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Foundation for an Upcoming Study on Risk Perception and Proper Personal Protective Equipment Use of GSU Laboratory Workers

Jacquan Jordan

ABSTRACT

FOUNDATION FOR AN UPCOMING STUDY ON RISK PERCEPTION AND PROPER PERSONAL PROTECTIVE EQUIPMENT USE OF GSU LABORATORY WORKERS

By

JACQUAN JAMEL JORDAN

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INTRODUCTION: There have been 1,141 laboratory acquired infections between the period of 1979-2005 according to the American Biological Safety Association. This substantial number of infections represents a risk for laboratory workers. These laboratory infections are not frequent in all laboratories and it has been concluded that "human errors represent a very high percentage of the cases." (Wurtz et al, 2016) The research shows that this human error is a result of flawed risk perception and poor biosafety habits.

AIM: The aim of this thesis is to build a constructive foundation for a future study on risk perception and biosafety habits of GSU laboratory workers. This thesis will accomplish this goal by conducting a literature review on factors that contribute to biosafety habits and risk perception, editing of the survey tool, and pilot interviews using the completed survey tool.

METHODS: This thesis contains a narrative literature review of research during 1995 to the present conducted on biosafety training, biosafety habits (including personal protective equipment use), and laboratory acquired infections. This literature explains the factors that contribute to worker's risk perception and improper use of personal protective equipment. The results of the literature review were utilized to create a survey tool for the upcoming research. Finally, this survey tool was pilot tested with two top researchers at the university.

RESULTS: The literature review conducted for this thesis highlighted the lack of consistency of biosafety habits, risk perception, and training in biosafety laboratory workers. Additionally, the findings of the literature suggest that laboratory acquired infections represent a real risk for workers who have poor biosafety habits. Thus, the literature suggests that a future study on the biosafety habits and risk perception of GSU laboratory workers is essential. The results of editing the survey tool and the pilot interview will help facilitate this future study.

DISCUSSION: Laboratory acquired infections represent a real risk for laboratory workers who do not follow proper biosafety habits, do not receive the proper biosafety training, or have poor judgement on risk perception. It is necessary to understand the biosafety habits of GSU laboratory workers to ensure that there is not a higher risk of laboratory acquired infections. Thus, the future study conducted by Dr. Lisa Casanova, with this thesis as a foundation, will be critical in investigating the current practices of GSU laboratory workers and their potential risk.

RISK PERCEPTION AND BIOSAFETY HABITS OF GSU LABORATORY WORKERS

by

Jacquan Jamel Jordan

B.S.A., University of Georgia
B.S.EH University of Georgia

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ATLANTA, GEORGIA
30303

APPROVAL PAGE

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by

JACQUAN JAMEL JORDAN

Approved:

___Dr. Lisa Casanova
Committee Chair

__Dr. Sheryl Strasser
Committee Member

Date

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Author's Statement Page

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___Jacquan Jamel Jordan_____
Signature of Author

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1.) Introduction

1.1 Background

Laboratory acquired infections represent a serious occupational hazard for laboratory workers working with infectious agents in research laboratories. According to a study conducted by Karen Byers of the American Biological Safety Association there have been 1,141 laboratory acquired infections reported worldwide during the period of 1979 to 2005. (ABSA, 2005) Additional updated information gathered by Ms. Byers since 2005 has shown that number increased to 2033 infections. These numbers indicate a serious hazard for laboratory workers. These infections can be avoided by properly adhering to biosafety habits that prevent direct contact to infectious agents. Laboratory workers that are infected are not adhering to proper biosafety requirements for many reasons. The current literature suggests that some laboratory workers are not provided adequate training, make poor judgement in perceiving risk of the infectious agents they are working with, and do not fully utilize the personal protective equipment provided for them. Georgia State University has biosafety laboratories ranging from level 1-4 and work with infectious agents from as innocuous as E. coli to the very dangerous B virus. The level of threat associated with each biological agent increases with the corresponding biosafety level. Level 1 represents the lowest risk and level 4 corresponds with the most severe risk. These university workers are at risk if they are not practicing proper biosafety habits.

The purpose of this thesis is to build the foundation for a study into the current personal protective equipment habits, training, and risk perception of Georgia State laboratory workers. This includes the piloting and editing of the survey tool that will be used to investigate the personal protective equipment habits and risk perception of university laboratories and a literature review on all the factors that contribute to laboratory acquired infections. This information will be used in conjunction with laboratory management, if necessary, to create constructive changes in biosafety requirements to decrease the risk of laboratory acquired infections. This thesis, pilot interviews, and literature review will be used to support the final study.

1.2 Definitions Related to Study

Biosafety- the maintenance of safe conditions in biological research to prevent harm to workers, nonlaboratory organisms, or the environment.
BSL- Biosafety Level
CDC- Center for Disease Control and Prevention
LAI- Laboratory Acquired Infections
NOISH- National Institute for Occupational Safety and Health
PAPR- Powered Air Purifying Respirator

1.3 Aim of Study

Develop and pilot a structured interview/survey tool to investigate the use of personal protective equipment, biosafety training, and safety incidents in research university animal laboratory workers.

Survey the literature has on laboratory acquired infections, employee risk perception, biosafety training and personal protective equipment use to inform the interview/survey tool.

2.) Literature Review

More and more researchers have begun to investigate the exposure and rates of infection for laboratory workers, particularly those working with animals. The major pathway of infection discovered in these studies so far has been the respiratory pathway. Through the respiratory pathway laboratory workers are exposed to fungi, bacteria, viruses, and animal allergens that can cause infections to the workers exposed (Duc et al, 2008) However, a recent international study conducted on 23 different biosafety level 3 and 4 laboratories by Wurtz et al found that, "The analysis of the survey reveals that laboratory-acquired infections have been infrequent and even rare in recent years, and human errors represent a very high percentage of the cases." (Wurtz et al, 2016) Additionally, the study found that most of these infections (87%) were in laboratory technicians and those working with micro biotic organisms. Thus, the scope of this literature review was to collect recent and relevant information on what contributes to the risk perception of laboratory workers in acquiring laboratory infection and improper use of personal protective equipment that contribute to these infections. Risk perception and biosafety habits can be influenced by multiple factors; however, the literature indicates three measurable potential reasons: training protocols and laboratory biosafety culture for animal laboratory workers, the dissemination of existing information regarding infections acquired by biosafety laboratory workers, and effectiveness of popularly used personal protection equipment in animal laboratories.

2.1 Training and Laboratory Culture

The personal protective equipment required to work in a biosafety laboratory is generally uniform according to the biosafety level, however, the amount of training on the personal protective equipment and how to work in these laboratories varies greatly. There are no set training structures for laboratory management to abide by. A recent framework of guidance for biosafety level 4 laboratories was established by Duc et al, this framework was put together by studying BSL-4 laboratories and found, "that the BSL-4 laboratory director is the key person most responsible for ensuring that staff members are appropriately prepared for BSL-4 operations."(Duc et al, 2008) The authors suggested this particular biosafety level requires at least didactic, one-on-one, and mentored on the job training for each employee working in the laboratory. This becomes problematic for individuals who are working in a biosafety level 2, 3 or 4 especially, because Duc et al also found that, "BSL-4 laboratory orientation training assumes that the person has already mastered all procedures for safe and secure handling of infectious agents at the BSL-2 and ideally BSL-3 levels." (Duc et al, 2008) Thus, individuals who were improperly trained at the biosafety level before, will never receive proper training in the previous biosafety level. This will build an unsteady foundation of biosafety habits and may eventually lead to an incident in the laboratory.

Training varies from laboratory to laboratory and largely depends on what industry the laboratory is funded by. There are three major funding sources for laboratories: academic, government, and private laboratories. In 2008, there was a survey of biosafety professionals who work in BSL-2 and BSL-3 laboratories conducted by Chamberlain et al. The authors of this study were trying to identify the variance in biosafety training and incident reporting that existed in each category of laboratories. The study surveyed a total of 258 eligible members of the American Biological Safety Association, who mostly identified themselves as biosafety officers or environmental health officers. Fifty-two percent were from academia, 16% worked for the government, and 23% worked for private industry. The survey showed that most laboratories required some form of biosafety training and about 75% had a biosafety officer. Additionally, the study showed that 93% of the BSL-3 and 73% of the BSL-2 laboratories receive an annual biosafety inspection by their biosafety officer. However, the authors left the definition of biosafety training to the laboratory protocol that the responder works in. The results of the detailed questions on specific training situation illustrates the variance in training. Those who work in BSL-2 laboratories indicated that 23% of the institutions performed drills or activities for hazardous spills and only 7% had activities for hands on training regarding needle-stick incidents. Most indicated that didactic training was the method used for teaching new employees about needle-stick incidents. This represents a potential issue for these laboratories, because these individuals may not be able to practice the proper biosafety habits without hands on practice. The proper balance of didactic, one-on-one, and mentored hands on training is required to prevent all incidents. However, the study illustrates that most BSL-2 laboratories current biosafety training only utilizes didactic training. The study also found that 73% of the study respondents indicated that there was a biosafety officer responsible for maintaining a protocol for reporting incidents. However, only "Forty-four percent of respondents indicated that within the last 12 months, their institutions have created and disseminated at least one newsletter, e-newsletter, or flyer that addressed biosafety issues." Therefore, there is a disconnect on how this information is collected and how it is disseminated to the employees. These employees need to get this information to continuously comply with new biosafety regulations and to learn from mistakes others may have made regarding their biosafety practices. This study highlights the lack of regulated biosafety training in BSL-2 laboratories in academia, government, and private industry. The authors suggest that it may be time to "develop industry-wide biosafety competencies that offer more detailed and uniform guidance about what each laboratory worker should be expected to know and demonstrate [and] certain practices such as posting incident-reporting protocols in accessible places such as biosafety websites and turning laboratory incidents into shared lessons learned are likely to improve biosafety regardless of the biosafety level of the laboratory."(Chamberlain et al, 2008) These two suggestions will be effective in creating uniformity in the training provided for each individual, however there also must be a change in the laboratory culture that affects biosafety behavior.

In addition to being responsible for the biosafety training, laboratory management is also responsible for the biosafety culture of the laboratory. This can be thought of in lay terms, as the strictness of the laboratory management. However, this is important because it can greatly influence the risk perception of the individuals who work in the laboratory. A study conducted by Ozsahin et al in 2006 surveyed 84 individuals who work in research and clinical laboratories to identify safety awareness in laboratories workers. The study showed that only 67.9% of the individuals washed their hands after each procedure, 36.9% answered correctly on waste disposal

questions, and only 69% answered correctly on protective habits. These findings highlighted the authors suggestion that "that regular education about laboratory safety must be provided as part of professional education programs and after their completion" (Ozsahin et al, 2006) This regular education that the author suggests is a part of the culture that laboratory management must maintain for proper biosafety practices. Another study conducted by Arezes and Miguel in 2008 sought to investigate the occupational hazards of worker safety habits. This study was conducted on participants that used hearing protection devices as their personal protective equipment. The authors sought to determine when the participants felt like it was necessary to wear these devices. 516 industrial workers from both genders and all education levels were surveyed and the authors found that "individual risk perception of the considered workers' sample, and other perceptual-cognitive factors, seem to be important predictors of their safety behavior." (Arezes et al, 2008) The authors also found that the workers were poor judges of their perceived risk. This study highlights that employees cannot be trusted to be the judges of when specific personal protective equipment is used. The risk should instead be established by occupational health regulations or in the case of laboratories, biosafety professionals, who are trained in determining the need for personal protective equipment. This will lead to great compliance in biosafety and lessen the possibilities of laboratory inquired infections and other biosafety incidents.

2.2 Laboratory infections acquired by animal laboratory workers

The existence of acquired infections by laboratory workers has been examined for decades and has become an increasingly important topic in biosafety. This information has not been properly circulated in biosafety laboratories to reinforce the need for proper personal protective equipment practices. "The largest survey of infections was reported in 1976 by Pike, who found that 4079 LAIs were caused by 159 biological agents, although ten agents caused infections accounting for 50 % of cases (brucellosis, Q fever, hepatitis, typhoid fever, tularemia, tuberculosis, dermatomycoses, Venezuelan equine encephalitis, psittacosis, and coccidioidomycosis). "(Wurtz et al, 2016) This information is important because it shows that the issue of laboratories infections has been a constant issue since over 40 years ago, while the scientific community has gained more information on safer habits, the issue of infections still persists in biosafety laboratories. Wurtz et al, conducted a study on BSL-3 and BSL-4 laboratories workers in 2016. The study surveyed 119 institutions and 23 responded. The authors found that "four of the 23 surveyed laboratories reported 15 LAIs caused by four different pathogenic organisms." (Wurtz et al, 2016) While this only represents less than 20% of the surveyed laboratories, 15 different laboratories inquired infections in only 4 laboratories shows how important it is to have biosafety training and proper use of personal protective equipment. The study showed that 73% of the infections occurred in BSL-3 were there are not as many strict biosafety regulations as the BSL-4. Additionally, most of the infections were in laboratory technicians, these individuals are less experienced and trained in proper biosafety habits as management and other senior level laboratory workers. The authors of this study concluded that the rate of laboratory inquired infections has decreased dramatically since the Pike study

conducted in 1976. This is in large part due to the new regulations that has arisen since that study was conducted. However, the authors also stated, “due to training and careless behavior with [personal protective equipment] infections still occur. It is important to properly train and educate laboratory animal workers on the right and most effective way to use protective protection equipment.” (Wurtz et al, 2016)

There was an additional study conducted on the connection to laboratory acquired infections and biosafety habits conducted by Sewell in 1995. This study focused on the prevalence of laboratory associated infections and how these infections occurred. These infections according to the data collected by Sewell “resulted from work with the infectious agents (21%) or animals (17%), exposure to infectious aerosols (13%), and accidents (18%).” (Sewell, 1995) These statistics show how infections are due to accidents and exposure to infectious agents that could be minimized by proper biosafety habits. Sewell also sought to characterize the habits of individuals who have fewer incidents and found that “characteristics of persons who have few accidents include adherence to safety regulations, a respect for infectious agents, ‘‘defensive’’ work habits, and the ability to recognize a potentially hazardous situation.” (Sewell, 1995) These characteristics can be fostered by all individuals who work in biosafety laboratories with proper biosafety training, laboratory risk education, and proper biosafety culture. However, it is important to disseminate information from the studies like Sewell and Wurtz et al to establish the necessary “respect for infectious agents” that will prevent accidents and other incidents that lead to laboratory acquired infections. This respect will not only prevent accidents, but will also contribute to the proper biosafety culture that will encourage workers to use personal protective equipment.

2.3 Effectiveness of improperly used personal protective equipment

The focus of this study is on the biosafety habits of laboratory workers, including the proper use of personal protective equipment. The most used personal protective equipment in BSL-2’s and BSL-3’s at Georgia State University include: the N95 respirator, lab coats, aprons, surgical masks, gloves, and the powered air purifying respirator. It is important to use these protective items, but even more important to use these items properly to ensure that they’re protective qualities are fully utilized.

The N95 is a respirator rated by the National Institute for Occupational Safety and Health and recommended by the CDC for protection against most cases of air contamination. However, this respirators effectiveness can vary based on how it is utilized. A study conducted by Reponen et al in 2010 found that “Overall protection factors increased when subjects passed fit testing.”(Reponen et al, 2010) Therefore, it is not enough to simply wear a N95 respirator to maximize its protective potential. However, it is still important that laboratory workers wear this respirator when dealing with air contamination, because they it offers more protection than the alternatives of a surgical mask or no protective equipment at all. This conclusion is supported by a study conducted by Macintyre et al. The authors of this study conducted a randomized clinical

trial on health workers to find the increased protective factor of the N95 respirator. The study population included 488 hospital workers that were above the age of 18 and were followed for four weeks. These individuals received pharyngeal swabs that were later cultured and analyzed to determine the presence of "adenoviruses, human metapneumovirus, coronavirus 229E/NL63, parainfluenza viruses 1, 2 or 3, influenza viruses A or B, respiratory syncytial virus A or B, rhinovirus A/B and coronavirus OC43/HKU1." (Macintyre et al, 2011) The authors of the study found that "rates of respiratory tract infection were approximately double in the medical mask group compared to the N95 group in health workers who wore masks throughout their shift." (Macintyre et al, 2011) The authors postulated that they were not able to find statistical significance, because the study may have been underpowered. However, the findings do reinforce the need for wearing some form of respiratory protection when dealing with air contamination. Similarly, is the importance for using gloves when working in a laboratory. Skin is the first potential point of contact for most infectious agents that laboratory workers deal with. Sewell emphasized this in his study and stated, "Gloves are the most important protective barrier, because contamination of the hands is a frequent cause of exposure to HIV, HBV, and other pathogens." (Swell, 1995) However, even the most basic personal protective equipment like gloves can be utilized ineffectively if the laboratory worker is not using proper biosafety habits. Individuals who use gloves that are not the proper size or have holes in them can increase the chances of laboratory acquired infections.

Aprons and lab coats do not currently have any literature available explaining the exact protection factor or infection control. However, both serve as dermal protection and can be thought of similarly to gloves. Lab coats and aprons should be worn anytime the laboratory worker is in contact with infectious agents to decrease the chances of infection. Powered air purifying respirators or PAPRs are another form of personal protective equipment used to deal with air contamination. These devices are mostly used in BSL-3's and BSL-4's. The PAPRs are usually in the form of a hood or full-face mask and utilize a powered filter that removes a certain amount of contaminate from the air to a level that is safer of the worker wearing it. If individuals are working in a laboratory where PAPRs are provided, then it is a necessity that this equipment is used to prevent infection. However, biosafety hazards can be increased when the worker wears this equipment and does not know necessary information about the PAPR. A study conducted by Martin et al sought to examine the performance of PAPRs over the course of an entire shift. The authors found that "it is impossible to look at a PAPR and tell how well it will perform over the course of an entire work shift. Furthermore, a visual inspection cannot tell a respirator user if the respirator worn daily is equipped with electrostatic filters. From results presented in this study, it is clear total PAPR unit performance, particularly when electrostatic filters are used, could be an area of concern." (Martin et al, 2006) This study indicates that it is not enough for the worker to wear the PAPR the entire shift, the worker must know information about the filter and the length of time it provides protection. This reinforces the theme of the literature on personal protective equipment that proper training and use is essential to maximize the protective factors of these items.

Based on the current research regarding perception of risk exposure, training protocols and biosafety habits, and effectiveness of personal protection equipment, there is still a gap between these crucial factors and how much neglecting these factors contribute to human error that results in laboratory acquired infections or accidents. The goal of this study and thesis will be to connect this gap by collecting more primary information regarding laboratory animal workers risk perception and corresponding personal protective equipment use. There is an additional gap in the research regarding the biosafety level and corresponding perceived risk. This information will be compared to the participants given safety incident history to determine whether these factors greatly contributed to the human error that causes laboratory infections.

3.) **Methods and Procedures**

3.1 Context of Study

This purpose of this thesis is to be a foundation for an important study on biosafety habits and risk perception of Georgia State University BSL laboratories. These phases included: a literature review on factors that contribute to laboratory acquired infections, editing and completion of the survey tool and two pilot interviews of senior level BSL management.

3.2 Rationale of Study

According to Wurtz et al, "The largest survey of infections was reported in 1976 by Pike, who found that 4079 LAIs."(Wurtz et al, 2016) However, a recent study conducted by Karen Byers of the American Biological Association has found an additional 1,141 infections from 1979 to 2005. This high number of infections represents a serious risk to laboratory workers who do not practice proper biosafety habits. Therefore, it is necessary to conduct a preventative study to understand the biosafety habits and risk perception of Georgia State University laboratory workers to determine if these individuals are at additional risk for laboratory acquired infections.

3.3 Study Population

The pilot interview portion of this survey was a senior level principal investigator who supervises personnel working in an ABSL2 animal laboratory, and a health behavior expert who has conducted extensive survey research.

3.4 Survey Tool

The created survey tool was first edited to create a flow that would facilitate easy and accurate completion by the interviewer. This included introducing a numbering system that will make data entry easier. The survey tool contains 70 items and addresses the domains of biosafety practices, training, and attitudes towards personal protective equipment.

4.) Results of pilot interviews, survey editing, and literature review

4.1 Pilot Interviews

The pilot interviews were conducted with the purpose of identifying weaknesses in the flow of the survey and to understand the best way to deliver the interview for future research. This interview lasted for approximately 35 minutes and resulted in two critical findings. The first finding was the need to add more detail and specificity to the introduction. The second finding was to make further editing of the diction in the survey. The second lasted approximately 45 minutes, and the subject pointed out the potential skepticism laboratory workers may have in answering the survey and provided suggestions for how to address this problem.

4.2 Survey Editing

Questions on this survey were numbered and finally resulted in a total of 70 items. In addition to numbering, the questions were edited to include skips if the certain items do not pertain to the participant taking the survey. This increased the flow of the survey tool. The survey tool's introduction was also edited to increase specificity about the purpose of the study. A codebook was also created to ensure that responses and survey data will be stored properly for the future study. Lastly, questions and the introduction were edited for grammar, spelling, and punctuation.

4.3 Literature Review

The results of the literature review provided insights on which domains would be important to include in the survey instrument developed.

5.) DISCUSSION AND CONCLUSION

5.1 Discussion of Study Aim

Based on the literature review and the pilot interviews this thesis has found that the future study of biosafety habits, training and risk perception is necessary to determine any potential risk of laboratory acquired infections in GSU laboratories. Additionally, the findings in this thesis has found that it will be necessary to further edit the introduction of the survey tool to include information that will address concerns future participants may have about the use and disposition of survey results. This will be particularly important in establishing candid responses and full cooperation in all laboratories. Lastly, the literature review conducted in this thesis has found a lack of consistent and structured biosafety training; in addition to a significant amount of laboratory acquired infections since the study conducted by Pike in 1976. These infections represent a real risk for laboratory workers who do not practice the appropriate biosafety habits.

5.2 Suggestion for Future Study

The most important findings from this thesis will significantly help build the foundation for the future study conducted on university laboratory workers. The future study must be able to track the personal protective equipment use and training of all laboratory workers at the university, who agree to participate in the study. This study will highlight the need for changes in safety policy and allow researchers to identify potential ways to reduce the risk of laboratory acquired infections.

5.3 Conclusion

This thesis was constructed to create a foundation for a future study on biosafety habits, training, and risk perception of GSU laboratory workers This was accomplished by creating a thorough literature review, editing of the future survey tool, and completion of two critical pilot interviews. The results of the literature review highlighted the lack of consistency in biosafety habits and training by laboratory workers. Additionally, the literature details the very real risk of laboratory acquired infections. These findings suggest that the future study that will be conducted is necessary to determine if there are any habits of GSU laboratory workers that will put them at an increased risk of laboratory acquired infections. The editing of the survey tool and findings from the pilot interview will greatly contribute to this future study.

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