a needle from a patient.
4. Looking at the patient, I.V. bag, monitor, medicine tray, etc. while handling a contaminated needle.
5. Putting a needle down on a bed, food tray, or medicine tray for later disposal.
6. Carrying contaminated needles in pockets or medicine pouches.
7. Improperly disposing of a needle (in a garbage can, in linens, or on a food tray.)
8. Disassembling needles before disposal.
9. Starting the next step in a procedure before disposing of a needle or other sharps.
10. Not checking to see if the sharps container is full before disposing needle.
11. Not looking at the sharps container during the disposal procedure.
12. Not ensuring that needles have not penetrated a sharps container before handling it.
13. Not warning a patient that they are about to get a needle.
14. Not looking at a colleague while passing a contaminated needle to them.
15. Taking a suture needle out of a needle driver with one's hands.
16. Violation of a needle safety procedure for whatever reason.
17. Recapping, breaking, or bending used needles.
18. Not using needles and sharps containers in the proper way (e.g., taking shortcuts).
19. Not warning other people in a room that you are transporting a contaminated needle to a sharps container

Critical behaviors are violations of safety procedures and unsafe acts that are highly associated with NSIs. Therefore, engaging in these behaviors is expected to be related to the occurrence of an NSI. For this reason, it is felt that critical behaviors are potentially a very productive level of analysis. For example, specific critical behaviors that are found to be the most common or are associated most highly with NSIs can be targeted and addressed.

Hypothesis 3: A positive relationship is hypothesized between engaging in critical behaviors and the number of NSIs.

There are eight variables which are expected to be predictive of whether or not critical behaviors are engaged in; (I) Factual Knowledge about NSIs, (II) Administrative support (III) Interpersonal Support, (IV) Risk-taking Personality, (V) Stressors, (VI) Gender, (VII) Conflicting or Unrealistic Procedures and (VIII) Previous Experience with Needlestick Injuries.

Factual Knowledge About Disease Transmission Via Needlestick Injuries

Lack of knowledge about risks, or inaccurate knowledge, can often lead to irrational fears and anxieties. By the same token, it can also lead to a false sense of security or a lack of appreciation of the actual risks involved. Thus, the amount of factual knowledge that an individual has may have an effect on her/his perception of the risks associated with an activity. Risk perceptions are driven by the perceived severity and probability of accidents with severity appearing to have a stronger influence (Chy-Dejoras, 1994; Wolgalter & Barlow, 1994; Young, Wogalter, & Brelsford, 1994). Thus, if knowledge about severity and probability are inaccurate the perceptions of risk will be correspondingly inaccurate. For example, there is a higher level of concern about the possibility of contracting AIDS from an NSI than there is about contracting Hepatitis B. In actuality, however, the probability of contracting AIDS is only 0.36% (Anglin, Kyriacou, & Hutson, 1994; Stock, Gafni, & Block, 1990) compared to the 25% to 43% probability associated with Hepatitis B. Research in the area of risk perception

indicates that this finding is not entirely surprising as relevant information about risks is often overlooked as the result of being buried in less relevant information, contradicted by information from other sources, or blurred by emotions (Fischhoff, 1987). As well, it has been proposed that people within social groups downplay certain risks and emphasize others as a way to maintain and control the group (Slovic, 1987). The effects of factors such as emotions and information from peers may be lessened if the nurses have knowledge what the risks are and the mechanisms for disease transmission along with confidence in the accuracy of that knowledge.

In the area of needlesticks, a lack of accurate or factual knowledge has been found to be the cause of a number of misconceptions and irrational or misplaced fears (e.g. Grossman & Silverstein, 1993; Wang, Simoni, & Paterson, 1993). Thus, it has been suggested that the areas in which education or training programs should focus are: changing personal beliefs, allaying fears, reducing misconceptions about modes and frequencies of transmission, and stressing the safety and efficacy of vaccines. This should be done by providing the HCW with accurate and explicit information (Jemmott, Freleicher, & Jemmott, 1992; Laughery & Brelsford, 1994; Spence Laschinger & Goldenburg, 1993; Yiasemides Handelman, 1992). Previous research has found that accurate knowledge of the risks related to NSIs is associated with an increased perception of their risk (Ferguson, Cox, Farnsworth, Irving, & Leiter, 1994), an increase in the use of universal precautions (Hersey & Martin, 1994) and an increase in

compliance to other safety precautions and warnings (DeJoy, 1994). Education and training on the actual risks and statistics associated with needlestick injuries have been found to be associated with a marked drop in their occurrence (Jagger, 1994). Further, it has been found that having accurate knowledge about disease transmission and likelihood is especially important in novel situations where perceptions of risk have not yet been formed (Reutter & Northcott, 1994). The level of factual knowledge is hypothesized to be related to the occurrence of critical behaviors. Higher knowledge levels are expected to decrease irrational fears while increasing the perception of risk associated with NSIs. A corresponding decrease in critical behaviors is expected.

Hypothesis 4: A negative relationship is hypothesized between factual knowledge about disease transmission via NSIs and the number of critical behaviors engaged in.

Administrative Support

Organizational factors at both the administrative and departmental levels are expected to affect the incidence of needlestick injuries. Factors at the administrative level include things such as whether an NSI prevention program is in place at the facility, whether ergonomically designed needles and sharps containers are provided for the employees, and whether personal NSI rates are kept in the individual's file or included in performance reviews. These types of factors send messages to employees about upper level management's beliefs about NSIs. The absence of such things as prevention programs and ergonomic

equipment sends a message that NSIs are not a problem nor are they a cause for concern. These factors may also send messages to the employees as to the stance the administration takes toward responsibility and accountability. For example, Hersey and Martin (1994) have found that including injury rates in performance evaluations results in higher compliance rates to safety precautions. While this may indicate that the organization takes the injuries seriously, it also attributes the blame solely to the worker. Organizational factors at the departmental level that have been found to be related to the perceived risk associated with NSIs and compliance behaviors to safety procedures include such things as whether reminder or warning messages are posted and the patterns of shift work (Hersey & Martin, 1994; Klauer Triolo, 1989). Factors at both the departmental and administrative levels of the organization are hypothesized to affect the number of critical behaviors engaged in. If HCWs feel that the organization, through programs and other factors, ascribes high levels of seriousness and risk to NSIs then they are predicted to also believe NSIs pose a serious health risk.

Hypothesis 5: A negative relationship is hypothesized between the level of administrative support and the number of critical behaviors engaged in.

Interpersonal Support

As well as organizational factors, interpersonal factors are also hypothesized to affect the occurrence of critical behaviors. Factors at this level include such things as the attitudes and actions of coworkers. Previous studies

have found that nurses in novel situations will look to more experienced coworkers to determine the degree of threat. When they observe the comfort levels of other nurses, this comfort level becomes contagious (Reutter & Northcott, 1994). It has also been found that nurses' perceptions of the work environment as conducive to following universal precautions and other safety procedures is associated with one of the strongest positive correlations with compliance to safety precautions (Gershon, Karkashian, & Felknor, 1994). Whether this type of environment is created depends on the actions and opinions of coworkers. Peer influences and approval are so strong that researchers have found the probability of social embarrassment or disapproval to be a stronger motivator than the possibility of serious injury, especially when the probability of injury is perceived as remote (Horst, McCarthy, Robinson, McCarthy, & Krumm-Scott, 1994). As well, warning studies in the safety literature have found compliance rates of up to 100% when a confederate complies (e.g. Chy-Dejoras, 1994; Racicot & Wogalter, 1994), with higher compliance rates occurring when the number of social models increases (Wogalter, McKenna, & Allison, 1994).

Hypothesis 6: High interpersonal support within the organization is hypothesized to have a negative relationship to the number of critical behaviors engaged in. If individual HCWs feel that their coworkers associate higher levels of risk with NSIs and see that they do not engage in critical behaviors then they too will not engage in critical behaviors.

Risk-taking Personality

Lack of compliance to universal precautions has been found to be positively associated with high scores on risk-taking personality (Gershon, Karkashian, & Felknor, 1994). It is reasonable to project that this pattern would be found for all safety procedures (e.g. recapping) and not just universal precautions. Similar findings have been found in the warnings literature. Studies by Purswell, Schlegel and Kejriwai (1994) and Vrendenburg and Cohen (1994) both found that high levels of risk-taking were associated with non-compliance to safety warnings.

Hypothesis 7: It is hypothesized that risk-taking personality will have a positive effect on the number of critical behaviors engaged in. As the level of risk-taking personality increases, the number of critical behaviors engaged in will also increase.

Stressors

The next factor hypothesized to have a direct effect on critical behaviors is stressors. It has been found that situational factors can change an individual's risk perceptions (Reutter & Northcott, 1994). For example, the anxiety associated with biohazards varies as the context changes (Ferguson, Cox, Farnsworth, Irving, & Leiter, 1994). Additionally, situational variables, such as feelings of loss of control due to time constraints, have been found to renew a sense of fear of AIDS amongst health care workers (Reutter & Norhtcott, 1994). This increase in anxiety or fear about biohazards is associated with a lowered sense of control

over the situation (Ferguson, Cox, Farnsworth, Irving, & Leiter, 1994). In other cases, situational factors may simply override any other variables which may have had an effect on whether or not a needlestick injury occurs. An example of this would be when time constraints prevent HCWs from taking precautions they would normally take in other situations. The situational variables, or stressors, that are believed to be related to the incidence of NSIs include both those external and internal to the individual.

Internal stressors are comprised of things such as fatigue, mental workload, events in the individual's personal life that affect performance at work (e.g., cause lapses in attention), conflicts with other workers or supervisors and feelings of loss of control over their environment. The effects of misalignment of circadian rhythms due to shift work has been studied extensively in the health care literature. Error rates for the night shift are significantly higher than those for the day shift (Klauer Triolo, 1989; Neuberger, Harris, Kundin, Bischone, & Chin, 1984). These higher rates have been attributed to poor lighting conditions, less staff and fatigue caused by shift work. Error rates, lapses in attention and reaction times are highest amongst nurses on rotating shift work schedules that disturb circadian patterns (Gold, Rogacz, Bock, Tosteson, Baum, Speizer, & Czeisler, 1992). Rotating shift work and chronic stress from other sources are the main contributors to fatigue. Fatigue can increase the perception of mental workload on an individual as well as contribute to slips in attention, interpersonal conflicts and dissatisfaction with the job. These factors can also contribute to

personal stress due to the reduction in available time for involvement with family and social events (Klauer Triolo, 1989). Conflicts with coworkers and dissatisfaction with one's job or work environment can affect the general work climate and have a profound effect on accident and error rates (Sheehy, & Trudeau, 1992). A feeling of loss of control is often cited as a main stressor amongst health care workers (Reutter & Northcott, 1994). These feelings may result from things such as dealing with patients known to have infectious diseases, always feeling rushed, increased physical and mental workload due to understaffing, and not having enough time to take proper precautions in emergency situations.

External stressors include such factors as time constraints (especially in emergency and operating units), understaffing, lighting conditions, distractions, the cost of compliance to safety regulations and unruly patients. Time constraints are important external stressors for a number of reasons. Firstly, they cause the HCW to rush through procedures thereby increasing the likelihood that a step will be left out or a motor slip will occur. Secondly, when time pressures are involved, HCWs often feel that the patient's care would be compromised if time was taken to follow all safety procedures or practice universal precautions. Thirdly, the chance of having a needlestick inflicted upon you by a coworker increases if all members of the health care team are rushed and working in a small area. finally, time constraints contribute to internal stressors such as loss of control. There are two main factors which contribute to time constraints: (1) critical patient situations

such as in emergency and operating rooms, and (2) understaffing such that the HCWs have to move quickly through their care with any one individual. Due to the fine motor skills required to manipulate needles, environmental factors such as lighting and noise levels as well as distractions and unruly patients all have the potential to affect NSI rates.

It should be noted that in many cases the internal and external stressors are inextricably linked. For example, the external stress of time constraints may cause the internal stressor of feeling rushed which may lead to a feeling of loss of control. Another example is that understaffing due to the current stringent economic times is an externally inflicted stress that may result in the internal stresses of higher mental workloads and fatigue.

Hypothesis 8: There is a positive relationship between stressors (both internal and external) and the number of critical behaviors engaged in. That is, as the number of stressors increases so will the number of critical behaviors engaged in.

Gender

Gender is believed to have an effect on the incidence of critical behaviors. Within the literature on warnings, the consensus is that females are more likely than males to look for and read warnings on products (Godfrey, Allender, Laughery, & Smith, 1994; Laughery & Brelsford, 1994). As well, they are more likely to comply with warnings (Goldhaber & deTurck, 1994; Laugery & Brelsford, 1994; Vrendenburg & Cohen, 1994). It would be reasonable to hypothesize,

therefore, that female HCWs would be more likely to comply with safety procedures and universal precautions. Only one study was found in the NSI literature that compared compliance rates across gender. In accordance with the warning literature, this study found that males were less likely to comply with universal precautions than females (Gershon, Karkashian, & Felknor, 1994). There is some evidence to indicate that females have higher NSI rates than males (60.8/1000 vs. 26.7/1000 employees) (Neuberger, Harris, Kundin, Bischone, & Chin, 1984). However, exposure rates were not controlled for in the study reporting these findings. Traditionally, occupations which deal with needles most frequently, such as nurse and phlebotomist, are dominated by females. Therefore, this findings may be due to a higher exposure rate to needles amongst female HCWs as compared to male HCWs. Based on past literature, it is predicted that once exposure is controlled for, females will have lower NSI rates than males.

Hypothesis 9: There is a relationship between the gender of the HCW and the number of critical behaviors engaged in with females having lower levels than males.

Conflicting or Unrealistic Procedures

Another factor proposed to have an effect on critical behaviors is the perception of safety procedures as conflicting or unrealistic with other procedures. Certain critical behaviors are proposed to be a solution to conflicting or unrealistic procedures. For example, many nurses feel that it is unsafe to walk

with an exposed, contaminated needle to a sharps container that is not located at the point of use. Thus, the procedure of not recapping used needles is not perceived to be realistic for them in that situation. Another example can be seen in the task of starting an I.V.. Once the needle used to start the I.V. has been removed from the patient, safety procedures dictate that it should be disposed of immediately. However, operating procedures for starting an I.V. specify that the catheter must be secured in place right away thus conflicting with the safety procedure. There are many other cases in which a similar situation arises where HCWs feel that they must violate safety procedures for various reasons. It is hypothesized that the number of critical behaviors engaged in will increase as the number of procedures perceived as conflicting or unrealistic increases.

Hypothesis 10: The presence of conflicting or unrealistic procedures will have a positive relationship with the number of critical behaviors engaged in. That is, in the presence of conflicting or unrealistic procedures the number of critical behaviors will increase.

Previous Experience With Needlestick Injuries

Each individual HCW will have different experiences, both personal and vicarious, with needlestick injuries. This experience is believed to have a profound effect on the person's perception of the risks associated with NSIs. In a study specific to the health care setting, findings indicate that because veteran nurses who dealt with AIDS patients were not contracting the disease, nurses new to the department concluded that the risk must be minimal. The finding that

repeated benign experiences not only reduce the perceptions of risk but also decrease the credibility of the warnings has been found repeatedly in the safety and warning literature (Chy-Dejoras, 1994; DeJoy, 1994; Goldhaber & deTurck, 1994; Horst, McCarthy, Robinson, McCarthy, & Krumm-Scott, 1994; Karnes, Leonard, & Rachwal, 1994). To complicate matters, benign experience is often associated with the presence of an optimism bias where the individuals feel unrealistically confident about their ability to avoid to negative events (DeJoy, 1994). With regard to needlestick injuries, the same relationship is hypothesized to hold true. The number of NSIs that result in the transmission of a disease is relatively low. As a result, many nurses will only have benign experiences.

Hypothesis 11: When nurses have repeated personal and vicarious experiences with needles and NSIs without incident, the potency of the threat associated with NSIs will decrease. Correspondingly, safety behaviors will also decrease. Because it is predicted that most experiences that nurses have with NSIs will be benign, it is hypothesized that there is a positive relationship between experience with NSIs and engaging in critical behaviors. As the number of benign experiences increases, so will the number of unsafe behaviors.

Hypothesis 11b: Previous experience with NSIs is predicted to also have an indirect relationship with the occurrence of critical behaviors and NSIs through conflicting or unrealistic procedures (see Figure 5).

Experience with NSIs is also hypothesized to be related to whether procedures are regarded as being conflicting or unrealistic with other safety

procedures. As the number of NSIs sustained as the result of procedural conflicts or constraints increases, it is hypothesized that the perception of procedures as conflicting or unrealistic will correspondingly increase.

Hypothesis 12: As the amount of experience with NSIs increases so will the perception of procedures as being conflicting or unrealistic.

Summary

The proposed theory addresses factors at several levels of a health care organization and how they may be linked to ultimately be predictive of the occurrence of an NSI. It is felt that this approach will lead to a more effective prevention program than approaches that just look at factors related to HCWs. The model proposed will be tested using LISREL 8 (Joreskog & Sorbom, 1993) and is particularly useful in that it can outline which of the factors in the theory account for the most variance in critical behaviors and, therefore, in NSIs. This creates a situation where efforts at preventing NSIs can focus on these critical areas. With the exception of the individual factors of personality, age, gender, and tenure all factors in the model have the potential for strategic intervention. It is hoped that the theory will not only outline which factors are the most critical, but will also give an indication of the types of interventions that would be the most effective.

The following section describes the methods involved in a four phase study aimed at testing the above hypotheses. The first three phases involved the development of a questionnaire to be used to gather data on the variables

included in the model. The fourth phase consisted of collecting the data to be used in the LISREL analysis from a sample of working nurses.

Methods

This section will outline and describe the individuals who participated, the materials used, and the procedures that were followed in conducting this study. There were four phases to the study. The first phase consisted of determining a number of behaviors and environmental factors that are associated with the occurrence of NSIs. The second and third phases centered on developing the questionnaire used to gather data for testing the structural model. The fourth phase involved of the administration of the final questionnaire to the target population. The steps carried out in each of the phases will be presented in chronological order. This is followed by a description of the participants involved in phase four whose data was used in the testing of the structural model and a detailed description of the scales used in the questionnaire.

Procedure

Phase 1

The first phase of the study sought to determine the critical behaviors that may lead to a needlestick injury. A critical behavior was defined as one which could predict the occurrence of NSIs or near misses either to a HCW working directly with needles or to others around them. Critical behaviors include such actions as recapping used needles, putting a contaminated needle down for later disposal, and improper disposal of a contaminated sharp object. In order to determine which actions were critical behaviors a number of steps were carried

out. Occupational health and safety records were collected in two major hospitals in the Calgary area from 1991 to 1995 and analyzed. This analysis consisted of determining what the health care workers were doing at the time of the injury and what objects they were using. Interviews based on the critical incident technique (Flanagan, 1954) were then carried out with three experienced nurses. Five additional experienced nurses participated in a focus group and filled out questionnaires that were developed based on the critical incident technique. These interviews and questionnaires addressed not only critical behaviors but also a number of different dimensions that may affect the occurrence of an NSI (see Appendix B). The result was a list of behaviors that were thought to be highly related to the occurrence of an NSI (see Table 4 for the complete list).

Phase 2

Phase two consisted of the development of a questionnaire to be used in phase four to test the proposed systems level causal model of needlestick injuries. The items on the questionnaire were developed based on the results of the interviews and focus groups in Phase 1 as well as the results and findings of previous studies. The final version of the pilot questionnaire consisted of 68 items that addressed the factors outlined in the model (see Appendix C). Seven scales were developed to measure the following factors: job stress (9 items), procedural stress (5 items), administrative support (7 items), interpersonal support (5 items), reporting practices (5 items), knowledge about disease transmission via NSIs (6 items), and conflicting or unrealistic procedures (8

items). The remainder of the items were questions addressing demographics (7 items) , experience with NSIs (2 items), critical behaviors (11 items) and opinions about ergonomic equipment (3 items). Thus, the survey consisted of seven independent scales each one measuring one construct as well as items looking at demographics, critical behaviors, experience, and ergonomic equipment. In this pilot phase, the main goal was to develop a questionnaire that could be used on a larger population of working nurses, and to test the internal reliabilities of the seven scales.

For the pilot study 88 participants filled out the test questionnaire. Participants were third and fourth year nursing students in The University of Calgary and Mount Royal College Conjoint Nursing Program, graduate nursing students at The University of Calgary, and nursing faculty members from The University of Calgary. Before analyses were conducted, questions that were poorly worded (based on multiple comments in margins indicating confusion over what the question was asking) or were not answered by the majority of respondents were eliminated.

Because seven individual scales were developed for this questionnaire, principle components analyses were run on each of the intended scales. Before this was done, however, a maximum likelihood common factor analysis was run on the entire questionnaire. As it was known that there were seven intended scales, the common factor analysis was run on the entire questionnaire to determine whether questions that were meant to measure the seven underlying

constructs were actually loading together (e.g., that all questions aimed at measuring stress appeared to be grouped). In order to have statistical stability for a common factor analysis on this questionnaire 680 participants would have been required; 10 participants per item being tested (Tabachnick & Fidell, 1996). With a sample size smaller than this the results are unstable as they are susceptible to the effects of chance and can be strongly influenced by individual differences. Because there were only eighty-eight participants the results were used merely as a guide and no questions were dropped as a result. In this analysis, six interpretable factors were extracted. Five of the factors corresponded with intended scales. The last factor consisted of a combination of items on the administrative and interpersonal support scales. It was, therefore, decided that these two scales would be combined into one called safety environment for further analyses.

Principle components analyses and internal consistency analyses were then carried out on the five intended scales as well as the combined administrative and interpersonal support scale (safety environment). Questions that did not load highly on their intended component were dropped unless it was felt that the reason they were not loading was due to the student sample. For example, a couple of students indicated that neither they nor their counterparts could recap needles doing so would result in them failing their course. In such cases the questions were kept (e.g. item 3 in the safety environment scale). In addition, questions addressing knowledge, experience, and demographics were

also kept. The results of the principle components analyses and item internal consistency analyses are summarized in Table 5. On the internal consistency analyses, the components containing the job stress, conflicting or unrealistic procedures, procedural stress, and NSI reporting scales all exceed an alpha level of 0.70 which is generally accepted for research purposes (Nunnaly & Bernstein, 1994). While the safety environment, and knowledge of disease transmission via NSIs scales are below this level they meet or exceed Nunnaly's (1967) criterion range of 0.50 to 0.60 for instruments in the early stages of development.

Table 5
Principle Components Analyses and Item Internal Consistency Analyses For The Six Scales On The Pilot Questionnaire

Procedural Stress Scale	
Questionnaire Item	α if item deleted
Violate safety procedure for the welfare of the patient	.72
Violate safety procedure due to time constraints	.73
Violate safety procedure due to personal stressors	.73
Violate safety procedure due to uncooperative patients	.73
Violate safety procedure due to situational factors	.75
Task procedures conflict with safety procedures	.74
Safety procedures unrealistic with regard to time	.74
Scale α = .76	

Safety Environment Scale	
Questionnaire Item	α if item deleted
Do coworkers wear gloves	.53
Do coworkers wash hands	.52
Do coworkers refrain from recapping needles	.62
Do coworkers wear safety goggles	.59
Are there adequate numbers of sharps containers	.60
Are there safety reminders around the department	.52
Are safety inservices or safety education provided	.54
Scale α = .60	

Conflicting or Unrealistic Procedures Scale	
Questionnaire Item	α if item deleted
How often are procedures unrealistic with regard to time	.63
How often are procedures unrealistic with regard to workload	.53
Do procedures for completing a task interfere or conflict with safety procedures regarding needles	.68
Do different needle safety procedures conflict with each other	.69
Scale α = .70	

Job Stress Scale	
Questionnaire Item	α if item deleted
Does personal (non-work related) stress affect NSIs	.85
Does fatigue affect NSIs	.80
Do distractions affect NSIs	.83
Does lighting, heat, and other environmental factors affect NSIs	.82
Does shift work patterns affect NSIs	.81
Scale α = .85	

Table 5 (continued)
Principle Components Analyses For The Six Scales On The Pilot Questionnaire

NSI Reporting Scale	
Questionnaire Item	α if item deleted
How likely are you to report an NSI via prescribed procedures	--
Does the hospital have an NSI reporting program	--
Scale α = .74	
Knowledge Scale	
Questionnaire Item	α if item deleted
What percentage of Hepatitis B NSIs result in transmission	--
What percentage of AIDS NSIs result in transmission	--
Scale α = .63	

One change to the path model to be tested was made based on the results of the pilot study. Because the questions addressing administrative support and interpersonal support loaded together on one component these two scales were combined to make one called safety environment which measured both (see Figure 6).

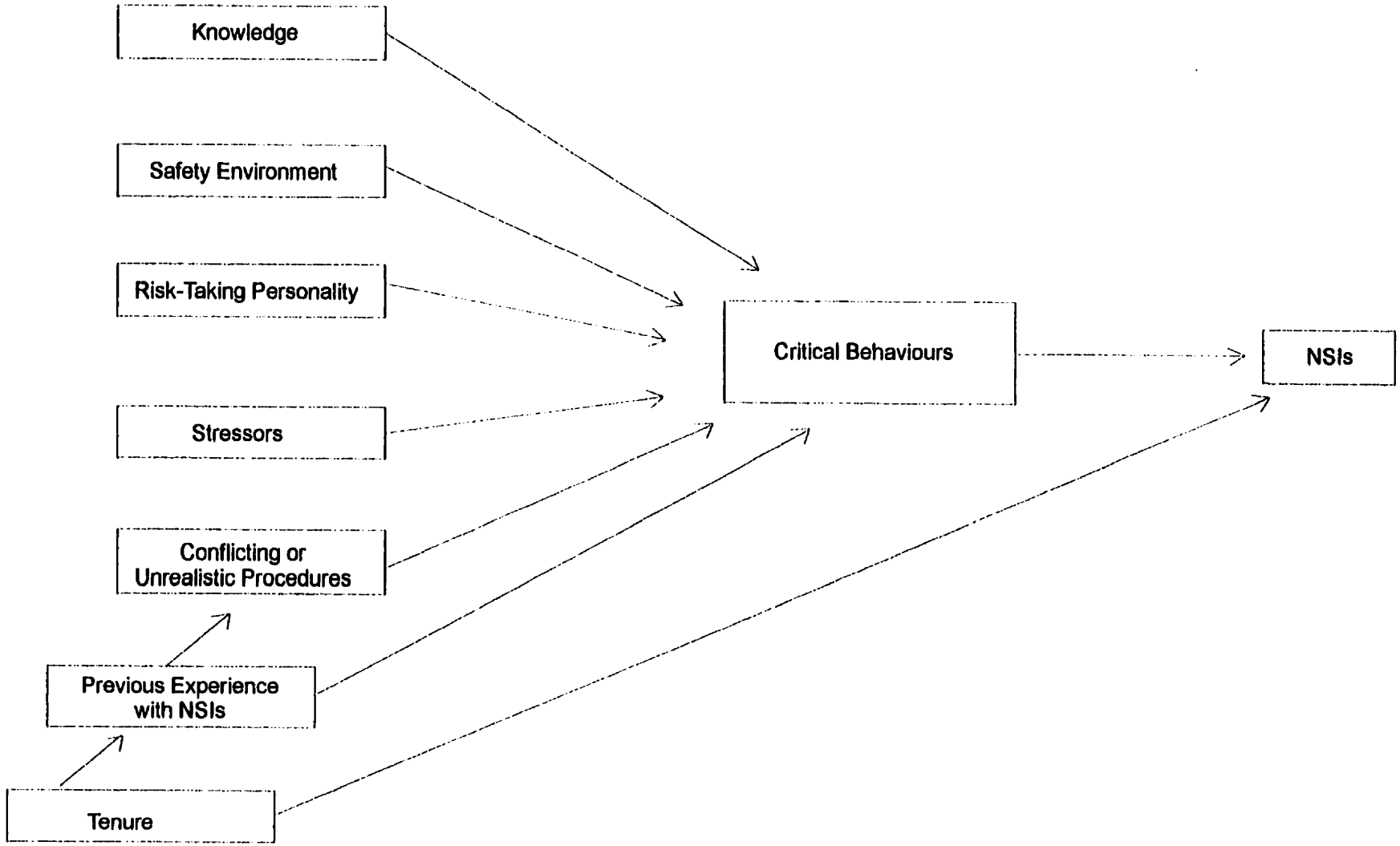


Figure 6. Causal model to be tested.

Phase 3

In this phase, the questionnaire was revised based on the results as well as to adapt the questionnaire so as to be suitable for a population of nurses working in hospitals rather than students and teachers. A number of items were re-worded to increase their clarity. In order to keep the number of questions down, the items on reporting were dropped as under-reporting of NSIs has already been well documented in the literature. For the final questionnaire, the conflicting or unrealistic procedures scale in the pilot study was combined with the procedural stress scale due to the similarity of the items. A number of questions were added addressing both personal and vicarious experience with NSIs to create the experience scale. Additional items were also added to both the safety environment and knowledge about NSIs scales in order to better measure these constructs. Previous findings have indicated that risk-taking personality is related to the occurrence of NSIs. Therefore, an established risk-taking personality scale (Franken, Gibson, & Rowland, 1992) was included. As well, a critical behaviors scale based on the results of phase one was added as a measure for that construct. The goal at this phase was to improve the reliability of the scales measuring the six factors and to collect data that could be used to test the causal model. The final version of the questionnaire was 68 items long (see Appendix D). With 68 items, the questionnaire was six pages long. While the length may have affected the response rate, it was felt that all of the questions included were essential to effectively capture the constructs of interest.

Because revisions were made to the original questionnaire and a different sample was being used, internal consistency reliability analyses were conducted on the scales before the proposed structural equations model was tested.

As the measure used was a self-report questionnaire, a number of steps were taken in an attempt to decrease the amount of response bias and method variance. One type of response bias occurs when participants respond in a way they feel is socially desirable as opposed to answering honestly. This was a concern for a number of questions that addressed issues such as violating safety procedures which may be perceived as undesirable traits. By including a social desirability scale, the tendency to respond in a socially acceptable way could be measured. If necessary, the social desirability factor could then be partialled out in the analysis. A 10-item short form (Version XI) of the original Crowne-Marlowe Social Desirability Scale was used in this study. This short form was tested by Stratian and Gerbasi and found have the highest internal consistency out of a set of short forms (1972, cited in Fischer & Fisk, 1993).

Social desirability can also be regarded as a form of method variance. Method variance is defined as "an artifact of measurement that biases results when relationships are examined among constructs measured in the same way" (Spector, 1987, p. 438). Method variance reflects the tendency for traits to correlate more highly as a result of being measured in the same way (Campbell & Fisk, 1959). As such, it can affect the chances of incorrectly rejecting null hypotheses that there is no relationship among variables (Paglis & Williams,

1996). If we know sources of method variance, however, we can take steps to control them so that accurate conclusions can be made (Spector & Brannick, in press). Accordingly, a number of steps were taken in this study to reduce the amount of method variance. (1) The order of the questions is randomized such that questions looking at each variable were not presented as a unit. (2) Social Desirability was measured. (3) A number of questions were reverse coded. (4) For the conflicting or unrealistic procedures and critical behaviors scales, the questions were worded such that the frequency of behaviors was solicited rather than the effectiveness of the behavior. (5) Different response scales were used both between and within scales. (6) Only perceptions and attitudes were measured. All of these strategies have been proposed as ways in which to reduce the effects of method variance (Jex, Beehr, Heinisch, & Chen, 1993; Paglis & Williams, 1996; Schmitt, 1994; Spector, 1994; Spector & Brannick, in press).

Phase 4

Phase four consisted of mailing out the final questionnaire to 650 nurses who were working in Alberta hospitals for the duration of the study. The recruiting procedure consisted of sending a package to the selected nurses. Each package contained a cover letter (see Appendix E) that explained the purpose of the study and the informed consent, the structure of the questionnaire, the estimated time commitment and an addressed, stamped return envelope. The questionnaire took approximately 15 minutes to complete.

Nurses were not asked to give their names or any other identifying information and all answers were kept confidential. The mail-out was done by an independant mailing company in order to keep the names and addresses of those solicited confidential.

Participants

650 Alberta nurses were sent a questionnaire and solicited as participants. Recruiting was done through the membership list of the Alberta Association of Registered Nurses (AARN). The mail-out of the survey was conducted two and a half months after the annual registration update was completed. Therefore, all of the data on the sample was current and no questionnaires were lost or had to be removed from analysis due to occupation changes, department changes, full/part time status changes, or change of address. Because the number of male nurses in the AARN is quite small (< 2%) obtaining a representative sample of males would have been difficult. As a result, a random sample of all female nurses was drawn and the gender variable was dropped from the path model.

Two hundred and nine nurses completed and returned the surveys for a response rate of 32%. Response rates for mailed questionnaires typically range from 10% to 50%. Thus, the response rate of this study is comparable to other mail-out studies (Weisberg, Krosnick, & Bowen, 1989). It was hoped that the response would be higher as the nurses who were involved in the development phases of the questionnaire were very enthusiastic and indicated that they felt

nurses would be interested in participating. One possible reason for getting a lower response rate than expected may have been due to the fact that the mail-out occurred in mid-December, 1996. The holiday season may have detrimentally affected the response rate.

Participants' ages ranged from 26 to 61 years ($\underline{M}$ = 39.19, $\underline{SD}$ = 7.83) and experience as a nurse ranged from five to 40 years ($\underline{M}$ = 16.36, $\underline{SD}$ = 7.49). Nurses sampled were all working full time in an emergency room or critical care unit at the time that the questionnaire was sent out. Eighty-four respondents were emergency room (E.R.) nurses and 125 were critical care unit (C.C.U.) nurses. The ratio of E.R. to C.C.U. in this sample is 3:4 and the ratio in the A.A.R.N. is approximately 3:5. Therefore the larger number of C.C.U. nurses is representative of the A.A.R.N. population. There were no differences between the E.R. and C.C.U. nurses in the number of career NSIs, NSIs in the previous five years, or close calls in the previous five years. Due to the relatively low transmission rates, it was expected that most of the nurses' NSI experiences would be of a benign nature. This prediction was confirmed. Only one respondent had contracted an illness as the result of an NSI and 38 respondents knew of others who had. Demographics of the full sample are provided in Table 6. Due to the non-exploratory nature of LISREL 8 it was decided to split the sample and use one half in an exploratory manner (EXP) and the other half with no modifications as a confirmatory sample (CON). Therefore, an odd-even split was performed and it was determined that they were no differences between the

samples. The demographics of the exploratory (EXP) and confirmatory (CON) samples are summarized in Table 7. In all cases, the categories for the demographic variables were chosen in order to make the distribution of cases as close to a normal curve as possible. The means and standard deviations for the variables are provided in Table 8. Figure 7 shows the number of career NSI for the total sample as well as for the exploratory and confirmatory samples.

Table 6
Full Sample Demographics And Experience With NSIs (N = 209)

Variable	# of Cases	% of Sample
Age		
1) 26-32 years	46	22
2) 33-39 years	81	39
3) 40-46 years	42	20
4) 47-53 years	27	13
5) 54-61 years	13	6
Tenure		
1) 5-11 years	72	34
2) 12-18 years	59	29
3) 19-25 years	50	24
4) 26-32 years	24	11
5) 33-40 years	4	2
Department		
1) Emergency (E.R.)	84	40
2) Critical Care Unit (C.C.U.)	125	60
NSIs In The Previous Five Years		
1) 0	72	34
2) 1	87	42
3) 2-4	37	18
4) 5-6	11	5
5) 7 or more	2	1
Close Calls in the Previous Five Years		
1) 0	37	18
2) 1-5	113	54
3) 6-10	36	17
4) 11 or more	23	11
Number Of Coworkers Having Sustained One or More NSIs		
1) 0	1	1
2) 1-5	71	34
3) 6-10	74	35
4) 11-15	16	8
5) 16 or more	47	22
Number of Coworkers Having Contracted An Illness From AN NSI		
1) 0	171	82
2) 1	27	13
3) 2 or more	11	5

A number of observations can be made about the sample used in this study. Respondents were distributed from those with only five years of experience to those approaching retirement age. Likewise, the sample represents a wide range of experience from as few as five years to as many as 40 years as a nurse working in a hospital. The number of career NSIs and the number of NSIs in the previous five years is relatively low compared to previous studies conducted on Alberta nurses in the past few years (Baraneicki, 1993; Dekker & Robson, 1992). In these studies it was found that, on average, the Alberta nurses sampled sustained approximately two NSIs per year. The difference between the number of NSIs in this sample and those found in previous studies could be the result of many things, including: sampling differences, distrust about the anonymity of the results, a reduction in the number of NSIs, or a reduction in the number of reported NSIs. Another interesting observation is that the number of close calls in the previous five years is much higher than the number of NSIs sustained in the same time frame. This is in accordance with the common conception that many close calls occur for every NSI. The proportion of close calls to NSIs in this sample was approximately 4:1. One last observation is that the number of people who have contracted a disease from an NSI or know of another who has is very low compared to the reported overall NSI rates for self and others. This provides evidence for a situation where personal and vicarious NSI experiences are, for the most part, benign.

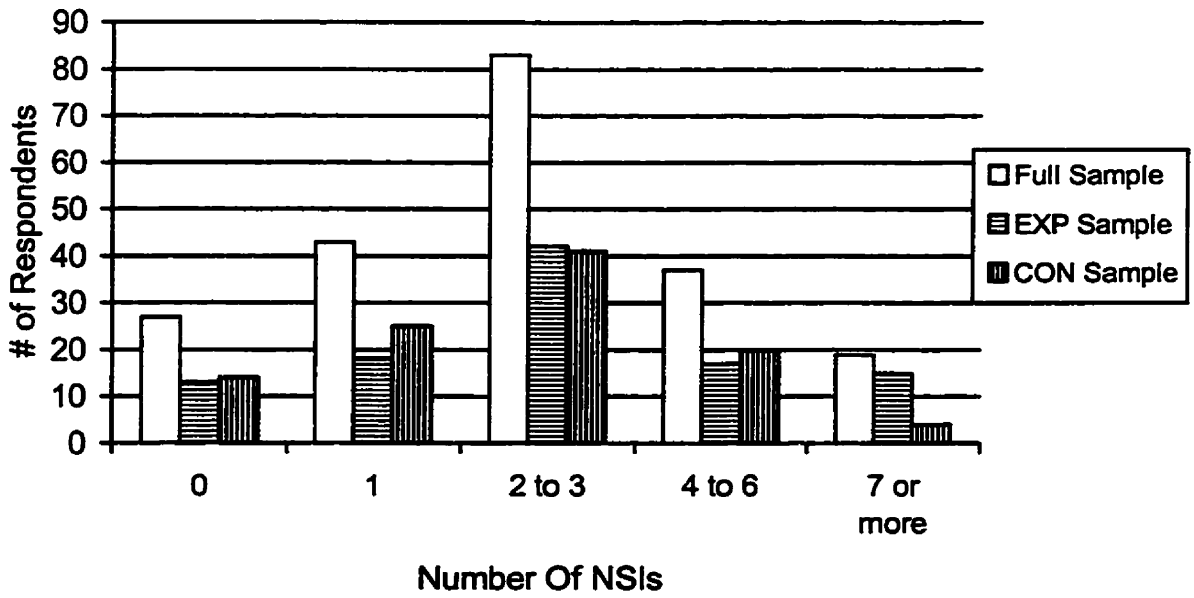
Table 7
Exploratory (N=105) And Confirmatory (N=104) Sample Demographics and NSI Experiences

Variable	# EXP	% EXP	# CON	% CON
Age				
1) 26-32 years	23	22	23	22
2) 33-39 years	45	43	36	35
3) 40-46 years	20	19	22	21
4) 47-53 years	14	13	13	13
5) 54-61 years	3	3	10	9
Tenure				
1) 5-11 years	38	36	34	33
2) 12-18 years	33	31	26	25
3) 19-25 years	24	23	26	25
4) 26-32 years	9	9	15	14
5) 33-40 years	1	1	3	3
NSIs In The Previous Five Years				
1) 0	31	29	41	40
2) 1	45	43	42	40
3) 2-4	20	18	17	16
4) 5-6	7	8	4	4
5) 7 or more	2	2	0	0
Close Calls in the Previous Five Years				
1) 0	23	22	14	13
2) 1-5	54	51	59	58
3) 6-10	18	17	18	17
4) 11 or more	10	10	13	12
Number Of Coworkers Having Sustained 1^{+} NSIs				
1) 0	0	0	1	1
2) 1-5	34	32	37	36
3) 6-10	40	38	34	33
4) 11-15	6	6	10	9
5) 16 or more	25	24	22	21
Number of Coworkers Having Contracted An Illness From AN NSI				
1) 0	85	81	86	83
2) 1	14	13	13	12
3) 2 or more	6	6	5	5

Table 8
Means And Standard Deviations Of The Demographic Variables For The Full, Exploratory, And Confirmatory Samples

Variable	Mean	Standard Deviation
Age		
Full Sample	39.19	7.83
Exploratory Sample	38.42	7.08
Confirmatory Sample	39.96	8.48
Tenure		
Full Sample	16.35	7.49
Exploratory Sample	15.66	6.87
Confirmatory Sample	17.08	8.03
Career NSIs		
Full Sample	3.35	4.49
Exploratory Sample	3.92	5.24
Confirmatory Sample	2.77	3.50
NSIs In The Previous Five Years		
Full Sample	1.17	1.52
Exploratory Sample	1.38	1.79
Confirmatory Sample	0.96	1.17
Close Calls in the Previous Five Years		
Full Sample	6.75	11.68
Exploratory Sample	6.38	11.51
Confirmatory Sample	7.12	11.90
Number Of Coworkers Having Sustained One or More NSIs		
Full Sample	12.36	12.11
Exploratory Sample	12.71	11.86
Confirmatory Sample	12.00	12.42
Number of Coworkers Having Contracted An Illness From AN NSI		
Full Sample	0.39	2.16
Exploratory Sample	0.53	2.97
Confirmatory Sample	0.23	0.66

Figure 7: Number of Career NSIs Sustained By The Respondents



Measures

All variables were measured via self-report. Seven scales were used to measure the variables outlined in the hypothesized path model. In addition, a social desirability scale was included as well as a number of questions that measured demographics and items for discussion purposes. All but two scales used seven point Likert-Type scales. The 'knowledge about disease transmission via NSIs' and 'previous experience with NSIs' scales had open-ended responses so as not to force the data into large response categories. Data on these questions were categorized before being analyzed for internal consistency and used in the path model. With the exception of the risk-taking

and social desirability scales, the scales used were developed by the author based on the results of the pilot study.

Risk-taking

To test participants' level of risk-taking personality, a five item physical risk- taking scale was used (Franken, Gibson, & Rowland, 1992) (see Appendix F). A high score on a risk-taking scale indicates a willingness to expose oneself to situations with uncertain outcomes (Jackson, 1976). Examples of risk-taking items include: "I consider myself to be a risk taker" and "the greater the risk the more fun the activity". Scale responses ranged from 1 (strongly disagree) to 5 (strongly agree).

Social Desirability

The ten item version of Crowne and Marlowe's social desirability scale (cited in Fischer & Fisk, 1993) was used (see Appendix F). Questions on this scale include: "I always try to practice what I preach" and "I have never been irked when people expressed ideas very different from my own". Participants indicated their response on a 1 (strongly disagree) to 5 (strongly agree) scale.

Safety Environment

Safety environment was measured using 11 items. Four of the items addressed interpersonal factors and 7 looked at factors at the administrative level (see Appendix F). Examples of questions looking at the interpersonal safety environment include: "On average, what percentage of the time do your coworkers violate needle safety procedures (e.g., recap used needles)?" and "To

what degree do you feel that the following statement is true: Your coworkers believe that sustaining an NSI is a serious, possibly deadly, threat to one's health?". Items looking at the administrative safety environment include "In the facility in which you work, how often are you given training on how to use unfamiliar or new needles and needle devices?" and "To what degree do you feel that the following statement is true: The equipment in the hospital in which I work is updated as safety technology evolves?". Depending on the question asked there were a number of response formats. These were: a) 1 (strongly disagree) to 5 (strongly agree), b) 1 (0-20% of the time) to 5 (81-100% of the time), and c) 1(never) to 5 (very frequently).

Conflicting or Unrealistic Procedures

A seven item scale was used to assess the needle safety procedures as well as the participants' perceptions of them (see Appendix F). Examples of items on this scale include: "On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because workload levels prevent it?" and "On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g., immediate disposal of used needles, always following universal precautions) because other safety or task procedures conflict or interfere with them?". These items were answered on a scale ranging from 1 (0-20%) to 5 (81-100%).

Stressors

The stressors scale consisted of seven items measured from 1 (strongly disagree) to 5 (strongly agree). Included in this scale are items like: "To what degree do you feel that the following is true: Fatigue affects the occurrence of actions or behaviors that may lead to NSIs among health care workers." and "To what degree do you feel that the following is true: understaffing affects the occurrence of actions or behaviors that may lead to NSIs among health care workers." (see Appendix F).

Critical Behaviors

The list of critical behaviors was narrowed down to create ten items for a critical behaviors scale. To create this list, similar critical behaviors were combined into single items and relatively infrequently performed critical behaviors were not included. The final scale consisted of items addressing ten behaviors (see Appendix F). Examples are "On average what percentage of the time do you check to see if a sharps container is full before disposing of a needle or other sharp object? and "On average, what percentage of the time do you attend to other things (the patient, the state of the I.V. bags, monitoring equipment, etc.) while handling a contaminated sharp object?". Possible answers ranged from 1 (0-20%) to 5 (81-100%).

Factual Knowledge About Transmission of Disease Via NSIs

The respondents' level of knowledge about NSIs was assessed using a five item scale (see Appendix F). Three questions were open ended. Examples

of items on this scale include: "To the best of your knowledge, what percentage of NSIs that involve blood or other body fluids from a confirmed Hepatitis B patient will result in an unvaccinated health care worker contracting the disease? If you are unsure give your best estimate.". The remaining two items were on a five point scale and took the form of "To the best of your knowledge, how much blood (in milliliters) is required for the transmission of AIDS to occur?". The scale ranged from 1 (less than 0.00001 mL) to 5 (0.1 - 1 mL).

Previous Experience with NSIs

Experience was assessed with a six item scale. All questions were open-ended. For analyses purposes, the first and third items ("Approximately how many NSIs have you sustained during your career?" and "Approximately how many close calls have you had in the past five years?") were combined and used as the principle dependent variable. The second question addressed the number of NSIs sustained in the previous five years. This item was not used in the analysis as a low variance was expected, but was gathered for demographic purposes only. The remainder of the items were used as the measure of past experiences with NSIs. These questions addressed previous personal experiences with disease transmission via NSIs and vicarious NSI experiences (see Appendix F).

Demographics and Information Questions

All demographics such as years experience as a nurse and department worked in were assessed with single questions. In addition, a number of

questions were asked for informational purposes that were not to be used in the analyses. These questions addressed factors such as whether the nurses felt that ergonomically designed needles were effective in preventing NSIs from occurring and whether nurses felt interpersonal influences affected the incidences of NSIs (see Appendix F).

Results

Analysis

To test the proposed path model, structural equation analysis with LISREL 8 was used (Joreskog & Sorbom, 1993). There are a number of advantages to using this statistical method for testing path models. LISREL 8 is able to test all specified relationships between multiple independent and dependent variables simultaneously. This advantage is accentuated in models such as the one being tested in this study where the predictor variables are likely to be highly interrelated. Another advantage of using LISREL 8 to analyze a path model is that it gives a number of modification indices which indicate possible ways of improving the model. These indices are particularly useful in exploratory studies.

With LISREL 8 the parameters specified in the model (paths) are estimated, using a maximum likelihood procedure, to produce an estimated correlation matrix. If the proposed model is reasonable, then the estimated correlation matrix will be able to reproduce closely the sample correlation matrix. How well the estimated matrix reproduces the sample matrix is evaluated by a number of measures. The overall fit of the model to the data is assessed using a chi-squared goodness of fit index (χ^2) . If the model is consistent with the data, a small, non-significant chi-square value will result (Tabachnick & Fidel, 1996). However, the chi-squared statistic is often affected by factors such as sample size, normality assumptions, and independence of factors and errors. Therefore, this measure must be interpreted with caution. The goodness of fit index (GFI)

indicates the amount of variance and covariance in the data set that is accounted for by the model. The GFI ranges from 0 to 1 with higher numbers indicating a better fit. Values of 0.90 or higher indicate a good fit (Tabachnick & Fidel, 1996). The Adjusted Goodness Of Fit Index (AGFI) takes into account the degrees of freedom and also ranges from 0 to 1. Values of 0.80 or higher are reasonable and values of 0.90 are good (Tabachnick & Fidel, 1996). The last measure of how well the model fits the data is the root mean square residual (RMR). This value also ranges from 0 to 1 and is an indication of the average residual, or non-accounted for, variance and covariance in the model. In this case, values of 0.10 or less are desirable (Osman, Barrios, Aukes, Osman, & Markway, 1993).

In addition to assessing the goodness of fit of the entire model, the strengths of the individual paths can also be assessed. To assess the strength of a path a t-test is used. These values are the estimated parameter (path) coefficients divided by their standard errors. These t-tests assess whether the values of the paths are significantly different from zero. A value of 2.00 or greater is considered statistically significant (Joreskog & Sorbom, 1986). The sign of the t-value should be interpreted in the same way as a correlation coefficient.

As mentioned above, a strength of the LISREL 8 program is that it provides modification indices. These serve to help determine where the model can be modified in order to increase the fit of the model to the data. Modification

indices are generated for all paths in the model that have not been specified. A modification index of 5.00 or greater indicates that if that path were included in the model the overall χ^2 value would decrease significantly (Joreskog & Sorbom, 1986). Thus, the model's fit will increase. Before a modification can be made, however, the path must make sense and be justified on theoretical grounds.

LISREL, as a structural equation modeling technique, is not exploratoy in nature. That is, the researcher must specify, in advance and based on theory, what variables will be included in the model and what the relationships will be between them. LISREL can, however, be used as an exploratory technique where paths can be added or removed from the model based on the values of the t-tests and modification indices. Whenever this exploratory strategy is used care must be taken to ensure that Type I errors are not inflated. It is recommended that in such cases the new, revised model be tested on a second sample. This second sample serves as a confirmatory one and no modifications should be made to it (Tabachnick & Fidel, 1996). Because this study is the only one known that has used a causal modeling technique to examine factors related to the occurrence of NSIs, an exploratory approach was used. The sample was split in half using an odd-even split with one half being used as an exploratory sample and the other half being used as a confirmatory one.

Internal Consistency Analyses

Because some changes were made to the scales and the population used in this study was different from the student population used in the development

of the scales, the reliability of the scales was tested before the path model was tested. Internal consistency analyses were run on the safety environment, stressors, conflicting and unrealistic procedures, knowledge about disease transmission via NSIs, critical behaviors, risk-taking personality and social desirability scales. This was done to ensure that inter-item correlations were significant for the revised scales with this population indicating low levels of random error (Judd, Smith, & Kidder, 1991). The experience with NSIs scale was not analyzed for consistency in responding across items as there was no theoretical reason to expect that the items on this scale should be related. For example, the number of personal illnesses contracted as a result of an NSI has no theoretical tie to the number of others whom you know to have sustained an NSI.

As a result of the reliability analyses three items were dropped from the critical behaviors scale. Two were dropped as they did not have a significant item-total correlation. One of these was negatively worded and it is believed that this affected the participants' responses in a non-random way. The third item was dropped as all respondents gave the same answer and it had zero variance. As well, the question addressing whether the nurses had contracted an illness from an NSI was also dropped from the experience with NSIs scale. Only one person had become ill from an NSI and, therefore, the variance on this item was quite low. Table 9 summarizes the resulting reliability coefficients (Chronbach's alpha) for the seven scales.

Table 9
Chronbach's Alpha Levels Of The Seven Scales For The Full Sample

Variable	Chronbach's alpha
Safety Environment	.69
Stressors	.78
Conflicting or Unrealistic Procedures	.88
Knowledge about disease transmission via NSIs	.52
Critical Behaviors	.56
Risk - Taking Personality	.76
Social Desirability	.71

The stressors, conflicting or unrealistic procedures, risk-taking personality, and social desirability scales all exceed the .70 level that is generally accepted for research purposes (Nunnaly & Bernstein, 1994). While the safety environment, knowledge of disease transmission via NSIs, and critical behaviors scales are below this level they meet or exceed Nunnaly's (1967) criterion range of .50 to .60 for instruments in the early stages of development.

Because the sample was split in half to conduct exploratory and confirmatory structural equations modeling, internal consistency analyses were run on the two smaller samples to ensure there were no differences between groups. Table 10 summarizes the Chronbach's alphas for the exploratory (EXP) and confirmatory (CON) samples. Again, all variables meet the .50 criterion for questionnaires in early phases of development with five of the seven surpassing the .70 level criterion.

Table 10
Chronbach's Alpha Levels Of The Seven Scales For The Exploratory (EXP) And Confirmatory (CON) Samples

Variable	α EXP	α CON
Safety Environment	.67	.71
Stressors	.82	.72
Conflicting or Unrealistic Procedures	.87	.88
Knowledge about disease transmission via NSIs	.53	.52
Critical Behaviors	.52	.60
Risk - Taking Personality	.79	.72
Social Desirability	.71	.72

Comparisons Between the Exploratory and Confirmatory Samples

T-tests of all demographic items, scale items, and scales indicated that there were no significant differences between the exploratory and confirmatory groups. The means, standard deviations, medians, and possible ranges of the study variables for the full sample as well as the exploratory and confirmatory samples are presented in Table 11. Examination of Table 11 reveals a number of trends in responding which are summarized in what follows.

Table 11
Means (M), Standard Deviations (SD), Medians, (ME) And Possible Ranges Of The Study Variables For The Full, Exploratory (EXP) And Confirmatory (CON) Samples

				Possible Range	
	M	SD	ME	Min	Max
Safety Environment Scale					
Full (N= 205)	36.82	4.92	37.00	10	52
EXP (n= 102)	36.15	4.90	36.50	10	52
CON (n= 103)	37.49	4.92	37.00	10	52
Stressors Scale					
Full (N= 207)	26.38	4.11	27.00	5	35
EXP (n= 104)	26.51	4.32	27.00	5	35
CON (n=103)	26.25	3.90	26.00	5	35
Conflicting or Unrealistic Procedures Scale					
Full (N= 207)	12.65	5.28	11.00	5	35
EXP (n= 104)	12.98	5.42	11.00	5	35
CON (n= 103)	12.32	5.14	11.00	5	35
Knowledge About Disease Transmission Via NSIs Scale					
Full (N= 206)	8.21	2.86	8.00	0	15
EXP (n= 103)	8.32	2.87	8.00	0	15
CON (n= 103)	8.10	2.86	8.00	0	15
Critical Behaviors Scale					
Full (N= 207)	19.01	4.96	19.00	9	45
EXP (n=104)	19.23	4.96	19.00	9	45
CON (n= 103)	18.97	4.98	19.00	9	45
Risk-taking Personality Scale					
Full (N= 205)	10.04	3.10	10.00	5	25
EXP (n= 102)	9.95	3.15	10.00	5	25
CON (n= 103)	10.13	3.05	10.00	5	25

Trends in Responding

Safety Environment

The average score for safety environment was 36. The mid-point on this scale is 26, indicating that, overall, safety environments in the hospitals were higher than neutral. Higher than neutral scores indicate that the nurses perceive that the administration stresses and promotes safety and adherence to safety procedures. With regard to interpersonal support, it reflects that the individuals' coworkers are perceived as safety conscious and feel that NSIs are a serious threat to one's health.

Stressors

The stress questions looked at nurses' opinions about the influences that a number of common stressors had on the occurrence of NSIs. The average score on this scale was around 26 and the mid-point is 17.5. This indicates that, as a whole, the nurses in this sample feel that the stressors do impact whether or not an NSI occurs. The average score of 26 corresponds with scores of four (or agree) on the five point Likert scale used which ranged from strongly disagree to strongly agree.

Conflicting or Unrealistic Procedures

This scale looked at how often nurses felt that the safety procedures set out were either unrealistic or awkward and how often they conflicted with other procedures. The average score on this scale was 12.65. This indicates that the average response for individual questions was approximately two. On the five

point Likert scale used, a score of two means that the safety procedure is conflicting or unrealistic 21 to 40% of the time. While this may seem low, it means that the nurses feel that they cannot realistically or safely adhere to the safety procedures in as many as 21 to 40% of the cases.

Knowledge About Disease Transmission Via NSIs

The responses to these questions were given in an open-ended format. They were then categorized according to how close they were to the correct answer. Correct answers were given a score of '3' with the score decreasing as the answer was further from the correct response. The average response of around eight out of 15 indicates that the sample as a whole knew little about the specifics of disease transmission from needlestick injuries.

Critical behaviors

The mean score of 19 out of 43 indicates that the average score on the individual critical behavior items was approximately two. On the response scale given this indicates that the nurses were engaging in critical behaviors in 21 to 40% of their interactions with needles. This is high, considering that in many cases these behaviors are known by the nurses to be highly correlated with sustaining an NSI. It would appear that one of the most effective ways to prevent NSIs would be to focus efforts on decreasing the number of critical behaviors engaged in. Table 12 summarizes the frequencies of the critical behaviors engaged in most often by the nurses in this sample. From the table, the three behaviors that are engaged in the most often are recapping used

needles, disassembling needles before disposal, and starting the next step in a procedure before completing the last.

Table 12
Proportion Of The Sample Indicating That They Engage In Critical Behaviors

Critical Behavior	# of respondents	Percentage
1. Disassembling needles before disposal		
0-20% of the time	92	44
21-40% of the time	33	16
41-60% of the time	23	11
61-80% of the time	20	10
81-100% of the time	41	19
2. Not immediately disposing of contaminated needles		
0-20% of the time	151	72
21-40% of the time	28	14
41-60% of the time	16	8
61-80% of the time	11	5
81-100% of the time	3	1
3. Transporting used needles down hallways or through rooms where others are present		
0-20% of the time	127	61
21-40% of the time	40	19
41-60% of the time	22	10
61-80% of the time	14	7
81-100% of the time	6	3
4. Recapping used needles		
0-20% of the time	90	43
21-40% of the time	48	23
41-60% of the time	26	12
61-80% of the time	31	15
81-100% of the time	14	7

Table 12 (continued)
Proportion Of Sample Indicating That They Engage In Critical Behaviors

Critical Behavior	# of respondents	Percentage
5. Attending to other things while handling used sharps		
0-20% of the time	115	55
21-40% of the time	47	23
41-60% of the time	24	11
61-80% of the time	15	7
81-100% of the time	8	4
6. Pay close attention to needles during the disposal procedure (reverse code)		
0-20% of the time	122	59
21-40% of the time	50	24
41-60% of the time	21	10
61-80% of the time	11	5
81-100% of the time	4	2
7. Starting the next step in a procedure before completing the last one.		
0-20% of the time	55	27
21-40% of the time	42	20
41-60% of the time	45	22
61-80% of the time	44	21
81-100% of the time	21	10

Risk-Taking Personality

Overall, the risk-taking scores were low for the sample. The mean score of ten out of 25 indicates that, on average, the nurses disagreed that the risk-taking statements were true of them.

Structural Equation Modeling

Social desirability was correlated with risk-taking personality ($p \leq 0.00$), critical behaviors ($p \leq 0.00$), safety environment ($p \leq 0.05$), and stressors ($p \leq$

0.00). As a result, the effects of social desirability were partialled out. A correlation matrix of these partial correlations were used as input for the LISREL analysis.

Exploratory LISREL

Model 1 (as shown in Figure 6) was tested on the exploratory sample (N=105). Results of the LISREL analysis revealed that the proposed model only fit the data moderately well. The overall χ^2 value was 52.09 with 26 degrees of freedom ($p \leq 0.00$). The GFI was 0.90, AGFI was 0.82 and the RMR was 0.12. The resulting path coefficients are shown in Figure 8 and Table 13.

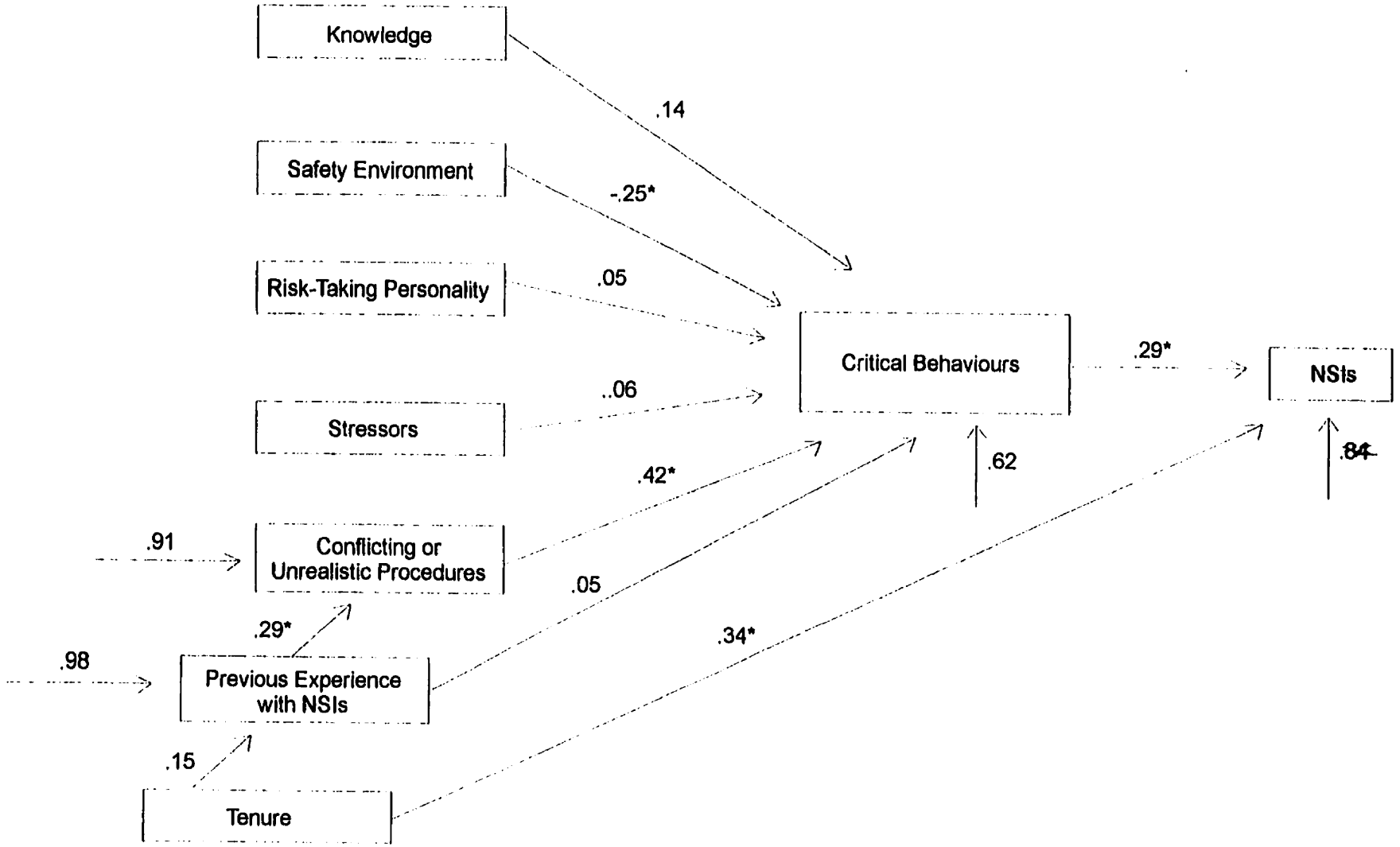


Figure 8. Path coefficients for exploratory sample. (*$p \leq 0.05$)

Table 13
LISREL Matrices: Exploratory Sample

	BETA			
Variable	Procedure	Critical	NSIs	Experience
Procedure	--	--	--	.29*
Critical	.42*	--	--	.05
NSIs	--	.29*	--	--
Experience	--	--	--	--

	GAMMA				
Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	--	--	--	--	--
Critical	.06	--	.05	-.25*	.14
NSIs	--	.34*	--	--	--
Experience	--	.15	--	--	--

	Modification Indices for BETA			
Variable	Procedure	Critical	NSIs	Experience
Procedure	--	9.70	0.07	--
Critical	--	--	3.85	--
NSIs	1.10	--	--	2.59
Experience	8.26	8.20	3.60	--

	Modification Indices for GAMMA				
Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	1.98	8.26	1.63	12.94	0.68
Critical	--	0.51	--	--	--
NSIs	0.21	--	0.13	0.28	2.73
Experience	1.97	--	0.32	5.47	0.15

Note. Procedure = conflicting or unrealistic procedures; Critical = critical behaviors; Experience = previous experience with NSIs; RTP = risk-taking personality; Safety = safety environment; Knowledge = knowledge about disease transmission via NSIs. * > 2.00.

Modifications

The modification indices (MI) indicated that there were two paths which could be freed to increase the fit of the model (see Table 14). The paths that made theoretical sense were entered in one at a time until there were no more modification indices larger than 5. The change in χ^2 was tested after each path was freed in order to ensure that the path was contributing significantly to the model. The largest modification index was for the path from safety environment to conflicting or unrealistic procedures (MI = 12.94). This path was freed and a second LISREL was run. The difference in χ^2 was 14.36 which was significant ($p \leq 0.00$). While the GFI, AGFI and RMR were improved by freeing this path (GFI=0.93, AGFI=0.87, RMR=0.10), the overall χ^2 value was still significant (χ^2 (25) = 37.73, $p \leq 0.05$). Only one modification index remained that was greater than 5.00. This path, from safety environment to previous experience with NSIs (MI = 5.81) was freed and another LISREL run. The resulting change in χ^2 was 6.08 which was significant ($p \leq 0.05$). The GFI, AGFI and RMR indices were again improved (GFI=0.94, AGFI=0.89, RMR=0.10) and the overall χ^2 was no longer significant (χ^2 (24) = 31.65, $p \geq 0.05$). Because there were no remaining modification indices above 5.00 and the fit of the model was good, no further modifications were carried out. The difference in χ^2 after each step and the significance of this difference are summarized in Table 14. The effect of freeing the above two paths on the overall χ^2 and the goodness of fit indices are

summarized in Table 15. The final model is shown in Figure 9 and summarized in Table 16.

Table 14
Difference In χ^2 After Each Modification And The Significance Of The Difference

Path Freed	Change in χ^2	df	Significance of change
Safety environment to Procedures	14.36	1	0.00
Safety environment to Previous Experience with NSIs	6.08	1	0.02

Table 15
GFI, RMR, Overall χ^2, And Significance Of Overall χ^2 After Each Modification

Path Freed	GFI	AGFI	RMR	overall χ^2	df	Sig. χ^2
Initial model	.89	.82	.12	52.09	26	0.00
Safety environment to Procedures	.93	.87	.10	37.73	25	0.05
Safety environment to Experience with NSIs	.94	.89	.10	31.65	24	0.14

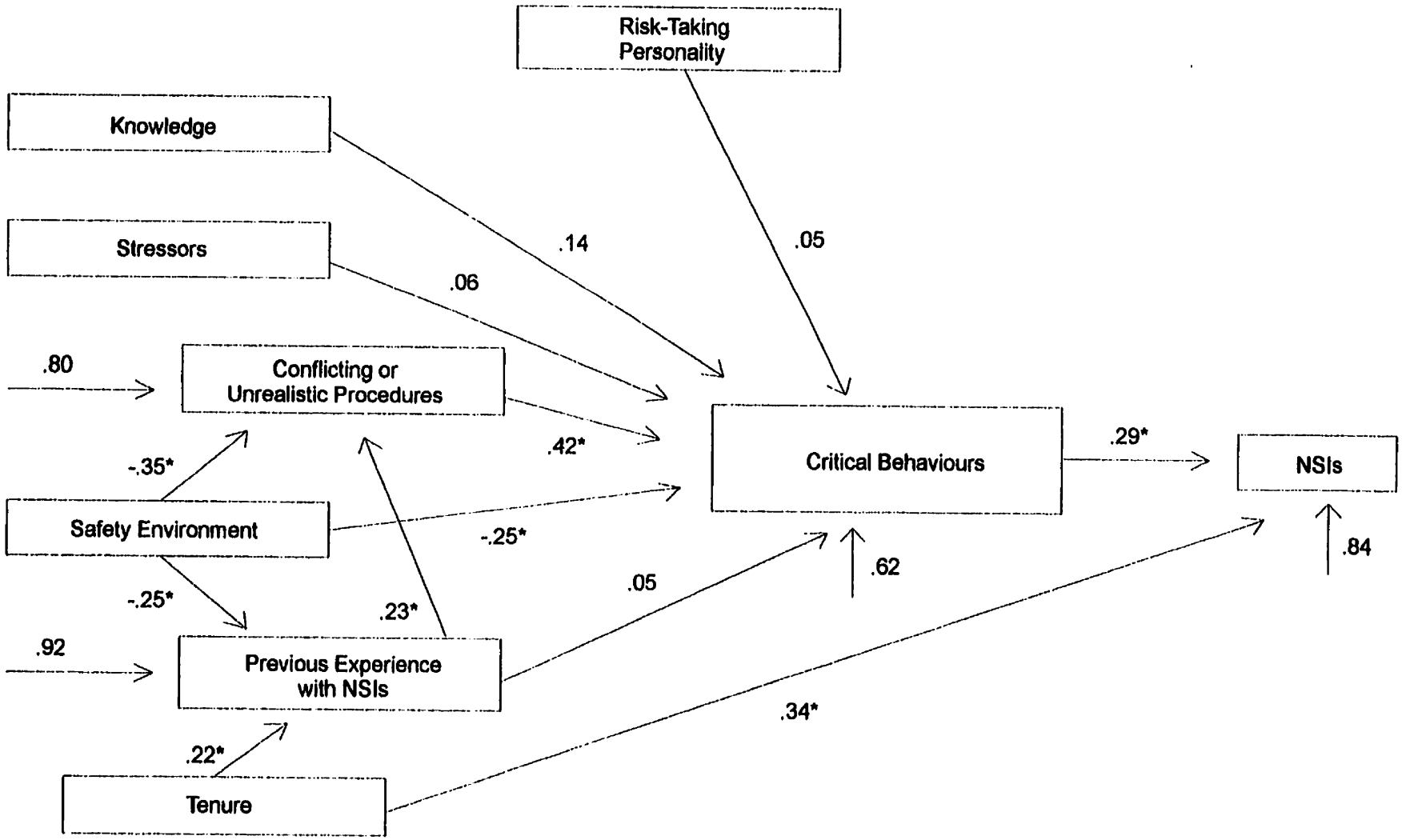


Figure 9. The resulting model and path coefficients for the exploratory sample after modifications. (*$p \leq 0.05$)

Table 16
LISREL Matrices: Exploratory Sample After Modifications

BETA

Variable	Procedure	Critical	NSIs	Experience
Procedure	--	--	--	.23*
Critical	.42*	--	--	.05
NSIs	--	.29*	--	--
Experience	--	--	--	--

GAMMA

Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	--	--	--	-.35*	--
Critical	.06	--	.05	-.25*	.14
NSIs	--	.34*	--	--	--
Experience	--	.22*	--	-.25*	--

Modification Indices for BETA

Variable	Procedure	Critical	NSIs	Experience
Procedure	--	-0.01	-0.02	--
Critical	--	--	-0.21	--
NSIs	0.12	--	--	--
Experience	0.91	0.53	0.17	--

Modification Indices for GAMMA

Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	1.14	3.55	1.06	--	0.74
Critical	--	0.52	--	--	--
NSIs	0.21	--	0.13	0.32	2.72
Experience	0.69	--	0.23	--	0.11

Note. Procedure = conflicting or unrealistic procedures; Critical = critical behaviors; Experience = previous experience with NSIs; RTP = risk-taking personality; Safety = safety environment; Knowledge = knowledge about disease transmission via NSIs. * > 2.00.

Confirmatory LISREL

The confirmatory sample (N=104) was used to test the model resulting from the exploratory analysis which is identified in Figure 9. The confirmatory

LISREL revealed that the model fit the data well, with an overall χ^2 value of 28.88 with 24 degrees of freedom ($p = 0.22$). The GFI was .94, the AGFI was .89 and the RMR was .08 (see Table 17). The results of the confirmatory LISREL are summarized in Figure 10 and Table 18.

Table 17
Fit Indices Of The Exploratory And Confirmatory Samples

Model	GFI	AGFI	RMR	overall χ^2	df	Sig.of χ^2
Exploratory	.94	.89	.10	31.65	24	0.14
Confirmatory	.94	.89	.08	28.88	24	0.22

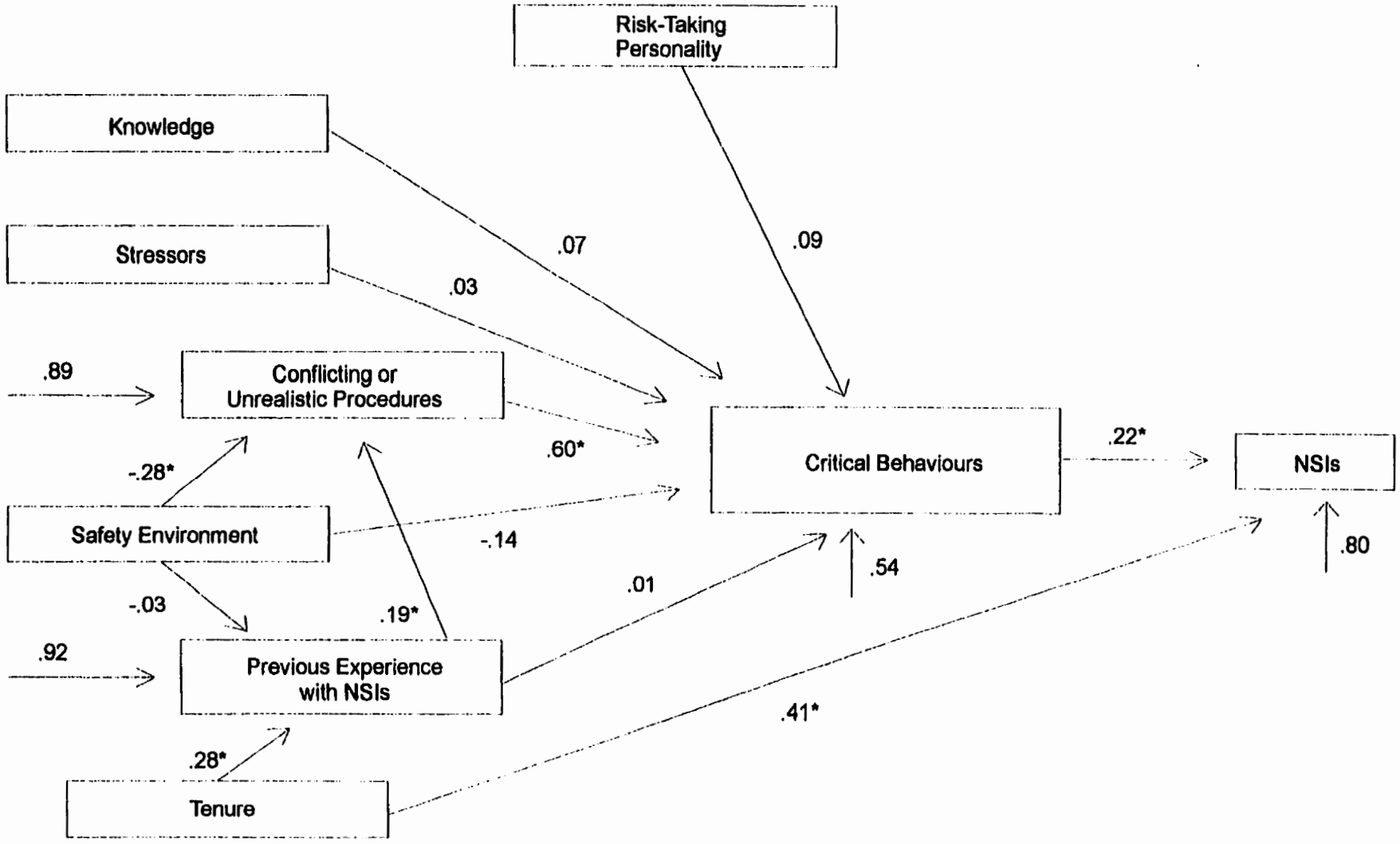


Figure 10. Path coefficients for the confirmatory sample on the modified causal model. (*$p \leq 0.05$)

Table 18
LISREL Matrices: Confirmatory Sample

BETA

Variable	Procedure	Critical	NSIs	Experience
Procedure	--	--	--	.19*
Critical	.60*	--	--	.11
NSIs	--	.22*	--	--
Experience	--	--	--	--

GAMMA

Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	--	--	--	-.26*	--
Critical	.03	--	.09	-.14	.07
NSIs	--	.41*	--	--	--
Experience	--	.28*	--	-.03	--

Modification Indices for BETA

Variable	Procedure	Critical	NSIs	Experience
Procedure	--	0.73	1.05	--
Critical	--	--	0.01	--
NSIs	0.08	--	--	0.78
Experience	0.08	0.26	0.75	--

Modification Indices for GAMMA

Variable	Stressors	Tenure	RTP	Safety	Knowledge
Procedure	0.85	0.08	1.25	--	0.19
Critical	--	0.26	--	--	--
NSIs	1.04	--	4.68	2.55	0.06
Experience	0.14	--	1.39	--	1.98

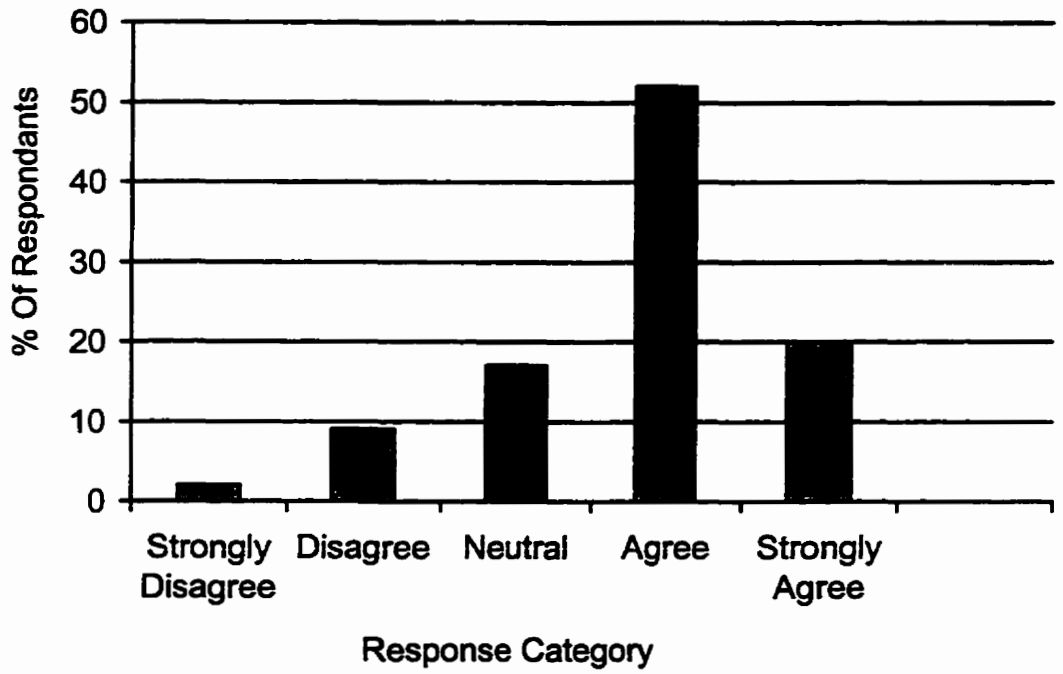
Note. Procedure = conflicting or unrealistic procedures; Critical = critical behaviors; Experience = previous experience with NSIs; RTP = risk-taking personality; Safety = safety environment; Knowledge = knowledge about disease transmission via NSIs. * > 2.00.

Analysis of Exploratory Descriptive Questionnaire Items

In addition to the items on the questionnaire which measured the variables used in the LISREL analysis, a number of questions relating to

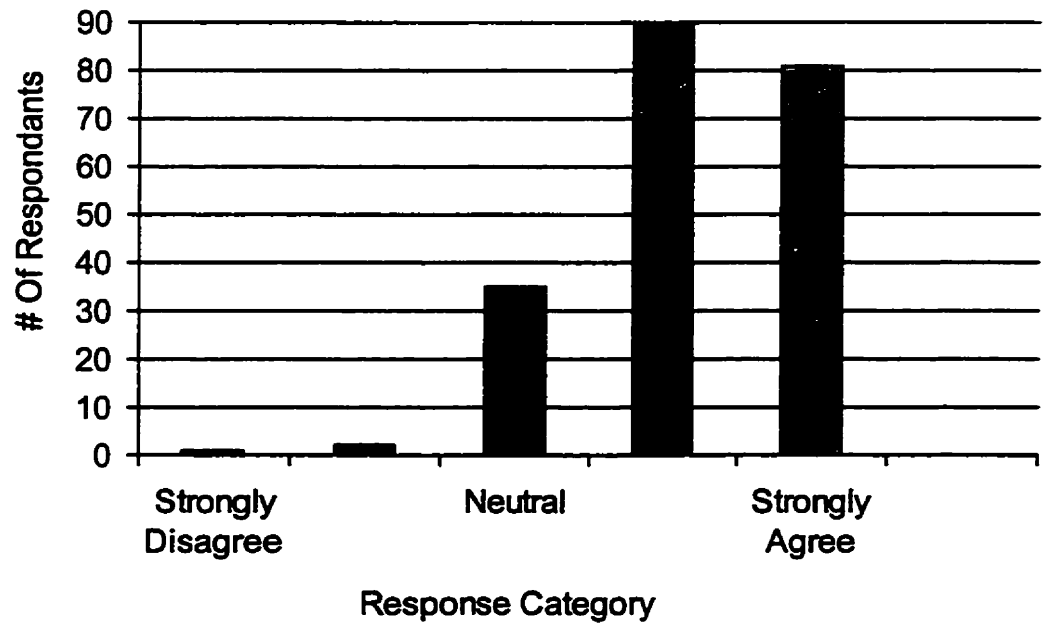
ergonomic equipment and opinions about the impact of the various factors on NSIs were also analyzed. The first question about ergonomic equipment addressed whether or not the nurses felt that ergonomic equipment is effective in preventing NSIs from occurring. Figure 11 summarizes the results.

Figure 11
Percentage Of Respondents Agreeing That Ergonomic Equipment Is Effective



As Figure 11 illustrates, the majority of nurses (≈72%) either agreed or strongly agreed with the statement that ergonomic equipment is effective in preventing NSIs. Figure 12 summarizes the results of the second equipment question which asked if nurses agreed with the statement that they preferred ergonomic equipment over traditional equipment.

Figure 12
Number Of Respondents Agreeing That They Prefer Ergonomic Equipment



Again, the majority of nurses (≈82%) indicated that they either agreed or strongly agreed with the statement that they preferred the ergonomic equipment. These items indicate not only that the nurses feel that the ergonomic equipment is effective in preventing NSIs but also that they prefer to use it.

The three remaining information questions addressed the nurses' opinions about the effect of knowledge and interpersonal stressors on the occurrence of NSIs as well as the dangers associated with NSIs. The first two questions asked whether the nurses felt that knowledge of risks associated with NSIs affects the occurrence of NSI and whether they felt peer opinions and/or peer approval affect the occurrence of actions or behaviors that may lead to NSIs among

health care workers. The final question asked whether the nurses think that sustaining an NSI is a serious, possibly deadly, threat to their health. The results of these questions are summarized in Figures 13 through 15 respectively.

Figure 13
Percentage Of Respondents Agreeing That Knowledge Affects NSIs

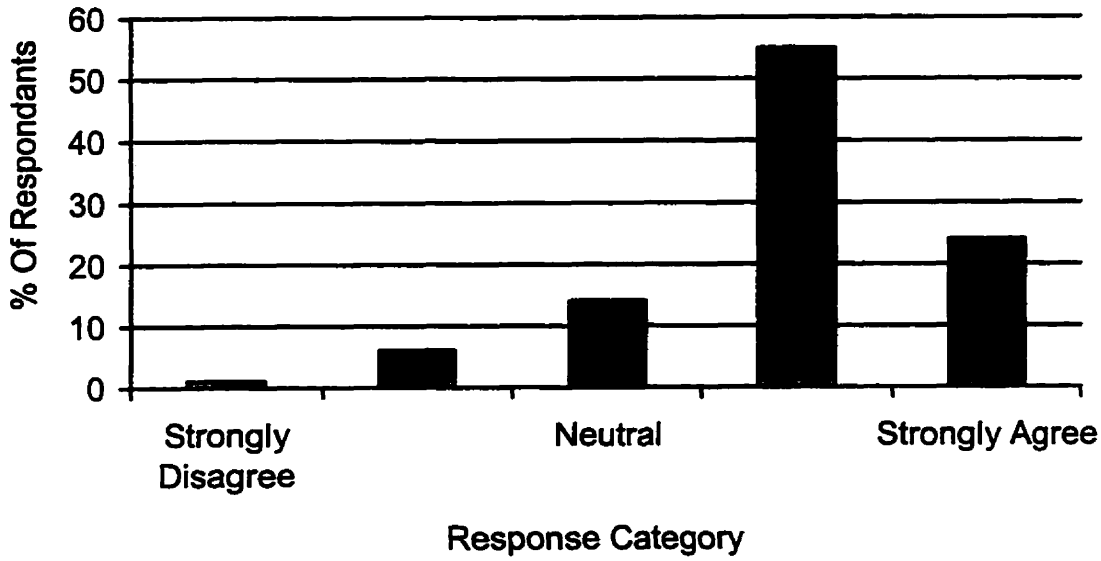


Figure 14
Percentage Of Respondents Agreeing That Peer Relationships Affect NSIs

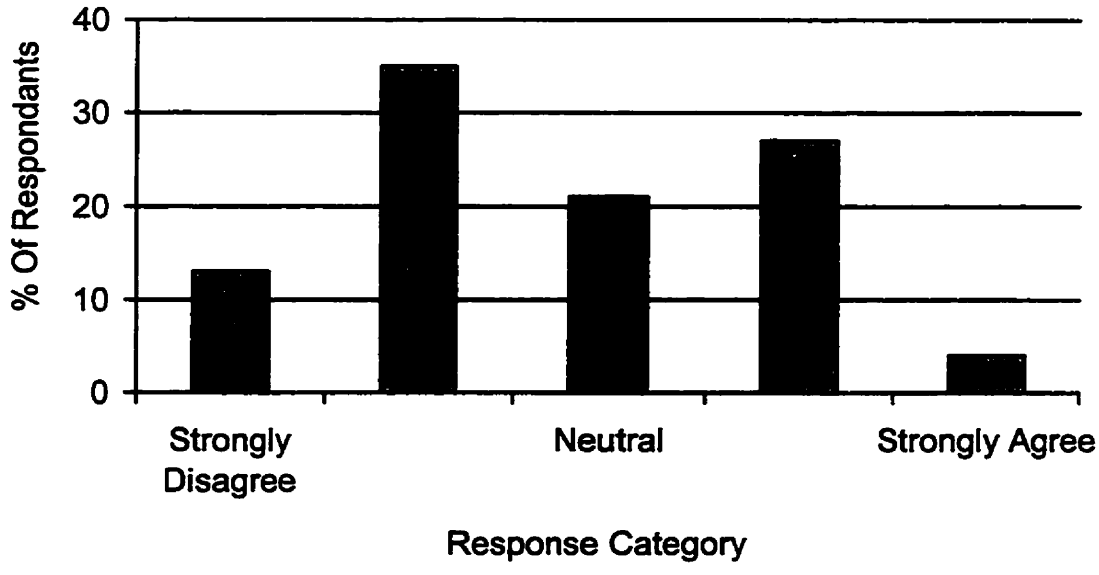
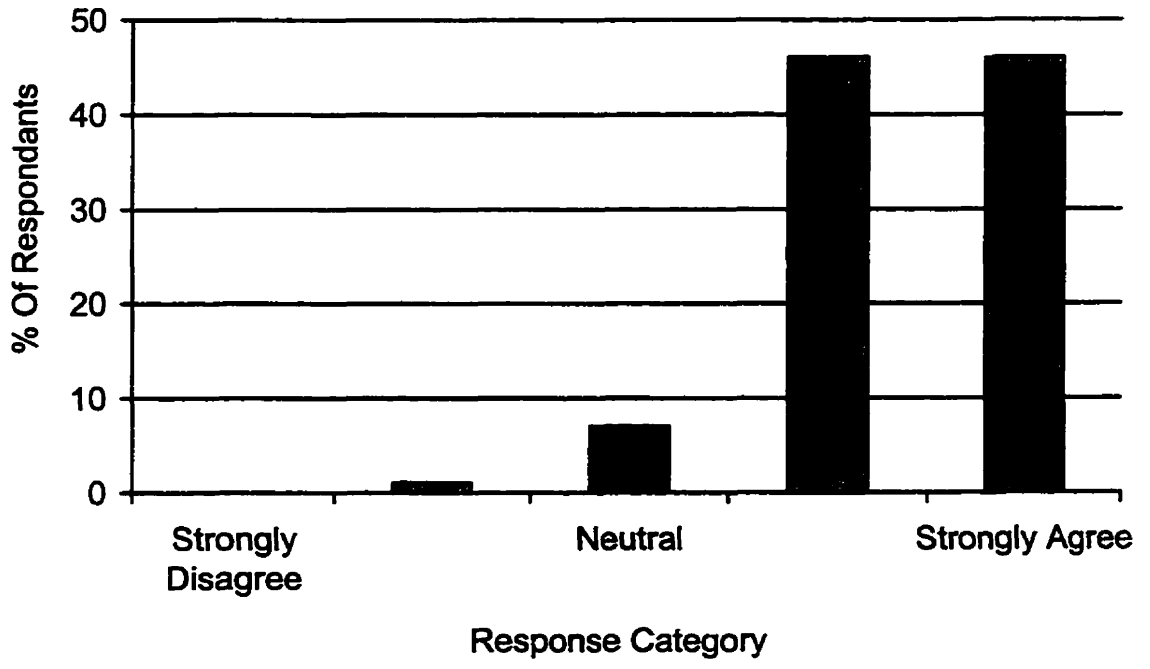


Figure 13 indicates that nurses feel that knowledge about NSIs and disease transmission via an NSI will affect the occurrence of NSIs with approximately 79% agreeing or strongly agreeing. Only seven percent disagreed or strongly disagreed with this statement and 14% were neutral. In contrast, Figure 14, shows that there is disagreement among nurses as to whether the occurrence of NSIs is affected by peer opinions or approval. Roughly 35% disagree, 27% agree and 21% neither agree nor disagree. Lastly, Figure 15 indicates that no nurses strongly disagree that NSIs are a serious and potentially deadly threat and that 92% of the respondents either agree or strongly agree with this statement.

Figure 15
Percentage of Respondents Agreeing That NSIs Are Serious And Potentially Deadly



The next section will expand on the results found and discuss the implications of these findings for NSI research and prevention programs. Limitations of the current study will be addressed and future research proposed.

Discussion

This study took a systems approach in examining factors that may contribute to the occurrence of NSIs. Many different aspects of a health care organization were combined and included in a model that assessed the contribution of individual, interpersonal, and administrative factors to circumstances in which NSIs are sustained. Previous research in a number of areas of human factors, social psychology, and medical safety were drawn upon to create the model tested.

Overall Summary

Overall, the model was not disconfirmed by the data. Full support (significance in both models) was found for seven of the twelve hypothesized paths. In addition, one that was not originally hypothesized was also found to be significant. Partial support (significance in only one model) was found for two proposed hypotheses as well as an additional path that was not originally postulated. Support was not found for four hypotheses: knowledge, risk-taking personality, stressors, and previous experience with NSIs were not found to affect critical behaviors. A more detailed interpretation of the results and practical implications for nurses as well as the health care system as a whole are discussed.

Support for the Entire Model

What did emerge from the model was support for the theory that factors external to the individual, and outside of the individual's control, were predictive

of engagement in critical behaviors. Performing critical behaviors was found to be predictive of an NSI occurring with conflicting or unrealistic procedures having the strongest relationship with whether critical behaviors were engaged in. Partial support was found for relationships between critical behaviors and the safety environment, stressors, and experience with NSIs. The safety environment and experience with NSIs were found to be related to procedures being perceived as conflicting or unrealistic. Partial support was also found for the safety environment being predictive of experience with NSIs. These results provide an explanation for the ineffectiveness of previous NSI prevention programs which have focused on individual behaviors. It is apparent that two of the main predictors of performing these unsafe actions are poor procedures and the strong influences of the safety environment in their workplace.

One of the most significant findings of the overall model was that variables associated with the individual HCWs were not significantly related to the critical behaviors. These findings have important implications for NSI research and prevention programs. While the tendency in the past has been to blame needlesticks on the actions of individual heath care workers, this study has shown that variables linked to the individual such as age, tenure, risk-taking personality and knowledge about disease transmission via NSIs do not account for a significant proportion of variance in critical behaviors.

I. Factors Influencing the Occurrence of NSIs

Tenure

As hypothesized, tenure was found to be significantly related to NSIs. Both the direct path and the indirect path via previous experience with NSIs were found to be significant. This result most likely reflects the higher exposure to needles and other sharps by more experienced nurses over their career. Support was found for this in that there were no significant differences in the number of NSIs or the number of close calls in the previous five years between nurses with more than twenty years experience as a nurse and those with twenty years or less.

Critical Behaviors

Not only were critical behaviors found to be related to NSIs, they were also found to be quite frequent in the sample population (see Table 11). Averaging across critical behaviors, these actions were performed more than 40% of the time by 29% of the nurses in this sample and more than 60% of the time by 17% of the sample. If an effective solution to the NSI problem is to be found, the occurrence of these behaviors must be drastically reduced and preferably eliminated.

It is felt that critical behaviors are potentially a very productive level of analysis for attempting to reduce the number of NSIs. This is because critical behaviors are specific actions that are highly associated with NSIs. By reducing the frequency of these behaviors the number of NSIs can be expected to

correspondingly decrease. The situations that are compelling HCWs to engage in critical behaviors must be analyzed and changes made to decrease the probability of these situations occurring in the future. The safety environment and conflicting or unrealistic procedures were both found to affect the occurrence of critical behaviors. Therefore, any attempt to reduce the number of critical behaviors will have to address these factors.

II. Factors Related to the Occurrence of Critical Behaviors

Safety Environment

In the exploratory sample, it was found that when the level of the safety environment was high the number of critical behaviors engaged in decreased. While only partial support was found for this path it is proposed that it is important.

This relationship suggests that not only are coworkers' actions and opinions predictive of an individual's behavior but so are the policies and practices of the administration. These results indicate that if the individuals' coworkers stress safety, and the administration lets the nurses know they feel that NSIs are serious, then nurses engage in fewer unsafe needle practices.

Conflicting or Unrealistic Procedures

Support was found for the prediction that as the number of safety procedures that are conflicting or perceived as unrealistic increases so will the number of critical behaviors. The coefficients for this path were quite high which indicates a strong relationship. It is postulated that most of the critical behaviors

engaged in are actually a response to being in a position where proper safety procedures cannot be carried out. For example, if a procedure is unrealistic with regard to time, a nurse may start the next step in a procedure before fully completing the last one.

III. Factors Related to the Occurrence of Conflicting or Unrealistic Procedures

Previous Experience with NSIs

Previous experience with NSIs and conflicting or unrealistic procedures were found to be related. If critical behaviors are engaged in due to procedures being poor, and an NSI is perceived by the nurse to be the result of the critical behavior, then as the number of personal and vicarious experiences with NSIs increase so will the perceptions of the procedures as being conflicting or unrealistic.

Safety Environment

One relationship uncovered as a result of the modification indices was that between the safety environment and conflicting or unrealistic procedures. In both samples scores on the conflicting or unrealistic procedures scale were found to decrease as the safety environment increased. A high safety environment score is associated with fewer procedures rated to be problematic as many procedures that would be awkward or unrealistic with conventional equipment may be improved by the introduction of engineering equipment, training programs, and increased support from coworkers.

IV. Factors Related to the Amount of Experience a HCW has with NSIs

Tenure

As tenure increased so did experience with NSIs. As the number of years an individual has worked as a nurse increases so will the amount of personal and vicarious experience with NSIs due to the increased exposure to needles.

Safety Environment

In the exploratory sample, previous experience with NSIs decreased as the safety environment increased. If the level of the safety environment is high, the respondents and their coworkers are less likely to sustain NSIs therefore resulting in low scores on the experience scale.

V. Factors not Significantly Related to the Occurrence of Critical Behaviors

Stressors

The LISREL analysis did not provide support for a relationship between critical behaviors and stressors. However, the zero-order correlation between these variables was significant indicating that there is a relationship ($r = 0.18$, $p \leq 0.01$). In addition, on the questionnaire nurses overwhelmingly agreed that stressors affect NSIs. A possible explanation lies in the way that the LISREL program works. In the LISREL analysis all relationships are looked at simultaneously. Any variance that is shared by two variables will be attributed to only one. Therefore, the strongest relationship will have the shared variance attributed to it and the magnitude of other relationships will correspondingly decrease. As a result, if one relationship is very strong it may overshadow other,

less strong, relationships. In such a case, relationships that are significant in individual analyses (e.g., simple correlations) may become non-significant in the larger model. This may have been the case in this study for the stressors variable as the coefficient for the path going from conflicting or unrealistic procedures to critical behaviors was quite large. Based upon both the significant correlation with critical behaviors and the nurses' opinion that stressors play a significant role in NSIs it is felt that this variable is important and should not be dropped from future studies or NSI prevention programs.

Previous Experience with NSIs

Although experience with NSIs and critical behaviors were significantly correlated ($r = 0.33$, $p \leq 0.00$) the path between them in the path model was not. Like the relationship between stressors and NSIs the relationship between these two variables is likely being masked by the strong relationship between conflicting or unrealistic procedures and critical behaviors. Reviewed literature and theory would suggest that the positive correlational relationship indicates benign experiences reduce nurses' perceptions of risk associated with NSIs. This would, correspondingly, result in more critical behaviors. Because the correlation was significant and possibly overshadowed by the very strong relationship between conflicting or unrealistic procedures, it is felt that this variable should not be discarded in future models.

Risk-Taking Personality

No support was found for the hypothesized path between risk-taking personality and critical behaviors. One respondent made an interesting comment about the risk-taking questions: she agreed the risk-taking statement was true of her generally, but not at work. Therefore, even if a nurse is a high risk taker, the types of behaviors associated with this personality trait do not appear to necessarily extend to behaviors in the work environment.

Knowledge About Disease Transmission via NSIs

While it was hypothesized that higher levels on the knowledge score would correspond to fewer critical behaviors engaged in this was not supported by the data. Interestingly, however, when asked if they agreed that knowledge about NSI transmission rates had an effect on NSIs, the majority of nurses indicated that they agreed or strongly agreed. HCWs may have felt that while the product is, in fact, hazardous, they are not in danger due to their carefulness or skill (Chy-Dejoras, 1994) and consequently no behavioral change results (Stryker, Coates, DeCarlo, Haynes-Sanstad, Shriver, & Makadon, 1995). This is supported by the mounting evidence that people perceive their own chances of encountering health and safety problems as less than that of their peers (see Weinstein, 1984).

Another possible explanation for this finding is in the different possible effects that knowledge of disease transmissions may elicit. Those who focus on likelihood may increase the number of critical behaviors engaged in as a result of

knowing the facts as the transmission rate for AIDS and most other diseases is low. In contrast, knowing the transmission rates may result in a decrease in critical behaviors if the severity of transmission is the main concern for the individual. Therefore, putting NSI prevention efforts into making the HCWs more knowledgeable may have varying effects on the individuals involved and there is no guarantee that any behavioral changes will result.

Recapping

A number of comments were made on the questionnaires about recapping which revealed an interesting dichotomy. A number of respondents wrote "never" next to the question after circling the zero to 20% category. In contrast comments like "the one time I followed procedures and didn't recap I got an NSI" and "because I'm a klutz I prefer to recap needles if I have to transport them any distance" were made next to the 81 - 100% of the time category. By far, the largest number of comments on this topic were of this latter type. Other examples include: "recapping seems to be the standard procedure", "I always recap - I think that not recapping causes more NSIs", and "my coworkers always recap". One possible reason for this dichotomy is that always avoiding recapping may not be the best procedure. For example, recapping affords protection in certain cases (e.g. when handling of contaminated needles is necessary). As a result, HCWs will often recap in order to deal with the physical constraints in the context in which they work.

Recommendations

A close examination of the variables in the model and the relationships between them indicates that the areas in which NSI prevention programs and efforts should be placed are on increasing the safety environment and decreasing the number of safety procedures that are conflicting or perceived as unrealistic. Additionally, the partial support for the relationship between stressors and critical behaviors indicates that efforts should also be made to decrease stressors or, at least, reduce the negative outcome of necessary stressors. In what follows recommendations are made as to possible ways of reducing NSIs as well as the relative costs associated with each recommendation.

Recommendations for Reducing NSIs via Reducing Conflicting or Unrealistic Procedures

Most importantly, it is clear that HCWs should not blindly follow procedures as the procedures are context insensitive. Rather, HCWs should realistically evaluate the situation and take action based upon this. In certain cases, it may be that the best plan of action would be to recap a used needle with care rather than continue handling it in light of stressors and other contextual factors. Evaluating the situation would also serve to encourage HCWs to take responsibility for their actions such as checking to ensure that sharps containers are not full before using them.

It appears that a number of critical behaviors are being engaged in as a result of poor safety procedures. Therefore, one main area of focus should be in re-evaluating the procedures and the circumstances in which they must be carried out. This task would be very large and very difficult as the safety procedures are intertwined with many other procedures and tasks. However, based on the relationship poor procedures have with NSIs it is predicted that it would be well worth the effort. It would also be a cost effective way to reduce NSIs as making alterations or modifications would not require a large capital investment and once the changes are made the cost to periodically check the procedures would be minimal.

A large number of procedures are dependent upon factors that are outside of the hospital administration's control such as time constraints and budget restrictions. In cases where safety procedures cannot be altered due to uncontrollable factors ergonomically designed equipment is particularly useful. For example, if a procedure cannot be altered such that it is reasonable for a HCW to dispose of a needle immediately after use, needles that automatically resheath themselves can be employed.

Recommendations for Reducing NSIs via the Safety Environment

One area in which hospital administration can focus its efforts is in increasing social acceptance of the necessity to follow safety procedures and avoid engaging in critical behaviors. HCWs should be informed of what critical behaviors are so that they are better able to take steps to avoid them. Studies in

the area of risk perception have found that the risk identification, assessment and communication process is inherently social in nature (Plough & Krimsky, 1987). Due to the nature of interpersonal influences, rewards of approval and support often have more effect on behaviors than both punishment or monetary and other physical rewards (Wortman & Loftus, 1988). Accordingly, risk messages embedded in informal social networks have a greater effect on an individual within a group than messages sent through formal channels (Plough & Krimsky, 1987). Therefore, efforts should be made to ensure that the department heads are very visible and vocal about the need to make needle safety a priority. If the head nurses do this, it is likely that this will filter down to the nursing staff as a whole. Other methods for creating a positive safety environment include providing comprehensive NSI prevention programs and training on the use of new equipment. Once the safety environment is established, and care is taken to reinforce it, it should have a self-propagating effect. As a result, this has the potential of being a very cost-effective way to combat unsafe behaviors that contribute to NSIs.

Administrative support is one area that appeared to be important to the nurses, as evidenced by the number of unsolicited comments made about the administrative items. It appears it is often the case that needles are recapped because sharps containers are too far away or poorly positioned. Simple changes to the workspace design and layout of areas in which needles are used is a cost effective way of reducing needle handling and recapping. Guidelines

regarding the emptying of sharps containers could be enforced at little or no expense. Additionally, if ergonomically designed containers are bought the chances of sustaining an NSI from protruding needles are drastically reduced.

Other complaints about hospital administration centered around training, ergonomic equipment and NSI prevention and treatment programs. This indicates that, at least for this sample, HCWs are very aware of what the administration's policies and support are concerning NSIs as well as the associated signals.

Recommendations for Reducing NSIs via Decreasing the Stressors and their Effects

Stressors in a hospital environment are often outside of the hospital administration's control. There are, however, a number of them which can be addressed. In addition, negative outcomes associated with stressors can often be lessened even if the stressor itself cannot be removed. Examples of sources of environmental stress which can be addressed are things such as heat, light, and noise conditions which can all affect performance, decision making, and concentration. An example in which a source of stress cannot be removed, but where its negative impact may be lessened is in the case of shiftwork and fatigue. While shiftwork may be inevitable in health care settings, the negative side effects may be reduced by using slow (where the same shift is used for one or two weeks so that the nurses can get accustomed to the new regime) and forward (the next shift begins at a later time of day than the previous shift)

rotation schedules (Buck & Lamonde, 1993; Monk & Folkard, 1992). It is possible for ergonomic equipment to be implemented in an attempt to further negate the effects of stress, especially those sources of stress that are outside the control of hospital administers.

Persuading Hospital Administrators to Allocate Resources to NSI Programs

A number of the recommendations made involve the output of capital and resources by the hospital. If current trends continue, hospitals and other health care organizations will have fewer and fewer resources to work with. The challenge lies in persuading the decision makers to see NSI prevention as a priority when allocating resources. Factors affecting administrative decision-making with regard to safety and injury prevention efforts are summarized by Reason (1990). Reason postulates that the primary origins of many accidents are in fallible decisions made by high level managerial decision makers. In the case of NSIs this would be in the decision that it is not cost effective to allocate resources to revamp procedures, reduce stressors, or purchase the more expensive ergonomic equipment. One of the main reasons for these arguably fallible decisions is that funds allocated to safety could, and often do, diminish those available for general operation. This poses an inherent dilemma to the decision makers as to where funds should be funneled. Decisions of where to allocate resources are affected by two factors: the certainty of outcome and the nature of the feedback. Unfortunately, safety programs are often disadvantaged in both of these areas. Outcomes associated with enhancing safety often are not

certain, especially in the short term. Feedback from safety programs tends to be negatively worded, intermittent, and often only compelling after a major accident or string of accidents. Resources given to operating goals will usually have more certain, immediate, and positive outcomes. The above ideas are summarized in Figure 16. It is likely that detailed cost benefit analyses of NSI prevention efforts will have to be presented to those making resource decisions. As well, once the funds are made available, records should be kept of outcomes so that positive feedback can be given to ensure that resources are not cut.

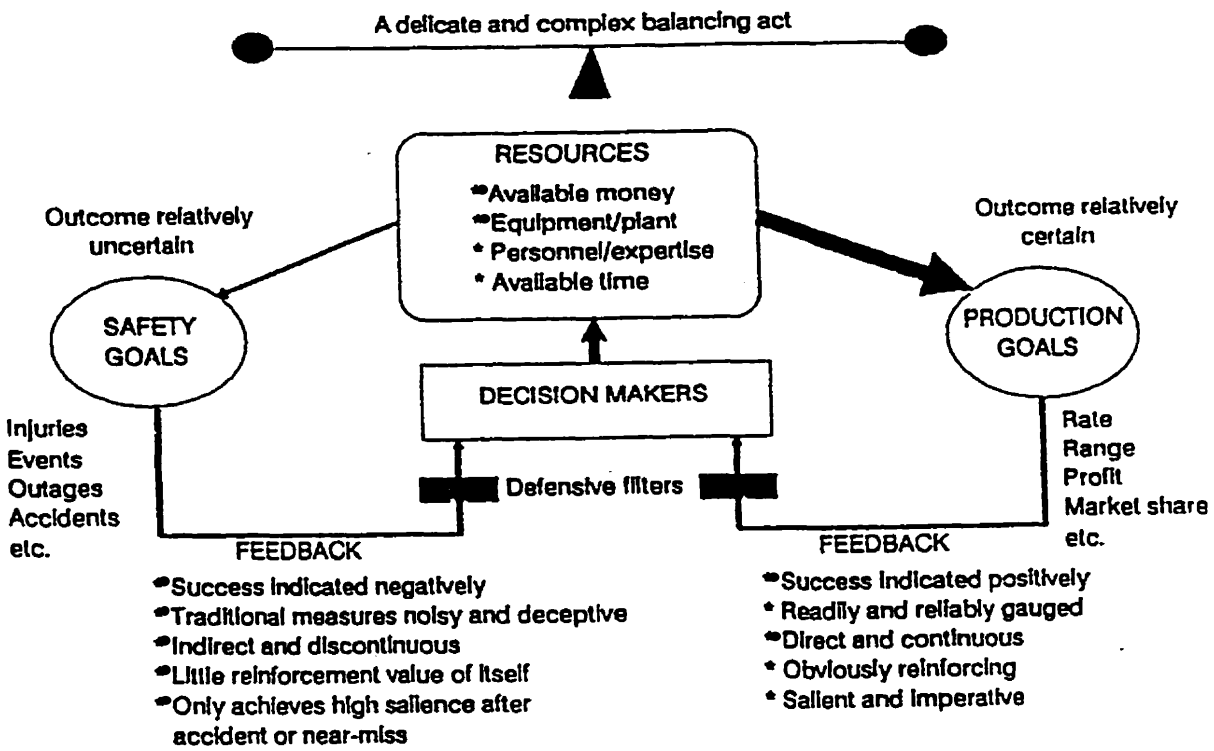


Figure 16: A summary of some of the factors that contribute to fallible, high level decision making. Resources allocated to production and safety goals differ (a) in their outcome and (b) in the nature and impact of their respective feedback. (Reason, 1990)

Limitations and Implications for Future Research

In this study, only the role of violations was considered. The original model based on the NSI error taxonomy (Figure 4) also predicts that slips, lapses and mistakes will account for a significant amount of variance in NSIs. Future research is needed not only to replicate the results found here but also to examine the role that these other types of errors play in NSIs.

The sample in this study consisted of critical care and emergency room nurses. There is the possibility that these nurses may differ from those in other specializations in a number of additional areas. Therefore, research that looks at how the factors tested in this model affect a wide variety of nurses must be conducted before generalizations can be made. Care must also be taken when making generalizations from these results due to the correlational, cross-sectional nature of the design.

Only partial support was found for certain paths in the model. Future research with larger sample sizes is needed to provide further support for these paths. Support was found for the need to take a systems approach in that many contextual factors were found to contribute to the occurrence of NSIs. Further studies in the area should continue to take a systems, or ecological, approach where behaviors are considered to be the result of a constant interrelationship between the individual and the context in which they are operating.

As mentioned previously, it is felt that stressors play a significant role in the occurrence of NSIs. Research using methods other than questionnaires should be conducted to assess the impact of various stressors.

From the results of this study, it is unclear what the relative contributions of the interpersonal and administrative aspects were. Research is needed to examine their relative influences as well as look at what specific factors within each are playing a role in NSIs.

It is possible that respondents were different in some systematic way than the nurses who did not respond. There is evidence that those who do not respond to mail out questionnaires are generally no different than those who do, other than being less cooperative (Weisberg, Krosnick, Bowen, 1989). However, research that follows up on those who did not respond may provide useful information.

All data used in this study were collected via self report measures. There is mounting consensus in the literature that self report measures which measure perceptions and attitudes are little affected by method variance (e.g. Jex, Beehr, Heinisch, & Chen, 1993; Paglis & Williams, 1996; Schmitt, 1994; Spector, 1994; Spector & Brannick, in press). As well, there have been some concerns raised as to whether multitrait-multimethod measures should be interpreted any less cautiously than self-report measures (Howard, 1994; Spector, 1994; Spector & Brannick, in press). Nonetheless, future research should look to other measures

for data collection such as physiological measures of stress and co-worker evaluations of behaviors .

There is an appalling lack of NSI statistics in Canada. A central body needs to start maintaining a database of: NSI rates in Canada, the number of NSIs per device accounting for the relative use of each device, and disease transmission rates. As well, a microanalytic approach needs to be taken to determine exactly what is going on contextually when an NSI occurs. This would aid in determining which procedures are error resistant as well as pointing to common underlying determinants of NSIs. To do this questions concerning external factors should be included on incident report forms so that statistics can be kept on these data as well.

This study used a sample of critical behaviors based upon the OHS records in two hospitals. Future research is needed into other critical behaviors. This data should be checked over time to determine if they change as health technology evolves.

While the implementation of ergonomic equipment is a step in the right direction, further research needs to be conducted to determine when the existing equipment is most effective and to continue developing new innovations in this area. Research also needs to be conducted on which of the ergonomic equipment that is available is the most effective.

The most important line of future research must be in examining NSIs as they relate to the factors of safety environments, conflicting or unrealistic

procedures, and stressors. Experimental studies are needed which look at whether there are any effects on NSI rates as a result of changes to these areas. The impact that changes along these dimensions have on other factors at different levels of the health care system should also be addressed. The focus on the individual behaviors of HCWs must be shifted and focused instead on the influence that the context and the latent errors inherent in the system have on these behaviors. There is a constant interaction between the HCW, the context and the solving of safety problems. Therefore, future research needs to attempt to gain a better understanding of the interrelationships between the individual and the environment. As well, research is needed into effective ways of getting administrations to devote more time and resources to the prevention of these types of injuries.

Conclusions

It was found that, overwhelmingly, the factors which accounted for significant amounts of variance in NSIs were contextual in nature. That is, the behaviors of HCWs are related to factors external to the individual. In order to understand why HCWs engage in unsafe acts these factors and the way in which they interact with the HCWs must be examined. Future research is proposed to address these contextual factors. Recommendations of ways to reduce NSIs by focusing on factors related to NSIs and critical behaviors are made. As well, recommendations of how to secure funding for NSI safety and prevention

programs are proposed. It is hoped that through the present and proposed research more effective ways of preventing NSIs can be found.

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Appendix A

Summary of Universal Precautions

Handle blood and other body fluids as if infectious

Handle all patients in a way that minimizes exposure to blood and other body fluids

Avoid needle pricks and cuts from sharps

Place sharps in puncture resistant containers

Needles are not to be recapped, cut, bent, broken, or removed from disposable syringes

Wash hands/skin surface after any contact with blood or other body fluids

Wear disposable waterproof gloves when in contact with blood or other body fluids

Wear gowns, masks, and eye protection during procedures likely to involve extensive splashing of blood or other body fluids

Use mouthpieces, pocket masks or resuscitation bags when doing mouth to mouth resuscitation, if available

Clean up spills and surfaces or items contaminated with blood or other body fluids using detergent and water.

Disinfect non - disposable items and surfaces with a solution of one part household bleach to nine parts water or an appropriate chemical germicide

Place items or waste soiled with blood or other body fluids in impervious bags and label before sending for reprocessing or disposal

Appendix B

Prevention of Injuries from Needlesticks (PINS) Focus Group Questions

Prevention Of Injuries From Needlesticks (PINS)

Focus Group Questions

We are conducting a study on needlestick injuries (NSIs). As a nurse, we believe that you are especially well qualified to give insight into the root causes of these types of injuries. What follows are a number of questions about needlestick injuries and factors that may contribute to their occurrence. Please answer all questions as fully and as accurately as possible. We ask that you think of an instance, or instances, in which you or someone that you know either incurred a needlestick injury or had a near miss. If you need more room please feel free to write on the back of the page. All of your responses will be kept completely confidential.

1. What do you feel is the primary cause of needlestick injuries?

2. What do you think are secondary causes of needlestick injuries?

3. Do nurses feel that needlestick injuries are serious? Why or why not?

4. It is very important for us to determine what the factors are that lead up to a needlestick injury. Please list everything that you can think relating to the following factors that might influence a nurse getting an NSI.

a. The immediate situation

b. The patient

c. The department that they are in

d. Procedures (safety or otherwise)

e. Stressors

f. Equipment

g. The hospital they are in

h. The time that the incident occurs

i. The nurse

j. Other

5. Can you think of any behaviors that nurses engage in that increase their chances of sustaining an NSI? It is important that you are very specific here.

6. In your opinion, why do nurses engage in these behaviors?

7. Have you ever sustained an NSI or do you know of anyone who has? How many?

8. Have you or anyone you know contracted an illness as a result of an NSI?

9. Are you personally concerned about NSIs? Why or why not?

10. What do you think are the best ways of eliminating NSIs?

11. Did you know that there is a problem with housekeeping and dietary staff getting NSIs from needles and other sharp objects that are not disposed of properly?

12. Make a list of all behaviors, actions, or situations that you have not mentioned so far that you feel could cause or influence the occurrence of an NSI

Appendix C

Prevention of Injuries by Needlesticks (PINS) Pilot Questionnaire

Prevention of Injuries by Needlesticks (PINS) Questionnaire

Thank You for agreeing to take part in this study. Please answer all questions before returning this questionnaire. It is very important that you are as honest and as accurate as possible. If you are unsure about an answer please give your best guess - do not leave any questions unanswered. For each question, please circle the number (1 - 5) above the answer you wish to select. Your participation in this study, and all information given will be kept completely confidential. **Do not put you name on this questionnaire.**

For the purposes of this study, a needlestick injury is defined as a puncture wound breaking the skin that was obtained by a sharp object that is contaminated by the blood or other body fluids of another person. It can be sustained by any sharp object, and does not necessarily have to be associated with a needle.

1. Age: _____
2. M _____ F _____
3. For your practicums, how many months have you spent in a hospital?: _____
4. What departments did you work in?: _____

5. Approximately how many needlestick injuries have you sustained?

0	1	2	3	4+

6. In the event of sustaining a needlestick injury, how likely are you to clean it yourself?

1	2	3	4	5
not at all likely	somewhat likely	unsure	likely	very likely

7. How much do you think the Hepatitis B vaccination decreases your chances of contracting a disease after sustaining a needlestick injury by?

1	2	3	4	5
no decrease		undecided		significant decrease

8. How many people do you know that have contracted a bloodborne disease from a needle stick injury?

1	2	3	4	5
0	1-2	3-4	5-6	7+

9. How often do you disassemble needles before disposing of them in sharps containers?

1	2	3	4	5
never	sometimes	half of the time	frequently	most of the time

10. What percentage of needlestick injuries that involved blood or other body fluids from a confirmed Hepatitis B patient will result in the health care worker contracting the disease?

1----------2----------3----------4----------5
less than 1% 1-25% 26-55% 56-75% 76-100%

11. How likely is it that there have been any confirmed cases of health care workers in Alberta contracting AIDS from a needlestick injury?

1----------2----------3----------4----------5
not at all likely somewhat likely unsure likely very likely

12. How often do your coworkers use safety designed equipment when given the choice?

1----------2----------3----------4----------5
rarely infrequently sometimes frequently almost always

13. How often do you put a contaminated needle or other sharp object on a bed, or a medicine or food tray for storage until it can be disposed of?

1----------2----------3----------4----------5
never sometimes half of the time frequently most of the time

14. How often are the procedures (safety or otherwise) awkward or difficult to perform?

1----------2----------3----------4----------5
rarely infrequently sometimes frequently very often

15. In your opinion, how serious a threat to your health is sustaining a needlestick injury?

1----------2----------3----------4----------5
not at all mild moderate extreme deadly

16. How often do you have to transport a contaminated needle or other sharp object down a hall or through a room where other people are present?

1----------2----------3----------4----------5
never sometimes half of the time frequently most of the time

17. In your perception, how serious a threat to personal health do your **coworkers** feel needlestick injuries are?

1----------2----------3----------4----------5
not at all mild moderate extreme deadly

18. In the event of sustaining a needlestick injury, how likely are you to report it via prescribed procedures?

1----------2----------3----------4----------5
not at all likely somewhat likely unsure likely very likely

19. What percentage of needlestick injuries that involved blood or other body fluids from a confirmed AIDS patient will result in an unvaccinated health care worker contracting the disease?

1——————2——————3——————4——————5
less than 1% 1-25% 26-55% 56-75% 76-100%

20. Do you have a preference for the traditional or safety designed (ergonomic) equipment?

1——————2——————3——————4——————5
traditional equipment no preference safety equipment

21. How often do you use safety designed equipment when you have the choice?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

22. Do you agree that this type of equipment is effective in preventing needlestick injuries from occurring?

1——————2——————3——————4——————5
strongly disagree disagree neutral agree strongly agree

23. While on your practicum, how often were you given training on how to properly use unfamiliar needles and needle devices?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

24. How often do you check to see if a sharps container is full before disposing of a needle or other sharp object ?

1——————2——————3——————4——————5
never sometimes half of the time frequently most of the time

25. Are there are adequate numbers of sharps containers in your department?

1——————2——————3——————4——————5
strongly disagree disagree neutral agree strongly agree

26. Do you ever worry about being stuck by a needle that is protruding from a sharps container?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

How often do you practice the following universal precautions?

27. Wearing gloves

1——————2——————3——————4——————5
not important undecided extremely important

28. Hand washing

1——————2——————3——————4——————5
not important undecided extremely important

29. Not recapping needles

1——————2——————3——————4——————5
not important undecided extremely important

30. Wearing goggles

1——————2——————3——————4——————5
not important undecided extremely important

31. Wearing impermeable gowns

1——————2——————3——————4——————5
not important undecided extremely important

What percentage of the time do **your coworkers** practice the following universal precautions?

32. Wearing gloves

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

33. Hand washing

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

34. Not recapping needles

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

35. Wearing goggles

1——————2——————3——————4——————5
rarely infrequently sometimes frequently almost always

36. Are there any safety reminders (e.g. posters, memos) posted around your department?

1——————2——————3——————4——————5
very few few some many very many

37. If available, how often do you participate in safety education provided by the facility?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently very often

38. How often are the procedures (safety or otherwise) unrealistic with regards to patient welfare?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently very often

39. How often do you attend to other things (the patient, the state of I.V. bags, monitoring equipment, etc.) while handling contaminated sharp objects?

1	2	3	4	5
never	sometimes	half of the time	frequently	most of the time

40. How often do you find that procedures for completing a task interfere or conflict with safety procedures regarding needles?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

How often do you find yourself in a position where you have to violate a safety procedure (e.g. immediate disposal of used needles, not following universal precautions) due to the following factors:

41. The welfare of the patient

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

42. Time constraints

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

43. Personal stressors

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

44. Uncooperative patients

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

45. Situational factors

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

46. How often are the procedures (safety or otherwise) unrealistic with regards to workload?

1	2	3	4	5
rarely	infrequently	sometimes	frequently	very often

47. In the event of sustaining a needlestick injury, how likely are you to have it checked by a colleague?

1	2	3	4	5
not at all likely	somewhat likely	unsure	likely	very likely

48. On average, what percentage of the time are you paying close attention to a needle or other sharp object you are using during the disposal procedure?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

49. How many different diseases are transmittable via a needlestick injury?

1——————2——————3——————4——————5
0-20 21-40 41-60 61-80 81-100

50. How often are the procedures (safety or otherwise) unrealistic with regards to time?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently very often

To what degree do you feel the following factors affect the occurrence of needlestick injuries among health care workers?

51. Personal (non-work related) stress

1——————2——————3——————4——————5
not at all mild moderate strong extreme

52. Fatigue

1——————2——————3——————4——————5
not at all mild moderate strong extreme

53. Peer opinions and approval

1——————2——————3——————4——————5
not at all mild moderate strong extreme

54. Under-staffing

1——————2——————3——————4——————5
not at all mild moderate strong extreme

55. Knowledge of risks associated with needlestick injuries

1——————2——————3——————4——————5
not at all mild moderate strong extreme

56. Shift work

1——————2——————3——————4——————5
not at all mild moderate strong extreme

57. Personal conflicts with coworkers or supervisors

1——————2——————3——————4——————5
not at all mild moderate strong extreme

58. Distractions

1——————2——————3——————4——————5
not at all mild moderate strong extreme

59. Lighting, heat, and other environmental factors

1——————2——————3——————4——————5
not at all mild moderate strong extreme

60. When using needles, how often do you find yourself in a position where you start the next step in a procedure before fully completing the last step?

1——————2——————3——————4——————5
never sometimes half of the time frequently most of the time

61. How often are safety inservices or other forms of safety education provided to the staff at your facility?

1——————2——————3——————4——————5
rarely infrequently sometimes frequently very often

62. How often do you find that different needle safety procedures conflict with each other?

1——————2——————3——————4——————5
0-20% 21-40% 41-60% 61-80% 81-100%

63. How often do you dispose of a needle in a location other than a sharps container (e.g. garbage bag)?

1——————2——————3——————4——————5
never sometimes half of the time frequently most of the time

64. Were safety designed I.V. needles available in the hospitals where you did your practicum? (choose one) Y _____ N _____

65. Were safety designed injection needles available in the hospitals where you did your practicum? (choose one) Y _____ N _____ Unsure _____

66. Were safety designed sharps containers available in the hospitals where you did your practicum? (choose one) Y _____ N _____ Unsure _____

67. Did the hospital where you worked have a needlestick prevention program?
Y _____ N _____ Unsure _____

68. Is there a post needlestick reporting and treatment program at the hospital that you worked in?
Y _____ N _____ Unsure _____

Appendix D

Prevention of Injuries by Needlesticks Survey (PINS) Final Questionnaire

Prevention of Injuries by Needlesticks Survey (PINS)

Thank you for agreeing to participate in this study. Please answer all questions before returning this questionnaire. It is very important that you are as honest and as accurate as possible. If you are unsure about an answer please give your best guess - *do not leave any questions unanswered.* For questions on pages two through six, please circle the number (1 - 5) above the answer you wish to select. Your participation in this study, and all information given will be kept completely confidential. **Do not put your name on this questionnaire.**

For the sake of clarity, a needlestick injury (NSI) is defined as a puncture wound breaking the skin that was obtained by a sharp object that is contaminated by the blood or other body fluids of another person. It can be sustained by any sharp object, and does not necessarily have to be associated with a needle.

1. Date of Birth: _____ 2. M ____ F ____

2. How many years have you been working as a nurse in a hospital or clinic?:
_____

3. What department(s) do you currently work in?: _____

4. Approximately how many NSIs have you sustained during your career? _____

5a. Approximately how many NSIs have you sustained during the last 5 years?
_____

5b. Approximately how many close calls have you had over the past 5 years (e.g. where a sharp has contacted your skin but not broken it or where a sharp has just missed you)? ____

6. Have you ever contracted a bloodborne disease or any other illness as a result of an NSI?
Y____ N____

7. Approximately how many people do you know of that have sustained an NSI?
____

8. Approximately how many people do you know of that have contracted a bloodborne disease or other illness from a needle stick injury? _____

9. To the best of your knowledge, approximately how many different diseases have been documented to be transmittable via an NSI? If you are unsure give your best estimate _____

10. To the best of your knowledge, what percentage of NSIs that involved blood or other body fluids from a confirmed Hepatitis B patient will result in an unvaccinated health care worker contracting the disease? If you are unsure give your best estimate _____%

11. To the best of your knowledge, what percentage of NSIs that involve blood or other body fluids from a confirmed AIDS patient will result in a health care worker contracting the disease? If you are unsure give your best estimate _____%

12. To the best of your knowledge, does the hospital where you work have a needlestick prevention program? If you are unsure, check no.
Y_____ N_____

13. To the best of your knowledge, is there a post needlestick reporting and treatment program at the hospital in which you work? If you are unsure, check no.
Y_____ N_____

14. On average, what percentage of the time do you disassemble needles (e.g. remove the needle from the syringe or I.V. tubing) before disposing of them in sharps containers?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

15. To what degree do you feel that the following statement is true of you?: I'm always willing to admit it when I make a mistake.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

16. To what degree do you feel that the following statement is true?: Safety designed (ergonomic) equipment is effective in preventing NSIs from occurring.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

17. When they have the choice, what percentage of the time do your coworkers use safety designed (ergonomic) equipment?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

18. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because other safety or task procedures conflict or interfere with them?

1——2——3——4——5
0-20% 21-40% 41-60% 61-80% 81-100%

19. To what degree do you feel that the following statement is true of you?: I consider myself to be a risk-taker.

1——2——3——4——5
strongly disagree disagree neutral agree strongly agree

20. To what degree do you feel that the following statement is true?: Personal (non-work related) stress affects the occurrence of NSIs among health care workers.

1——2——3——4——5
strongly disagree disagree neutral agree strongly agree

21. To what degree do you feel that the following statement is true?: Lighting, heat, noise, and other environmental factors affect the occurrence of actions or behaviors that may lead to NSIs among health care workers.

1——2——3——4——5
strongly disagree disagree neutral agree strongly agree

22. To what degree do you feel that the following statement is true of you?: I have never deliberately said something that hurt someone's feelings.

1——2——3——4——5
strongly disagree disagree neutral agree strongly agree

23. On average, what percentage of the time do you put a contaminated needle or other sharps in a place other than a sharps container for storage until it can be disposed of properly (e.g. beds, medicine or food trays, pockets)?

1——2——3——4——5
0-20% 21-40% 41-60% 61-80% 81-100%

24. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because you must deal with uncooperative patients?

1——2——3——4——5
0-20% 21-40% 41-60% 61-80% 81-100%

25. To what degree do you feel that the following statement is true of you?: I prefer safety designed (ergonomic) equipment over traditional equipment.

1——2——3——4——5
strongly disagree disagree neutral agree strongly agree

26. To what degree do you feel that the following statement is true of you?: I always try to practice what I preach.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

27. On average, what percentage of the time do you have to transport a contaminated needle or other sharp object down a hall or through a room where other people are present?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

28. To what degree do you feel that the following statement is true?: Fatigue affects the occurrence of actions or behaviors that may lead to NSIs among health care workers.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

29. In the facility in which you work, how often are you given training on how to properly use unfamiliar or new needles and needle devices?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

30. To what degree do you feel that the following statement is true of you?: I like to do things that almost paralyze me with fear.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

31. To what degree do you feel that the following statement is true?: There are not adequate numbers of sharps containers in my department.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

32. On average, what percentage of the time do you check to see if a sharps container is full before disposing of a needle or other sharp object?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

33. To what degree do you feel that the following statement is true of you?: I have never been irked when people expressed ideas very different from my own.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

34. To what degree do you feel that the following statement is true?: Under-staffing affects the occurrence of actions or behaviors that may lead to NSIs among health care workers.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

35. On average, what percentage of the time do you recap used needles for any reason?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

36. To what degree do you feel that the following statement is true of you?: The greater the risk the more fun the activity.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

37. To what degree do you feel that the following statement is true?: Peer opinions and/or peer approval affect the occurrence of actions or behaviors that may lead to NSIs among health care workers.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

38. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, all universal precautions) because they are awkward or difficult to perform?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

39. On average, what percentage of the time do your coworkers violate needle safety procedures (e.g. recap used needles)?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

40. To what degree do you feel that the following statement is true of you?: I never resent being asked to return a favour.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

41. To what degree do you feel that the following statement is true?: Distractions affect the occurrence of actions or behaviors that may lead to NSIs among health care workers.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

42. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) due to time constraints?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

43. To what degree do you feel that your coworkers think that it is always necessary to follow safety procedures for the handling and disposal of needles (e.g. immediate disposal of needles, not recapping)?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

44. To what degree do you feel that the following statement is true of you?: There have been occasions when I took advantage of someone.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

45. How often are safety reminders (e.g. posters, memos) posted around your department?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

46. To what degree do you feel that the following statement is true?: Knowledge of risks associated with NSIs affects the occurrence of NSIs among health care workers.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

47. On Average, what percentage of the time do you attend to other things (the patient, the state of I.V. bags, monitoring equipment, etc.) while handling contaminated sharp objects?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

48. To what degree do you feel that the following statement is true of you?: There have been occasions when I have felt like smashing things.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

49. To what degree do you feel that the following statement is true?: Your **coworkers** believe that sustaining an NSI is a serious, possibly deadly, threat to one's health.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

50. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because to the welfare of the patient takes priority?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

51. To what degree do you feel that the following statement is true of you?: I sometimes try to get even, rather than forgive and forget.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

52. To what degree do you feel that the following statement is true?: Shift work patterns affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

53. Do you think that sustaining an NSI is a serious, possibly deadly, threat to your health?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

54. On average, what percentage of the time do you pay close attention to a needle or other sharp object you are using during the disposal procedure?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

55. To what degree do you feel that the following statement is true of you?: I like to gossip at times.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

56. To what degree do you feel that the following statement is true?: Personal conflicts with coworkers or supervisors affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

57. To what degree do you feel that the following statement is true of you?: At times I have really insisted on having things my own way.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

58. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because workload levels prevent it?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

59. To what degree do you feel that the following statement is true of you?: I like the feeling that comes with taking physical risks.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

60. When using sharps, what percentage of the time do you find yourself in a position where you start the next step in a procedure before fully completing the last step (e.g. using an opsite prior to disposal)?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

61. How often are safety inservices or other forms of safety education provided to the staff at your facility?

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

62. On Average, what percentage of the time do you dispose of a needle in a location other than a sharps container (e.g. a garbage bag)?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

63. To what degree do you feel that the following statement is true of you?: Being afraid of doing something new often makes it more fun in the end.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

64. On Average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, all universal precautions) because the situation would not allow it?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

65. If dealing with an uncooperative patient or a frightened child, what percentage of the time do you ask someone else for assistance when giving injections or performing other tasks that involve the use of sharps?

1	2	3	4	5
0-20%	21-40%	41-60%	61-80%	81-100%

66. To what degree do you feel that the following statement is true?: The equipment in the hospital in which you work is updated as safety technology evolves.

1	2	3	4	5
strongly disagree	disagree	neutral	agree	strongly agree

67. To the best of your knowledge, how much blood (in milliliters) is required for the transmission of Hepatitis B to occur? If you are unsure give your best estimate.

1	2	3	4	5
less than 0.00001ml	0.00099 - 0.0001ml	0.0099 - 0.001ml	0.099 - 0.01 ml	0.1 - 1ml

68. To the best of your knowledge, how much blood (in milliliters) is required for the transmission of AIDS to occur? If you are unsure give your best estimate.

1	2	3	4	5
less than 0.00001ml	0.00099 - 0.0001ml	0.0099 - 0.001ml	0.099 - 0.01 ml	0.1 - 1ml

Appendix E

Cover Letter Accompanying Questionnaire

Dear Registered Nurse,

Do you consider needlestick injuries to be a concern for yourself or your colleagues? Do you feel it is important that the factors that may lead to a needlestick injury are discovered so that effective interventions can be made? If so, you may be interested in participating in my Masters thesis research entitled: Needlestick Injuries, Blame the system not the health care worker. To participate, you don't need to have sustained a needlestick injury to be able to provide important information.

This study has been approved of by the A.A.R.N. and your name was randomly chosen from their membership lists as a possible participant. Enclosed is a copy of the Prevention of Injuries From Needlestick Survey (P.I.N.S.) and a stamped, addressed return envelope. The questionnaire is composed of 68 questions which will take about 20 minutes to complete. The items on P.I.N.S. address issues, procedures, and actions relating to the use and disposal of needles and other sharps as well as a number of personality items taken from validated psychological tests. Your name is in no way attached to the questionnaire and all responses will remain completely confidential. By completing and returning the questionnaire you indicate your consent to participate in the study. Remember - you don't need to have sustained a needlestick injury to provide valuable information.

The goal of my research is to determine what factors affect the occurrence of needlestick injuries. Past research has overwhelmingly focused on behaviors and attitudes of individual nurses. As a result, the blame has been placed on the individual and interventions have focused on changing nurses' behaviors. In my study, I am attempting to discover factors at many different levels of a health care organization that may lead to needlestick injuries. Once these have been determined, more effective needlestick injury prevention programs and strategies can be developed.

Upon completion of the study, the information generated by P.I.N.S. as well as a series of recommendations for needlestick injury prevention will be distributed to the A.A.R.N. as well as to the major hospitals in Alberta. Anyone interested in the findings of this research should watch for my summary in the A.A.R.N. Newsletter next year. Your participation in this study is greatly appreciated and has the potential to reduce needlestick injuries to health care workers. Please return your completed questionnaire by **January 15th 1997**. If you have any questions feel free to contact me, Krista McIntosh, at the number listed below. Thank-you for your time and participation.

Sincerely,

Krista McIntosh, B.Sc.
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Appendix F

Summary Of The Final Scales Used In PINS

Risk-Taking Scale - Physical Risks Subscale

1. I like the feeling that comes with taking physical risks.
2. I consider myself to be a risk-taker.
3. Being afraid of doing something new often makes it more fun in the end.
4. The greater the risk the more fun the activity
5. I like to do things that almost paralyze me with fear.

Social Desirability Scale

1. I like to gossip at times.
2. There have been occasions when I took advantage of someone.
3. I'm always willing to admit it when I make a mistake.
4. I always try to practice what I preach.
5. I sometimes try to get even, rather than forgive an forget.
6. At times I have really insisted on having things my own way.
7. There have been occasions when I have felt like smashing things.
8. I never resent being asked to return a favour.
9. I have never been irked when people expressed ideas very different from my own.
10. I have never deliberately said something that hurt someone's feelings.

Safety Environment Scale Items 1-4 are interpersonal factors & 5-11 are Administrative

1. When they have the choice, what percentage of the time do your coworkers use safety designed (ergonomic) equipment?

2. On average, what percentage of the time do your coworkers violate needle safety procedures (e.g. recap used needles)?

3. To what degree do you feel that the following statement is true?: Your **coworkers** believe that sustaining an NSI is a serious, possibly deadly, threat to one's health?

4. To what degree do you feel that your coworkers think that it is always necessary to follow safety procedures for the handling and disposal of needles (e.g. immediate disposal of needles, not recapping)?

5. To the best of your knowledge, does the hospital where you work have a needlestick prevention program? If you are unsure, check no.

6. To the best of your knowledge, is there a post needlestick reporting and treatment program at the hospital in which you work? If you are unsure, check no.

7. In the facility in which you work, how often are you given training on how to properly use unfamiliar or new needles and needle devices?

8. To what degree do you feel that the following statement is true?: There are not adequate numbers of sharps containers in my department.

9. How often are safety reminders (e.g. posters, memos) posted around your department?

10. How often are safety inservices or other forms of safety education provided to the staff at your facility?

11. To what degree do you feel that the following statement is true?: The equipment in the hospital in which you work is updated as safety technology evolves.

Conflicting or Unrealistic Procedures Scale

1. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because workload levels prevent it?

2. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because the situation would not allow it?

3. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because the welfare of the patient takes priority?

4. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) due to time constraints?

5. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because they are awkward or difficult to perform?

6. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because you must deal with uncooperative patients?

7. On average, what percentage of the time do you find yourself in a position where you cannot realistically follow a safety procedure (e.g. immediate disposal of used needles, always following universal precautions) because other safety or task procedures conflict or interfere with them?

Stressors Scale: Items 1-3 are Internal Stressors, Items 4-7 are External Stressors

1. To what degree do you feel the following statement is true?: Personal (non-work related) stress affects the occurrence of NSIs among health care workers?

2. To what degree do you feel the following statement is true?: Personal conflicts with coworkers or supervisors affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

3. To what degree do you feel the following statement is true?: Fatigue affects the occurrence of actions or behaviors that may lead to NSIs among health care workers?

4. To what degree do you feel the following statement is true?: Shift work patterns affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

5. To what degree do you feel the following statement is true?: Distractions affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

6. To what degree do you feel the following statement is true?: Lighting, heat, noise, and other environmental factors affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

7. To what degree do you feel the following statement is true?: Under-staffing affects the occurrence of actions or behaviors that may lead to NSIs among health care workers?

Critical Behaviors Scale

1. On average, what percentage of the time do you disassemble needles (e.g. remove the needle from the syringe or I.V. tubing) before disposing of them in sharps containers?

2. On average, what percentage of the time do you dispose of a needle in a location other than a sharps container (e.g. garbage bag)?

3. When using sharps, what percentage of the time do you find yourself in a position where you start the next step in a procedure before fully completing the last step (e.g. using an opsite prior to disposal)?

4. On average, what percentage of the time do you pay close attention to a needle or other sharp object you are using during the disposal procedure?

5. On average, what percentage of the time do you attend to other things (the patient, the state of I.V. bags, monitoring equipment, etc.) while handling contaminated sharp objects?

6. On average, what percentage of the time do you recap used needles for any reason?

7. On average, what percentage of the time do you check to see if a sharps container is full before disposing of a needle or other sharp object ?

8. On average, what percentage of the time do you have to transport a contaminated needle or other sharp object down a hall or through a room where other people are present?

9. On average, what percentage of the time do you put a contaminated needle or other sharps in a place other than a sharps container for storage until it can be disposed of properly (e.g. beds, medicine or food trays, pockets)?

10. If dealing with an uncooperative patient or a frightened child, what percentage of the time do you ask someone else for assistance when giving injections or performing other tasks that involve the use of sharps?

<u>Knowledge Scale</u>

1. To the best of your knowledge, approximately how many different diseases have been documented to be transmittable via an NSI? If you are unsure give your best estimate.

2. To the best of your knowledge, what percentage of NSIs that involved blood or other body fluids from a confirmed Hepatitis B patient will result in an unvaccinated health care worker contracting the disease? If you are unsure give your best estimate.

3. To the best of your knowledge, what percentage of NSIs that involve blood or other body fluids from a confirmed AIDS patient will result in a health care worker contracting the disease? If you are unsure give your best estimate.

4. To the best of your knowledge, how much blood (in milliliters) is required for the transmission of Hepatitis B to occur? If you are unsure give your best estimate.

5. To the best of your knowledge, how much blood (in milliliters) is required for the transmission of AIDS to occur? If you are unsure give your best estimate.

Experience With Needlesticks Scale

1. Approximately how many NSIs have you sustained during your career?

2. Approximately how many NSIs have you sustained during the last 5 years?

3. Approximately how many close calls have you had over the past five years (e.g. where a sharp has contacted your skin but not broken it or where a sharp has just missed you)?

4. Have you ever contracted a bloodborne disease or any other illness as a result of an NSI?

5. Approximately how many people do you know that have sustained an NSI?

6. Approximately how many people do you know that have contracted a bloodborne disease or other illness from a needle stick injury?

Items Included For Discussion Purposes

1. To what degree do you feel that the following statement is true?: Safety designed (ergonomic) equipment is effective in preventing NSIs from occurring.

2. To what degree do you feel that the following statement is true of you?: I prefer safety designed (ergonomic) equipment over traditional equipment

3. To what degree do you feel that the following statement is true?: Knowledge of risks associated with NSIs affects the occurrence of NSIs among health care workers.

4. Do you think that sustaining an NSI is a serious, possibly deadly, threat to your health?

5. To what degree do you feel the following statement is true?: Peer opinions and/or approval affect the occurrence of actions or behaviors that may lead to NSIs among health care workers?

Demographics

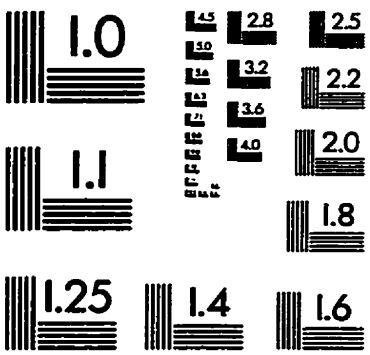
1. Age - in years

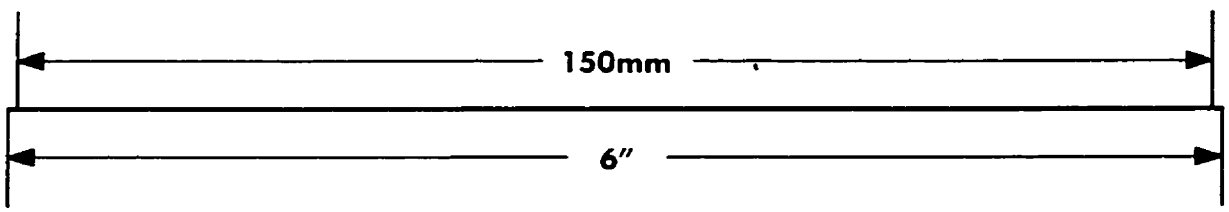
2. Gender - male or female

3. Tenure - How many years have you been working as a nurse in a hospital or clinic?

4.Exposure - What department(s) do you currently work in?

TEST TARGET (QA-3)





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