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Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
College Of Nursing
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Dedication

I dedicate this dissertation to my mother, Paulette Denise St Laurent Bouchard, who, although she never lived to see me finish my baccalaureate program let alone start my doctoral program, always told me, “Don’t give up…I know you can do it.”

Acknowledgments

I would like to express my gratitude to my chair, Dr. Candace Burns, and to my committee members Drs. Raymond Harbison and Gregory Holm, for their guidance, support, and patience over the years. Thank you for not giving up on me. I would also like to thank my newest committee member Dr. Kevin Kip for jumping in and helping me make it through to the end and for his patience and kindness. I would also like to acknowledge Dr. Paul Spector both for serving as outside chair and for his guidance in devising the MSDS test, Lakeside Occupational Medical Centers for allowing me to conduct my study at their clinic, South University for their understanding as I worked on my dissertation, Dr. Sarah Cobb for her input, Dr. Cathy Meade for getting me started in the field of health literacy, Dr. Jason Beckstead for sharing his statistical expertise over the years, and Cathy Cheshin for her assistance with the technical aspects of the writing process. Last, but certainly not least, I would like to thank my family, especially Gerry, Fran, Josée, Luc, and Julie Bouchard, and all of my friends for their constant support over the years.

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Abstract

More than 100 million American workers, 7 million workplaces, and 945,000 hazardous chemical products are covered under the Hazard Communication Standard (HCS), regulated by the Occupational Safety and Health Administration. There were a total of 1,183,500 recordable non-fatal illnesses and injuries in private industry workplaces in 2006 resulting in days away from work. Of these, 19,480 were due to chemicals and chemical products. In addition, there were a total of 5,703 work-related fatalities in 2006. In 191 of these, chemicals and chemical products were listed as the primary source of injury and as the secondary source of injury in 104 cases. The economic impact of both fatal and non-fatal occupational injuries amounted to $164.7 billion in 2006.

OSHA established the HCS in order to ensure that workers are informed of the hazardous chemicals with which they work, yet OSHA admits that many adults may have difficulty reading material that communicates hazards. Violations of OSHA's HCS were the third most cited violation in 2007. Since only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy, the state of affairs poses a serious problem for hazard communication, which nurses and nurse practitioners are often responsible for conveying. Health tasks that require *Proficient* health literacy include "drawing abstract inferences, comparing or contrasting multiple pieces of information

within complex texts or documents, or applying abstract or complicated information from texts or documents".

Donabedian's Structure-Process-Outcome framework served as the conceptual basis for this study. Twelve research studies (nine journal articles and three doctoral dissertations) published between 1993 and 2003 were reviewed. None of these studies measured the participants' literacy level. The purpose of this single administration, cross-sectional study was to examine literacy levels as a hypothesized predictor of test scores of employees presenting to the Lakeside Occupational Medical Center, Downtown Clinic, for a physical examination, immunization, drug screening, or follow-up appointment. MSDS test scores served as the dependent variable and were measured by an investigator-made test consisting of seven passages, taken from seven separate MSDSs for sodium hypochlorite, each from a different manufacturer. Sodium hypochlorite is commonly utilized in numerous industries including the janitorial, pulp, paper, textile, dairy, and water-cooling industries and is known to cause work-related health effects such as asthma and irritation of the eyes and throat.

Each passage was followed by five multiple choice questions. Literacy levels were measured utilizing the Short Test of Functional Health Literacy in Adults (STOFHLA). The readability level of the written material was measured utilizing the Simplified Measure of Gobbledygook (SMOG) and the Flesch-Kincaid Grade Level (FKGL). The characteristics of age, highest grade level completed, native language, and job category were measured by a demographic sheet.

The results indicate that there was a significant positive correlation between the total STOFHLA scores and the total scores on the MSDS test. Therefore, hypothesis number 1 was supported. Findings on the readability level of the examples of the MSDSs to the participant's overall MSDS score were inconclusive. However, the format of the MSDS, specifically the number of lines/sentence and the number of words that are 3 syllables or more, may influence comprehension. Therefore, written hazard communication material should be written in short sentences and use words less than 3 syllables. This way the likelihood of the material being understood by the worker will be increased. Further research aimed at understanding exactly how reading grade level and sentence structure impacts comprehension of hazardous materials information is needed.

Chapter One: Introduction

More than 100 million American workers, 7 million workplaces, and 945,000 hazardous chemical products are addressed by the Hazard Communication Standard (HCS), which is regulated by the Occupational Safety and Health Administration (OSHA, 2006a). There were a total of 1,183,500 recordable non-fatal illnesses and injuries in private industry workplaces in 2006 requiring days away from work. Of these, 19,480 were due to chemicals and chemical products (Bureau of Labor Statistics [BLS], 2007a). In addition, there were a total of 5,703 work-related fatalities in 2006. Of these, 191 listed chemicals and chemical products as their primary source of injury, and 104 listed the same as their secondary source of injury (BLS, 2007b). The economic impact of these fatal and nonfatal occupational injuries amounted to $164.7 billion in 2006 (BLS, 2007a).

OSHA established the HCS in order to ensure that workers were informed of the hazardous chemicals with which they work, yet OSHA admits that many adults may have difficulty reading material that communicates hazard (OSHA, n.d.). Violations of OSHA's HCS were the third most cited violation in 2007 (NSC, 2007). Only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy (Kutner, Greenberg, Yin, and Paulsen, 2006). Health tasks that require *Proficient* health literacy include "drawing abstract inferences, comparing or contrasting multiple pieces of information within complex texts or

documents, or applying abstract or complicated information from texts or documents" (Kutner et al.). "These data identify limited health literacy as a population-level problem of enormous proportion, affecting nearly 9 out of 10 English-speaking adults in the United States" (U.S. Department of Health and Human Services [DHHS], 2010). This state of affairs poses a serious problem for hazard communication, which nurses and nurse practitioners are often responsible for conveying.

The purpose of this study was to examine if an association was found between an employee's functional health literacy level and their comprehension of hazardous communication material, such as MSDSs. In particular, this study examined whether there was an association between an employee's health literacy level and his/her score on a Material Safety Data Sheet (MSDS) test which measured the employee's comprehension of the material on the test. This study also examined whether there was an association between the employee's score on each example of the MSDS test and the readability level of each example.

Background

Occupational Illnesses and Injuries

According to the BLS, of the 1,183,500 recordable non-fatal illnesses and injuries in private industry workplaces in 2006, 19,480 were due to chemicals and chemical products. The largest number (6,880) of these 19,840 fell under the category of "chemical products-general" with the greatest number (4,250) being listed under cleaning and polishing agents—in other words, disinfectants—not

elsewhere classified (BLS, 2007a). In addition, there were a total of 5,703 work-related fatalities in 2006. One hundred and ninety-one of these private industrial workplaces listed chemicals and chemical products as their primary source of injury and 104 as their secondary source of injury (BLS, 2007b). The average economic cost of fatal and non-fatal work injuries, per death, in 2006 was $31.1 million without employers' uninsured costs and $33 million with employers' insured costs (National Safety Council [NSC], 2008a). According to the NSC, these costs are a measure of the money spent and income not received due to work-related accidents, injuries, and fatalities. Cost is another way of measuring the importance of prevention in work settings (NSC, 2008a).

Hazard Communication Standard

OSHA, in its *Safety and health topics: Hazardous and toxic substances*, defines hazardous and toxic substances as "those chemicals present in the workplace which are capable of causing harm" (OSHA, 2006c). When the *Hazard Communication Standard* was revised in 1994, the National Institute for Occupational Safety and Health (NIOSH) estimated that there were as many as 575,000 hazardous chemical products in the aforementioned workplaces (OSHA, 1994). Twelve years later, that number has increased to more than 945,000 (OSHA, 2006b).

OSHA first promulgated the Hazard Communication Standard (HCS), 29CFR 1910.1200, in 1983 in order to ensure that workers were informed of the hazardous chemicals with which they work. The purpose of the HCS is "to ensure that the hazards of all chemicals produced or imported are evaluated, and that

information concerning their hazards is transmitted to employers and employees" (OSHA, 1994). The HCS, also known as The Worker Right to Know law, states that "employees have both a need and a right to know the hazards and identities of the chemicals they are exposed to when working" (OSHA, 1994). The main components of the HCS are container labeling, MSDSs, and employee training. Employers must ensure that labels on the chemical containers are legible, written in English, and prominently displayed on the container, or readily available during the employee's work shift. Since the HCS is a performance-oriented standard, the employer has the flexibility to adapt the rule to the workplace. In other words, there are no specific requirements for size, color, or text for labels. Moreover, although employers must have an MSDS for each hazardous chemical that they use, there is no OSHA-specified format as long as the required elements are included. OSHA has developed a non-mandatory MSDS format, OSHA Form 174, which may be utilized to comply with the standard (OSHA, 1986). Although the MSDS must be in English, OSHA does not specify what the reading level of the text should be (OSHA, 1994). OSHA admits that many adults may have difficulty reading hazard communication material and that in addition to this literacy issue, hazard communication training involves words and concepts that are not familiar to the average employee, and that are often new to employers as well (OSHA, n.d.).

OSHA commissioned a report to explore the issue of hazard communication in general, and MSDSs in particular. (Sattler, Lippy, & Jordan, 1997). This report found that, on average, literate workers understood only about

60% of the health and safety information on MSDSs associated with the hazardous chemical. Then-Assistant Secretary of Labor for OSHA, John L. Henshaw, commenting on the comprehensibility of MSDSs, stated that

> …one reason why there are concerns regarding comprehensibility is that there are multiple audiences for MSDS information—workers, employers, and safety and health professionals. What may be comprehensible to an experienced professional in the field of safety and health may be difficult for an employer or an employee to understand. (2004)

In order to standardize hazard communication in the United States, OSHA has proposed to adopt the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). “Under the GHS, labels would include signal words, pictograms, and hazard and precautionary statements and safety data sheets (SDSs)” (OSHA, 2009). According to OSHA, “adoption of the GHS could also address some of the issues that have been discussed in the U.S. regarding the HCS and its implementation, such as improving labels and SDS comprehensibility through implementation of a standardized approach” (2006b).

National Assessment of Adult Literacy

According to the 2003 National Assessment of Adult Literacy (NAAL), a nationally representative assessment of English literacy among more than 19,000 American adults 16 years and older, 93 million adults had *Basic* and *Below Basic* prose literacy level. Adults with these literacy levels range from being able to perform only the most simple and concrete literacy tasks to

performing simple and everyday literacy activities. An example of prose literacy on the NAAL was finding information in a news article, brochure, or instructional material (U.S. Department of Education, n.d.). Literacy has been defined as “an individual’s ability to read, write, and speak in English and compute and solve problems at levels of proficiency necessary to function on the job and in society, to achieve one’s goals, and develop one’s knowledge and potential” (National Institute for Literacy, 1991).

Health literacy has been defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000). Functional health literacy has been defined as “the ability to use reading, writing, and computational skills at a level adequate to meet the needs of everyday life situations (Parker, Baker, Williams, & Nurss, 1995).

For the first time, the 2003 NAAL measured health literacy. Only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy (Kutner et al., 2006). Health tasks that require *Proficient* health literacy include “drawing abstract inferences, comparing or contrasting multiple pieces of information within complex texts or documents, or applying abstract or complicated information from texts or documents” (Kutner et al.). “These data identify limited health literacy as a population-level problem of enormous proportion, affecting nearly 9 out of 10 English-speaking adults in the United States” (U.S. DHHS, 2010c). Other findings on the NAAL included that women had higher health literacy than men, Hispanic adults had lower average health

literacy than adults in any other racial/ethnic group, adults who spoke only English before starting school had higher average health literacy than adults who spoke other languages alone or other languages and English, and that starting with adults who had graduated from high school or had a GED, the average health literacy increased with each higher level of educational attainment (Kutner et al., 2006).

Occupational health literacy would require that workers be able to function safely on the job and have the capacity to obtain, process, and understand basic health information such as that found on the MSDS, or the SDS, when the GHS is implemented. The Institute of Medicine report states that health literacy is a public concern and that health literacy is of concern to those who address worker safety and health. It is an issue not only for those workers with limited literacy skills, but for every worker who is faced with complex or difficult texts at work (Nielsen-Bohlman, Panzer, Kindig, 2004). An MSDS could easily be considered a complex and difficult text at work.

According to the NAAL, literacy increased with more education. Eleven million adults were nonliterate in English. Of these 11 million people, 7 million could not answer simple test questions and 4 million could not take the test due to language barriers. Of those in the *Prose Below Basic* population 55% did not graduate from high school, 44% did not speak English before starting school, 39% were Hispanic adults, 20% were Black adults, 26% were 65 years or older, and 21% had multiple disabilities. In terms of age, adults 65 years or older had the lowest literacy (U.S. Department of Education, n.d.).

Toossi (2006) states:

> The labor force is expected to become even more diverse than it is now. Minorities, with higher population growth through immigration, higher fertility rates, and higher labor force participation rates, are projected to expand their share of the workforce considerably in the future.

This diverse labor force will need to be taken into consideration when hazard communication materials are devised, training is conducted, and workers are treated by healthcare professionals, including nurses and nurse practitioners.

The American Association of Occupational Health Nurses

Various health-related organizations have identified research and public health priorities that have implications for literacy and hazard communication. The American Association of Occupational Health Nurses (1998) identified various research priorities. Three of these research priorities have implications for literacy and hazard communication. These are: strategies that minimize work-related health outcomes (e.g. respiratory disease); health effects resulting from chemical exposures in the workplace; and strategies for increasing compliance with or motivating workers to use personal protective equipment.

The National Institute for Occupational Safety and Health

The National Institute for Occupational Safety and Health (NIOSH), in partnership with 500 organizations and individuals, established its National Occupational Research Agenda (NORA) in 1996. In 2006, NORA and its partners formed a sector-based approach for its research framework. One of the sectors consists of Transportation, Warehousing, and Utilities (TWU) and

identified the following priorities: health effects of occupational exposures, worker health and wellness, health and safety management, and health communication (NIOSH, 2006). According to NIOSH (2009), over 7 million workers are employed in this sector and although it only accounts for 5% of workers in the United States, it accounts for 15% of workplace fatalities. After consideration of public comments, the TWU Sector Council developed 4 strategic goal areas, one of which is physical, chemical, biological and psychosocial exposures (NIOSH, 2009).

Healthy People 2010 and 2020

The Healthy People Consortium, an alliance of 350 national organizations and 250 state agencies, developed the *Healthy People 2010* objectives (U.S. DHHS, 1996). From these objectives, chapters were developed. Chapter 11 of *Healthy People 2010* is devoted to health communication and Chapter 20 to occupational safety and health. The main goal of Chapter 11 is to "improve the health literacy of persons with inadequate or marginal literacy skills"; the main goal of Chapter 20 is "to promote the health and safety of people at work through prevention and early intervention" (U. S. DHHS, 2000).

Since Healthy People 2020 has been published, the topics of Health Communication and Health Information Technology and Occupational Safety and Health remain. One of the objectives in the former topic area is to increase healthy literacy skills and two in the latter topic area are to reduce deaths from work-related injuries and reduce nonfatal work-related injuries (U. S. DHHS, 2010a). According to Healthy People 2020, "workers spend a quarter of their

lifetime, and up to half of their waking lives, at work or commuting…Work is one of the most important determinants of a person's health. However, addressing occupational safety and health poses numerous challenges" (U. S. DHHS, 2010b). In addition, Healthy People 2020 (2010b) reports that:

- The workforce, like the U.S. population at large, is becoming increasingly diverse. These demographic changes result in new safety and health issues. For example, some workers—such as racial and ethnic minorities, recent immigrants, younger and older workers, workers with genetic susceptibility, and workers with disabilities—are more likely to have increased risks of work-related diseases and injuries.
- Workplaces are rapidly evolving as jobs in the current economy continue to shift from manufacturing to services.
- Major changes are also occurring in the way work is organized. Longer hours, compressed work weeks, shift work, reduced job security, and part-time and temporary work are realities of the modern workplace and are increasingly affecting the health and lives of workers.
- Finally, the new chemicals, materials, processes, and equipment that are being developed at an ever-accelerating pace pose emerging risks to occupational health.

The Agency for Healthcare Research and Quality

The Agency for Healthcare Research and Quality (Berkman et al., 2004), has found that low literacy is associated with adverse health, including poor health knowledge. An update to this literature review revealed that low health literacy level was consistently associated with increased hospitalizations, greater emergency care use, and a poorer ability to interpret labels and health messages, among other things (Berkman et al., 2011). Low health knowledge can be associated with adverse health in the occupational setting as well, especially with regards to safety and health and hazard communication.

Office of the Surgeon General

Given the more than 90 million people in this country who cannot adequately understand basic health information, the Office of the Surgeon General made “improving health literacy” one of its public health priorities (U.S. DHHS, n.d.). To address this public health problem, Then-Acting Surgeon General, Kenneth Moritsugu, held a workshop on improving health literacy. One of the conclusions that came out of this workshop was that “public health professionals must provide clear, understandable, science-based health information to the American people” (U.S. DHHS, 2006). Current Surgeon General, Regina Benjamin along with other members of the National Prevention, Health Promotion, and Public Health Council, released the National Prevention Strategy on June 16, 2011. One of the four strategic directions is “empowering people to make healthy choices: When people have access to actionable and

easy-to-understand information and resources, they are empowered to make healthier choices" (U.S. DHHS, 2011).

Definition of Terms

The definitions listed below provide the reader with terms that will be useful in reading this dissertation. These terms directly relate to this research and will be used throughout this document.

Adequate Functional Health Literacy. A score of 23-36 on the STOFHLA. People who have Adequate Functional Health Literacy will be able to read and interpret most health texts (Nurss, Parker, Williams, & Baker, 2001).

Basic Health Literacy. Having skills necessary to perform simple and everyday literacy activities (Kutner, Greenberg, Jin, & Paulsen, 2006).

Below Basic Health Literacy. Having no more than the most simple and concrete literacy skills (Kutner, Greenberg, Jin, & Paulsen, 2006).

Flesch-Kincaid Grade Level (FKGL). A readability formula that estimates the years of education needed, by United States school grade level, to understand a piece of writing. For example, a score of 8.0 means that an eighth grader can understand the document (Microsoft Office Online, 2008).

Functional Health Literacy. The ability to use reading, writing, and computational skills at a level adequate to meet the needs of everyday life situations (Parker, Baker, Williams, & Nurss, 1995).

Globally Harmonized System of Classification and Labeling of Chemicals (GHS). A harmonized system for hazard communication which includes labeling,

safety data sheets and easily understandable symbols, based on the classification criteria developed by the GHS (United Nations, 2007).

Hazard Communication Standard (HCS). An Occupational Safety and Health Administration Standard which provides workers with the right-to-know the hazards and identities of the chemicals they are exposed to in the workplace (OSHA, n.d.).

Health Literacy. The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (Ratzan & Parker, 2000).

Inadequate Functional Health Literacy. A score of 0-16 on the STOFHLA. People who have Inadequate Functional Health Literacy will be unable to read and interpret health texts (Nurss, Parker, Williams, & Baker, 2001).

Literacy. An individual's ability to read, write, and speak in English and compute and solve problems at levels of proficiency necessary to function on the job and in society, to achieve one's goals, and develop one's knowledge and potential (National Institute for Literacy, 1991).

Marginal Functional Health Literacy. A score of 17-22 on the STOFHLA. People who have Marginal Functional Health Literacy will have difficulty reading and interpreting health texts (Nurss, Parker, Williams, & Baker, 2001).

Material Safety Data Sheet (MSDS). Written or printed material which provides detailed information on each hazardous chemical, including its potential hazardous effects, its physical and chemical characteristics, recommendations for appropriate protective measures, and first aid measures should exposure

occur. MSDSs are to be readily accessible during each work shift to employees when they are in their work areas (OSHA, 1994).

National Assessment of Health Literacy (NAAL). A nationally representative assessment of English literacy among American adults age 16 or older (U.S. Department of Education, n.d).

Occupational Health Literacy. The ability to function safely on the job and have the capacity to obtain, process, and understand basic health information such as that found on the MSDS, or the SDS, when the GHS is implemented (Bouchard, 2007).

Occupational Safety and Health Administration (OSHA). A part of the United States Department of Labor which is responsible for ensuring safe and healthful working conditions for working men and women by setting and enforcing standards and providing training, outreach, education and assistance (OSHA, n.d. a)

Proficient Health Literacy. Having the skills necessary to perform more complex and challenging literacy activities (Kutner, Greenberg, Jin, & Paulsen, 2006).

Prose Literacy. The knowledge and skills needed to perform prose tasks (i.e., to search, comprehend, and use information from continuous texts). Prose examples include editorials, news stories, brochures, and instructional materials (Kutner, Greenberg, Jin, & Paulsen, 2006).

Safety Data Sheet (SDS). Written material which provides comprehensive information about a chemical substance or mixture for use by employers and

workers as a source of information about hazards and safety precautions (United Nations, 2007).

Short Test of Functional Health Literacy in Adults (STOFHLA). A functional literacy assessment tool designed to evaluate adult literacy in the health care setting (Nurss, Parker, Williams, & Baker, 2001).

Simplified Measure of Gobbledygook (SMOG). A readability formula that estimates the years of education needed to understand a piece of writing (McLaughlin, 1969).

Standard Occupational Classification (SOC). A system used by Federal statistical agencies to classify workers into occupational categories whereby occupations are placed into one of 23 major groups (Bureau of Labor Statistics, n.d.).

Significance of the Study

MSDSs communicate important information about a chemical to a worker. It is important for a worker to understand the information on the MSDS and resulting risks of exposure to the chemical. MSDSs are a key venue for educating workers about the chemicals with which they work. If a worker can't read or understand the information communicated via the MSDS, the worker is at increased risk for occupational injury or illness. Having access to an MSDS, or hazard communication material, which is easy-to-understand, would help all workers, especially the 90 million people in this country who cannot adequately understand basic health information, reduce exposure to hazardous chemicals and to minimize deleterious effects should exposure occur.

Since various health-related organizations have identified research and public health priorities that have implications for literacy and hazard communication, and only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy (Kutner et al., 2006) as per the last NAAL, research is needed to address the issue of literacy and hazard communication. This research is needed to ensure that the employees utilizing hazard communication materials, such as MSDSs, are able to understand them. Otherwise the materials are not serving their purpose of reducing exposure to hazardous chemicals and an alternate means of hazard communication may need to be developed.

Aim and Purpose

The overall aim of this research was to examine employee understanding of Material Safety Data Sheets (MSDSs) the goal being that of promoting worker safety as per the Occupational Safety and Health (OSH) Act of 1970. The OSH Act assures “safe and healthful working conditions for working men and women” (OSHA, 1970). Material Safety Data Sheets are written or printed materials concerning a hazardous chemical, which are prepared by chemical manufacturers and made available to employees who work with those hazardous chemicals. Since MSDSs may be the first written or printed material that an employee reaches for after an exposure to such a chemical, it is of utmost importance to ensure that the employees utilizing them are able to understand them.

Research Hypotheses

Hypotheses to be addressed are:

1. Literacy levels of participants as measured by the Short Test of Functional Health Literacy in Adults (STOFHLA) will be significantly related to the score on the MSDS test, i.e. the higher the employee's literacy level, the higher the score on the MSDS test.
2. Scores of participants on the MSDS test will indicate a relationship with the readability level of the examples on the MSDS test, i.e. the higher the readability level of the example, the lower the employee's score will be.

Chapter Summary

Chapter 1 presented a brief overview of the magnitude of the problem with the large numbers of work-related illnesses and injuries related to exposure to chemicals and chemical products and the number of people who fall below the *Proficient* health literacy level as per the 2003 National Assessment of Adult Literacy. The Hazard Communication Standard and its requirements were discussed, in general, and in relation to health literacy. Various health-related organizations have identified research and public health priorities that have implications for health literacy and hazard communication indicating a need for this research. The primary aim of this study was presented: to examine whether employees understand Material Safety Data Sheets. The two research hypotheses were stated: 1) Literacy levels of participants as measured by the

Short Test of Functional Health Literacy in Adults (STOFHLA) will be significantly related to the score on the MSDS test and 2) Scores of participants on the MSDS test will indicate a relationship with the readability level of the examples on the MSDS test.

Chapter Two: Review of the Literature

Overview

Chapter 2 presents a review of relevant literature pertaining to health literacy and the comprehension of hazard communication. The review of literature includes the search strategies used as well as gaps found in the research. Lastly, the framework for the study is discussed, clarifying the theoretical basis for the study.

Search Strategy

The following databases were used to search for research studies regarding literacy and hazard communication: the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Ovid MEDLINE, PubMed, Ovid PsycINFO, Social Services Abstracts, Social Sciences Full Text, the Education Resources Information Center (ERIC), and Dissertations & Theses: A & I. Search terms included “literacy,” “readability,” “comprehensibility,” “material safety data,” “hazardous substances,” “hazard communication,” “chemical hazards,” “worker safety,” “employee safety,” “employee health,” “worker health,” “occupational health,” “occupational health nursing,” and “occupational safety.” The year 1983 was chosen as the starting point for the literature review since that is the year that that HCS was first promulgated. Nine journal articles and three doctoral dissertations met the inclusion criteria for this study (see Conklin, 2003; Frazier, Beasley, Sharma, & Mohyuddin, 2001; Gucer, Oliver, & McDiarmid, 2003;

Janicak, 1996; Kolp, Sattler, Blayney, & Sherwood, 1993; Kolp, Williams, & Burtan, 1995; Lehto, 1998; Paul & Kurtz, 1994; Phillips, 1997; Phillips, Wallace, Hamilton, Pursley, Petty, & Bayne, 1999; Rosenmann et al., 2003; Wright, 1997). Research studies published in U.S. peer-reviewed journals or doctoral dissertations, in English, involving adult human subjects of working age and involving OSHA's HCS were included. Bouchard summarized the journal literature on literacy and the Hazard Communication Standard up through 2005 in a review article published in *AAOHN Journal* (2007).

Sodium Hypochlorite

Sodium hypochlorite has various uses in industry, including as a bleaching agent in laundry services; as a bleaching agent in the paper, pulp, and textile industries; as a disinfectant for glass, ceramics, and water; as an algicide and molluscicide in cooling water for power stations; in alpha-olefin sulfonate production (United States National Library of Medicine [NLM], Toxicology Data Network, 2003); as a disinfectant and bleaching agent in chemical and dairy industries (United States NLM, 2007), and in professional cleaning (Jaakkola & Jaakkola, 2006). Health effects of sodium hypochlorite include tissue damage; pharyngeal pain after ingestion; dermal burning pain, inflammation, and blisters; mild and transitory ocular irritation if the eyes are rinsed, or more severe effects and slower recovery if the eyes are not rinsed; ocular and nasal irritation, sore throat, and coughing at low concentrations of gases released from sodium hypochlorite solutions, or respiratory distress with airway constriction and pulmonary edema at higher concentrations; and reactive airways dysfunction

syndrome (RADS), a chemical irritant-induced type of asthma (Agency for Toxic Substances & Disease Registry, 2007). The Chlorine Institute has a Sodium Hypochlorite Incompatibility Chart, which states, “Do NOT mix Sodium Hypochlorite (bleach) with ANY other chemical unless adequate engineering controls and personal protective equipment (PPE) are in place” (n.d). Therefore, it is imperative that employees receive adequate training to ensure that they understand the risks of working with this chemical compound.

Theoretical Framework

Donabedian’s Structure-Process-Outcome framework served as the conceptual basis for this study (Donabedian, 2005). “Structure” includes the occupational health and safety professionals, such as nurses, who are involved in hazard communication; this communication can occur on-site, such as at the individual work-site, or off-site, such as at a freestanding occupational health clinic. “Structure” also includes physical facilities, such as the factory where the employee works; the clinic where the employees will be presenting for exposure treatment, a physical examination, immunization, drug screen, or follow-up appointment; and any equipment involved, such as PPE. Personal protective equipment can include respirators, gloves, protective clothing, and face shields that will protect the employee from potentially hazardous chemicals.

“Process” involves the activities carried out by the occupational health and safety professionals, including their communications and interactions with each other and with employees. In this study, communication involved hazard communication. Hazard communication includes labels, MSDSs, and employee

training. “Outcome” involves the prevention of work-related injuries and illnesses, which is the goal of occupational safety and health education. Prevention in this study is related to exposure to hazardous chemicals, which for research purposes is sodium hypochlorite. Primary prevention includes training and access to MSDSs, while secondary prevention includes the use of PPE to prevent, or minimize, illness or injury while working around hazardous chemicals. Nurses at all levels may be responsible for distributing and reviewing Material Safety Data Sheets with the employees and for educating the employee on the risks of working with hazardous chemicals. Advanced Practice Nurses such as Advanced Registered Nurse Practitioners (ARNPs) may diagnose and treat employees who may have been exposed to various chemicals. When doing so the ARNP would use the MSDS to assess the risks and hazards of the chemicals to which the employee may have been exposed, with the intent of teaching the worker to avoid future exposure. The occupational health nurse or nurse practitioner may also collaborate with other occupational health and safety professionals to ensure a favorable outcome. These other disciplines may include health and safety professionals such as certified safety professionals (CSPs), industrial hygienists, toxicologists, and occupational medicine physicians.

Gaps in Research

Although employers must have an MSDS for each hazardous chemical that they use, there is no OSHA-specified format as long as the required elements are included. This means that different manufacturers of the same

chemical, or chemical compound, may prepare MSDSs which are not identical. This same issue was found in this primary investigator's research when she selected 7 MSDSs for the same chemical compound from 7 different manufacturers. Although there were similarities between the 7 different MSDSs, none of them were identical. This lack of standardization can be an issue in worker health and safety. OSHA has developed a non-mandatory MSDS format, OSHA Form 174, which may be utilized to comply with the standard (OSHA, 1986), but since it is not mandatory, manufacturers can utilize whatever format they choose, as long as the required elements are present.

In addition, although the MSDS must be in English, OSHA does not specify what the reading level of the text should be (OSHA, 1994). This means that the manufacturer can write them at whatever level he or she chooses. OSHA acknowledges that many adults may have difficulty reading hazard communication material, which includes labels and MSDSs. No mention is made of ensuring the comprehension of the material, even if the employee can read the material. In addition, words found in hazard communication material may seem like a foreign language to employees and employers alike (OSHA, n.d.).

Aims of the proposed study addressed the following gaps:

Readability Level

OSHA acknowledges that many adults may have difficulty reading hazard communication material, which includes labels and MSDSs. Yet, a limitation of the research is that not all of the studies measured the readability level of the written material that they were assessing.

The following studies did not assess the readability level of the written material: Frazier et al., 2001; Gucer, et al., 2003; Janicak, 1996; Kolp et al., 1995; Lehto, 1998; Paul & Kurtz, 1994; Rosenmann et al., 2003. Of these, the following did not involve human participants and involved assessing written material in the form of MSDSs for accuracy or quality only (Frazier, et al., 2001; Kolp, et al., 1995; Paul & Kurtz, 1994). Frazier et al. (2001) state that many "MSDSs were hard to read" in regards to finding terms related to asthma or other pulmonary effects (p. 92). Although Gucer et al. (2003) addressed workplace communications about health hazards, they failed to mention whether any written hazard communication program was provided to women workers. Therefore, there was no mention of assessing any written material for readability. Janicak (1996) asked questions related specifically to the requirements of the HCS as pertained to MSDSs, but that study's questions did not address the readability level of the MSDSs. Lehto (1998) makes mention of readability when he talks about the fonts on smaller hazard labels as being "substantially lower in legibility and readability" (p. 45). The term "readability" is not defined, and no actual readability level is given. Although Rosenman et al. (2003) "recommend attention to adequate ventilation, improved warning labels and Material Safety Data Sheets, and workplace training and education" (p. 556), they did not speculate as to whether addressing the readability of the labels and MSDSs would be one way of improving them.

Since OSHA acknowledges that many adults may have difficulty reading hazard communication material, which includes labels and MSDSs, a gap in the

research is that not all of the studies measured the readability level of the written material that they were assessing.

Comprehensibility

According to OSHA, words found in hazard communication material may seem like a foreign language to employees and employers alike (OSHA, n.d.). This implies that the employee may not be able to read the hazard communication material. In addition, he or she may not be able to comprehend it. Having the ability to read hazard communication material does not indicate that the employee will be able to comprehend and to act on what he or she has read.

Not all of the studies that involved human subjects assessed whether comprehension or understanding occurred after hazard communication training. Gucer et al. (2003) stated that "employer-initiated risk communication, rather than alarming workers, actually reduces their anxieties" (p. 688), but they did not discuss whether comprehension or understanding of the training occurred. Rosenman et al. (2003) stated that improving "the presentation of information on labels, as well as workplace training and education as mandated by the Occupational Safety and Health Act's Hazard Communication Standard, should help to increase knowledge about the potential hazards of cleaning products" (p. 561-562), but increased knowledge does not necessarily mean that the workers comprehend or understand what they have learned.

Having the ability to read hazard communication material does not indicate that the employee will be able to comprehend and to act on what he or she has read. A gap in the research is that not all of the studies assessed

whether comprehension or understanding occurred after hazard communication training.

Literacy Level

According to the 2003 National Assessment of Adult Literacy (NAAL), only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy (Kutner et al., 2006). Health tasks that require *Proficient* health literacy include “drawing abstract inferences, comparing or contrasting multiple pieces of information within complex texts or documents, or applying abstract or complicated information from texts or documents” (Kutner et al.).

None of the studies measured the literacy levels of the participants (Conklin, 2003; Frazier et al., 2001; Gucer et al., 2003; Janicak, 1996; Kolp et al., 1993; Kolp et al., 1995; Lehto, 1998; Paul & Kurtz, 1994; Phillips, 1997; Phillips et al., 1999; Rosenmann et al., 2003; Wright, 1997). One of the studies briefly discusses literacy, but it does not measure it. Kolp et al. (1993) equate educational attainment, in the form of grade level completed in school, with worker literacy when they state that “the readability of MSDSs as well as worker literacy and reading grade levels, as reflected by educational attainment, appear to be important factors in the comprehension of MSDSs by workers” (p. 140). According to Doak, in Doak and Root (1996), years of education tell us what people have been exposed to, not what their current reading levels are, and on average, adults read three to five grade levels lower than the years of schooling attained (p. 6).

Wright (1997) discussed illiteracy in his “Need for the Study” section of his doctoral dissertation. He stated that manufacturers’ chemical fact sheets may not be appropriate for workers with marginal illiteracy and that these sheets may be ineffective as a training tool if the workers lack the education to interpret or comprehend them (p. 16). Although Wright provided a definition of illiteracy, he did not provide one for marginal illiteracy. As with Kolp et al. (1993), Wright erroneously equated educational achievement with reading ability.

According to the 2003 National Assessment of Adult Literacy (NAAL), only 12 percent of the adults surveyed in the United States demonstrated *Proficient* health literacy (Kutner et al., 2006). *Proficient* health literacy would be needed to apply complicated information from texts or documents such as that found in MSDSs. A gap in the research is that none of the studies measured the literacy levels of the participants.

Chapter Summary

This chapter presented a synthesis of the research available on literacy and hazard communication comprehension. Several gaps were identified indicating the need for this study. These gaps in research were: not all of the studies measured the readability level of the written material that they were assessing, not all of the studies assessed whether comprehension or understanding occurred after hazard communication training, and none of the studies measured the literacy levels of the participants. The conceptual framework presented in this chapter guided the development and the organization of the study.

Low literacy levels can pose a serious problem in any setting. When dealing with the occupational setting and potentially hazardous chemicals, low literacy can be life threatening. Research is needed to assess whether there is a correlation between workers' literacy levels and their understanding of written hazard communication material, for which readability levels are known. In order to meet the needs of workers with low literacy levels, it is imperative that occupational safety and health professionals, including nurses and nurse practitioners, provide workers with hazard communication materials that they are able to understand. In addition, it is imperative that an assessment of any given materials' comprehension take place, so that additional training can take place, if needed.

Chapter Three: Method

This chapter presents the methodology used in this study. Included are topics such as research design, the protection of human participants, study setting, sample, inclusion criteria, instrumentation, procedure, data analysis plan, and data and safety monitoring.

Research Design

The study utilized a single administration cross-sectional design. A convenience sample was recruited from employees who presented themselves to the Lakeside Occupational Medical Centers, Downtown Clinic, Tampa, Florida for a physical examination, immunization, drug screening, or a follow-up appointment.

Protection of Human Participants

Study Approval

Approval for this study was obtained from the Institutional Review Board (IRB) of the University of South Florida (see Appendix A: Institutional Review Board Approvals) and written permission from Dr. Richard Johnson, MD, MPH, President and Medical Director of Lakeside Occupational Medical Centers, P.A. (see Appendix B: Research Site Consent).

Recruitment Process

A Lakeside Occupational Medical Centers (LOMC) staff member informed all employees presenting to the LOMC Downtown Clinic for a physical examination, immunization, drug screening, or follow-up appointment of the study. Participants who indicated an interest in knowing more about the study were then brought to a private room that had been set aside specifically for data collection by the principal investigator. The investigator then further described the study, ascertained whether the employee met the inclusion criteria, and obtained informed consent. To help encourage participation, participants had the opportunity to enter a raffle for one of three $100 Visa gift cards. The raffle occurred after all participants had been recruited and was kept completely separate from the research booklets (see Appendix H: Raffle Drawing Sheet).

Informed Consent Process

Written informed consent was obtained from each eligible participant prior to participation in the research study (see Appendix C: Informed Consent Form). Understanding was assured by asking if the participant had any questions and if he or she could verbalize accurately what he or she had agreed to do as a participant in the study. The informed consent process included a description of the benefits and risks of participation, of which no benefits or risks were foreseen.

Study Setting

The sample for this single administration, cross-sectional study was recruited from employees who presented to LOMC Medical Center, Downtown

Clinic, located in Hillsborough County, Florida. The participants were employees from companies who had contracted with LOMC for occupational safety and health services and who had come to the clinic for a physical examination, immunization, drug screening, or follow-up appointment. At the time of this study, LOMC had seven clinics in Hillsborough and Pinellas County and provided services to the employees of over 16,000 individuals and businesses. Occupational safety and health services that LOMC provides include drug screening services, training programs such as exposure risks, physical examinations, immunizations, radiological services, medical services such as medical surveillance, consultation, and exposure monitoring, screening, and testing. The Downtown Clinic was chosen because of its high volume of patients.

Sample

Selection of the target sample size was based on power calculations with the principal goal of being able to estimate a non-zero correlation for hypothesis #1 with good precision (i.e. relatively narrow 95% confidence intervals). For hypothesis #1, statistical methods include internal consistency reliability analyses, individual item analyses with total scores, and the relationship between literacy level and scores on the MSDS test. The primary parameter estimated for these analyses is the correlation coefficient.

For the Pearson correlation between health literacy level, as measured by the STOFHLA, and scores on the MSDS test, a value between 0.30 - 0.70 was anticipated. With a sample size of 200 subjects, the study was powered to

provide overall good precision, as indicated by the width of the confidence intervals listed below (see Table 1) assuming 2-sided type I error rate of 0.05.

Table 1

Power Analysis for Hypothesis 1

Sample size	Hypothesized R	95% Confidence Interval		
		Lower	Upper	Width
200	0.30	0.168	0.421	0.253
200	0.40	0.277	0.510	0.234
200	0.50	0.388	0.597	0.209
200	0.60	0.503	0.682	0.179
200	0.70	0.622	0.764	0.143

Note. R = Correlation coefficient

For internal consistency analyses, it was anticipated that the 36 STOFHLA items and total and subscales of the MSDS test would have coefficient alphas ranging between 0.50 and 0.95. Precision estimates for this analysis (assuming 2-sided type I error rate of 0.05) are listed below (see Table 2), again indicating good overall precision with the target sample size of 200 subjects.

Table 2

Power Analysis Related to Hypothesis 2

Sample size	Hypothesized R	95% Confidence Interval		
		Lower	Upper	Width
200	0.50	0.388	0.597	0.209
200	0.55	0.445	0.640	0.195
200	0.60	0.503	0.682	0.179
200	0.65	0.562	0.723	0.162
200	0.70	0.622	0.764	0.143
200	0.75	0.682	0.805	0.123
200	0.80	0.744	0.845	0.101
200	0.85	0.806	0.884	0.078
200	0.90	0.870	0.923	0.054
200	0.95	0.934	0.962	0.028

Note. R = Correlation coefficient

With a target sample size of 200 subjects and 2-sided type I error effort rate of 0.05, the sample provided 80% power to detect a small correlation coefficient of 0.197 or higher. Thus, the study in aggregate was sufficiently powered to evaluate the proposed research hypotheses.

Inclusion and Exclusion Criteria

Inclusion criteria were the following: the participants were required to be employees presenting to the LOMC Downtown Clinic for a physical examination, immunization, drug screening, or follow-up appointment. Participants must have been without visual impairments that would preclude the participant from reading the written material in English. They also must have been able to participate in the study voluntarily.

Exclusion criteria were the following: the participants could not be employees presenting to the LOMC Downtown Clinic for a new injury. In addition, employees who could not see well enough to read the written material and those employees who could not read English were excluded.

Instrumentation

Three instruments were utilized to collect data: the Short Test of Functional Health Literacy in Adults (STOFHLA) found in Appendix D, an MSDS test (see Appendix F), and a brief demographic sheet (see Appendix G). All three instruments were combined into one booklet. The instruments are listed below in order of their administration. In addition, the participants had the option of completing a Material Safety Data Sheet Reading Comprehension Questionnaire Drawing Information Sheet (see Appendix H) for the opportunity to enter a raffle

for one of three $100 Visa gift cards. The Drawing Information Sheet asked for the participant's name, address, city, state, zip code, phone number, and email address. The Drawing Information Sheet was stapled on top of the booklet. Completed Drawing Information Sheets were removed by the participants and submitted separately to maintain booklet anonymity.

The Short Test of Functional Health Literacy in Adults (STOFHLA)

The STOFHLA is a widely used, timed reading comprehension test that takes approximately seven minutes to complete. It has a correlation of .91 with the full TOFHLA indicating a good estimate of the participant's functional health literacy, or reading comprehension (Nurss, Parker, Williams, & Baker, 2001). It consists of 36 reading comprehension items in two passages with every fifth to seventh word omitted. The subject selects a word to fill in the blank from a list of four multiple-choice options for each blank. Each selection is scored a "1" for correct or a "0" for incorrect. Scores are added to create a total score from 0 to 36. Scores between 23 and 36 indicate adequate health literacy, between 17 and 22 indicate marginal health literacy, and between 0 and 16 indicate inadequate health literacy. (A copy of the STOFHLA is included in Appendix D; a letter of permission granting access to its use is included in Appendix E.)

The MSDS Test

The MSDS test was developed by the principal investigator after a face-to-face consultation with Dr. Paul Spector, Area Director of the Industrial/Organizational Psychology program at the University of South Florida. During this consultation, Material Safety Data Sheets were reviewed and it was

decided to select the Hazards Identification section verbatim from 7 MSDSs with different readability levels and to devise 5 questions for each section (personal communication, November 14, 2007). Thereafter, a search was conducted on the database Safety Information Resources on the Internet (SIRI) that houses 180,000 MSDSs (SIRI, n.d.) for “sodium hypochlorite.” A total of 82 MSDSs were retrieved. Of these, 32 were from different manufacturers. Material Safety Data Sheets were excluded if they listed ingredients other than sodium hypochlorite and/or water.

The readability levels of the passages were calculated utilizing both The Simplified Measure of Gobbledygook (SMOG) and the Flesch-Kincaid Grade Level (FKGL). The SMOG and the FKGL are readability formulas which estimate the years of education needed to understand a piece of writing. The SMOG was developed by G. Harry McLaughlin (1969). It has a .985 correlation with the grades of readers who had 100% comprehension of test materials. The standard error of the estimated grade level is 1.5159 grades, comparable to that of other readability formulas (McLaughlin, n.d.). For the purposes of this study, a free online software tool which is available through McLaughlin’s website (n.d.) and which calculates both the SMOG and the FKGL was utilized to measure the readability level of the written material in the study (Online-Utility.org, n.d.). Scores from the FKGL have been found to be highly correlated with scores from other readability formulas (Meade & Smith, 1991). There was a strong positive correlation of 0.90 between the readability levels obtained utilizing the SMOG and the FKGL.

It was decided to omit those MSDSs with fewer than 30 words since the SMOG requires a minimum of 30 words for its calculation. This brought the number of MSDSs down to 28. The passage on “Hazards Identification” from each of the 28 MSDSs was analyzed for readability utilizing both the SMOG and the FKGL. The SMOG for the 28 MSDSs ranged from 10.98 to 16.69 and the FKGL for the same 28 MSDSs ranged from 11.14 to 17.97. A subset of seven of the passages was selected, spanning the abovementioned readability ranges (as defined by Aldon Corporation, 1992; Carolina Biological Supply Co., 2000; Fisher Scientific, 2007; Henry Schein Inc., 1987; Hill Brothers Chemical Co., 1987; Sigma Chemical Company, 1997; and Sultan Chemists Inc., 1998). (See Table 3 for the MSDSs with the readability levels of the Hazards Identification sections that were selected for this study and Appendices I through O for the MSDSs in their entirety.) There was a strong positive correlation of 0.90 between the readability levels obtained utilizing the SMOG and the FKGL.

Table 3

MSDSs with the Readability Levels of the Hazards Identification Sections

Manufacturer	*Date of MSDS*	*SMOG*	*FKGL*
Aldon Corporation	11/02/1992	11.89	13.01
Carolina Biological Supply Co.	09/05/2000	11.46	13.86
Fisher Scientific	11/08/2007	11.74	11.50
Henry Schein Inc.	01/01/1987	15.25	16.05
Hill Brothers Chemical Co	06/17/1987	13.49	12.61
Sigma Chemical Company	01/01/1997	16.69	17.97
Sultan Chemists Inc.	05/01/1998	10.98	11.14

Note. MSDS = Material Safety Data Sheet SMOG = Simplified Measure of Gobbledygook FKGL = Flesch-Kincaid Grade Level

An investigator-made MSDS test was developed by selecting the seven verbatim passages from MSDSs for sodium hypochlorite listed above in Table 3.

Following each passage were five multiple-choice questions based on each passage. The test was scored as either correct or incorrect. In order to control for reliability, two parallel forms of the investigator-made test were distributed. The tests were identical except that the passages were in reverse order in the second form. (A copy of both versions of the MSDS test (Versions A and B) are included in Appendix F).

Demographic Sheet

The investigator developed the demographic data sheet. It contained questions related to age, highest completed grade level, native language, and job category. The job categories were taken verbatim from the Bureau of Labor Statistics, Standard Occupational Classification (SOC) major groups. Each occupation in the SOC is placed within one of 23 major groups (BLS, 2008). This investigator added a 24th group (*Other*) for those participants who felt that their job did not fall within any of the categories listed. (A copy of the demographic sheet is included in Appendix G.) Data collection tools were tested on four individuals prior to the start of data collection to confirm usability and clarity and to process the orientation of the forms. It took between 11 and 23 minutes for these individuals to complete the data collection booklet. No adjustments to the forms were made.

Procedure

Participants were recruited at the LOMC Downtown Clinic by staff. The potential participant, or employee, was screened for the presence of inclusion criteria. After it was determined that the potential participant met the inclusion

criteria, a copy of the informed consent was given to the employee to look at while the investigator read the the informed consent to the employee. Employees who agreed to participate were asked if they had any questions. After ascertaining that all questions were adequately answered, the employee was asked to verbalize in his or her own words what the study consisted of. After ascertaining that the employee understood what the study consisted of, the employee signed the informed consent.

Employees were then given a booklet containing the STOFHLA, the MSDS test, and the demographic sheet. Since the STOFHLA is a timed reading comprehension test, the employees were allowed 7 minutes to complete the STOFHLA. If, at the end of 7 minutes, the employee had not completed the STOFHLA, he or she was asked to stop and to go onto the next section (the MSDS test). The employee was then given as long as he or she needed to complete the remainder of the booklet (the MSDS test and the demographic sheet).

To help encourage participation, the participants had the option of completing a Material Safety Data Sheet Reading Comprehension Questionnaire Drawing Information Sheet (see Appendix H). By entering the drawing, participants had the opportunity to enter a raffle for one of three $100 Visa gift cards. The Drawing Information Sheet asked for the participant's name, address, city, state, zip code, phone number, and email address. The Drawing Information Sheet was stapled on top of the booklet. Completed Drawing Information Sheets were removed by the participants after they had completed the booklet and

submitted separately to maintain booklet anonymity. Three names were randomly drawn after data collection was completed from the pool of 200 participants. The $100.00 Visa gift card was mailed to the 3 winners along with a thank you letter. (See Table 4 for the variables and measurement plan and Table 5 for the data collection steps.)

Table 4

Variables and Measurement Plan

Variable	*Operational Definition*	*Data Source*	*Variable Type (Function)*	*Frequency*
Readability Assessment (Readability Level)	Reading level of the written materials	Simplified Measure of Gobbledygook (SMOG)	Continuous (Approximates grade level from 4 to Master's degree)	Prior to starting study
Readability Assessment (Readability Level)	Reading level of the written materials	Flesch-Kincaid Grade Level (FKGL)	Continuous (Rates text by U.S. school grade level)	Prior to starting study
Literacy Assessment (Health Literacy Level)	Degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions	Short Test of Functional Health Literacy in Adults (STOFHLA)	Categorical (Categories indicate level of functional health literacy) Adequate (23 – 36) Marginal (17 – 22) Inadequate (0 – 16)	First (Prior to the administration of the MSDS test)
MSDS Test Scores	Ability to apply the material read to a written test	MSDS Test	Continuous (Comprehension of Hazard Communications) Possible Score (0 to 35)	Second (immediately after administration of the STOFHLA)
Demographics	Age	Demographic Sheet	Continuous (Employee Characteristics)	Third (immediately after the MSDS Test)
Demographics	Highest completed grade level, native language, and job category	Demographic Sheet	Categorical (Employee Characteristics)	Third (immediately after the MSDS Test)

Table 5

Data Collection Steps

Step	*Description*
1. Screening of Participant	The potential participant was screened for the presence of inclusion criteria
2. Informed consent	The consent was read to the participant
3. Administration of the Study booklet	7 minutes were allowed for the administration
a. STOFHLA	15 minutes were allowed for the administration, longer if needed
b. MSDS test	5 minutes were allowed for the administration, longer if needed
c. Demographic sheet	The participant had the option to complete a short contact form for the raffle
4. Raffle drawing form	3 names were randomly drawn after data collection was completed from the pool of 200 participants. The gift card was mailed to the winners along with a thank you letter.
5. Raffle drawing	

Note. STOFHLA = Short Test of Functional Health Literacy in Adults; MSDS = Material Safety Data Sheet

Data Analysis Plan

Preliminary Analysis

The Statistical Package for the Social Sciences (SPSS) 11.0 for Windows and the Statistical Analysis System (SAS) 9.0 were used with password protection for data entry, management, and analysis. Demographic information are presented by use of descriptive statistics. All data were initially examined for missing values, outliers, and inconsistent data as recommended by Tabachnick and Fidell (2001, p. 98-99).

The readability levels of the written materials were calculated utilizing the SMOG and FKGL formulas. The Simple Measure of Gobbledygook (SMOG) is a readability formula that estimates the years of education needed to understand a

piece of writing. It is a mathematical equation derived by regression analysis developed by G. Harry McLaughlin (1969) and has a .985 correlation with the grades of readers who had 100% comprehension of test materials. The standard error of the estimated grade level is 1.5159 grades, comparable to that of other readability formulas (McLaughlin, n.d.). The SMOG is calculated by counting the words of three or more syllables in three 10-sentence samples, estimating the count's square root, and adding three. A conversion table is used to convert the word count to a grade level. There are two different conversion tables: one for materials less than 30 lines, and one for materials more than 30 lines (Ohio KePro, n.d.). The result is the reading level of the written materials. If a person reads at or above a grade level, he or she will understand 90-100% of the information. For the purposes of this study, the SMOG calculator available online through McLaughlin's website (n.d.) and which calculates both the SMOG and the FKGL was utilized to measure the readability level of the written material in the study.

In addition, the Flesch-Kincaid Grade Level (FKGL) was utilized. The FKGL rates texts on a U.S. school grade level. For example, a score of seven means that an average seventh grader can understand the text. The formula is (.39 X ASL) + (11.8 X ASW) – 15.59, where ASL is the average sentence length (the number of words divided by the number of sentences) and ASW is the average number of syllables per word (the number of syllables divided by the number of words). Scores from the Flesh-Kincaid have highly correlated with scores from other readability formulas (Meade & Smith, 1991). There was a

strong positive correlation of 0.90 between the readability levels obtained utilizing the SMOG and the FKGL.

Literacy levels of each participant as measured by the STOFHLA were scored as a “1” for correct or a “0” for incorrect. Scores were added to create a total score from 0 to 36. Scores between 23 and 36 indicate adequate health literacy, between 17 and 22 indicate marginal health literacy, and between 0 and 16 indicate inadequate health literacy. Participants’ understanding of the MSDS examples was measured by the MSDS test. Readability level of the MSDS verbatim examples was measured by the means of the SMOG and FKGL.

The final preliminary work involved calculation of a Pearson correlation coefficient between the scores on the STOFHLA and the scores on the MSDS test. An independent group t-test was then used to compare mean scores of those who took Version A versus those who took Version B in order to see if there were any appreciable differences between the two forms of the investigator-made test. The principal investigator performed all statistical analyses.

Hypothesis Testing

Hypothesis 1.

Hypothesis 1 predicted that the functional health literacy level of the participants, as measured by the STOFHLA, would be significantly related to the score on the MSDS test. This hypothesis was tested by use of a Pearson correlation coefficient from scores on the STOFHLA and the MSDS test.

Hypothesis 2.

Hypothesis 2 predicted that the scores of participants on the MSDS test would indicate a relationship with the readability level of the examples on the MSDS test. This hypothesis was addressed by calculating each participant's score for each of the seven examples on the MSDS test. The means of the participants' scores were then compared.

Data and Safety Monitoring

No personal identifying information was collected from the participants other than on the raffle drawing sheet, which was kept separate from the research booklets. (See Appendix H for the Material Safety Data Sheet Reading Comprehension Questionnaire Drawing Information Sheet.) Participant privacy was ensured during the one time that the participant met with the principal investigator (PI) in a private room with a door. Only the PI and the dissertation committee had access to the data.

Participants were free to end participation in the study at any time. Consent forms were kept separate from the research booklets and the raffle drawing sheets. Computer files were on the PI's personal laptop, which was password protected, and on a pen drive, dedicated to this research study only, and used only by the PI. Consent forms and data were then stored in a locked file cabinet that will be kept for 5 years in the investigator's office at home. Shredding of the paper files and the deletion of the data on the pen drive will occur at the end of five years.

Chapter Summary

This chapter provided an overview of the research plan and included the research design, protection of human participants, study setting, sample, inclusion criteria, instrumentation, procedure, data analysis plan, and data and safety monitoring.

The study utilized a single administration, cross-sectional design. A convenience sample was recruited from employees who presented themselves to the Lakeside Occupational Medical Centers, Downtown Clinic, Tampa, Florida for a physical examination, immunization, drug screening, or a follow-up appointment. Three instruments were utilized to collect data: the STOFHLA, an MSDS test, and a brief demographic sheet. All three instruments were combined into one booklet. In addition, the participants had the option of completing a separate Material Safety Data Sheet Reading Comprehension Questionnaire Drawing Information Sheet for the opportunity to enter a raffle for one of three $100 Visa gift cards. The Statistical Package for the Social Sciences (SPSS) 11.0 for Windows and the Statistical Analysis System (SAS) 9.0 were used with password protection for data entry, management, and analysis. Security of the data were ensured by password protection, restricting access to the data only to the PI and the dissertation committee, and locking hard copies of the test booklets and consent forms in a locked file cabinet in the investigator's home office.

Chapter Four: Overview of Findings

The overall objective of this study was to examine whether employees understand Material Safety Data Sheets (MSDSs) with the purpose being that of promoting worker safety as per the OSH Act of 1970 (OSHA, 1970). The OSH Act assures “safe and healthful working conditions for working men and women” (OSHA, 1970). Material Safety Data Sheets are printed materials concerning hazardous chemicals prepared by chemical manufacturers and made available to employees who work with those hazardous chemicals. This single administration, cross-sectional study tested two hypotheses addressing the literacy level of the participants, the readability of the MSDS examples quoted verbatim from actual MSDSs, and the participants’ comprehension of the hazard communications in those MSDS passages (henceforth called the MSDS test). The first hypothesis addressed a possible significant correlation between participants’ literacy level and their scores on the MSDS test. The second hypothesis examined differences in the mean MSDS test scores across the seven readability levels of the examples on the MSDS test. This chapter will summarize the demographic factors and will present the results obtained from testing the hypotheses.

The first part of this chapter describes the demographic characteristics of the study sample. The second part of this chapter presents the results of the analyses that tested the hypotheses. The demographic characteristics and the

results from testing the hypotheses are given in tabular as well as narrative format. Lastly, this chapter summarizes the results.

Demographic Characteristics of the Study Sample

Sample

The sample consisted of 200 participants. Ninety-nine (49.5%) participants completed Version A of the MSDS test, while 101 (50.5%) completed Version B. Versions A and B were identical tests except that the passages were in reverse order in the second form. Demographic characteristics included age, highest completed grade level in school, first language, and job category. The continuous and categorical level data are discussed sequentially starting with all 200 participants and then separately for participants who took Versions A and B of the MSDS test .

For all 200 participants, the age of the individuals who participated in this study ranged from 18 to 68 years old. The average age was 43.09 (SD = 12.48). In comparison, the average age of those who took Version A of the MSDS test was 42.42 (SD = 12.82) and for Version B of the MSDS test was 43.74 (SD = 12.17). The ages of those who took Version A of the MSDS test versus those who took Version B were not significantly different ($p = .413$). For all 200 participants, the highest completed grade level ranged from grade 4 through Masters' degrees, with a mode of grade 12 (completion of high school; n = 99, 49.75%). Additionally, 83 (41.71%) either started or completed a college degree. Thus the majority (91.46%) of the sample were well educated with completion of high school or some amount of college. In comparison, the highest completed

grade level for participants who took Version A of the MSDS test ranged from grade 4 through Master's degrees, with a mode of grade 12 (completion of high school; n = 49, 49.49%). Additionally, 38 (38.38%) either started or completed a college degree. For Version B of the MSDS test, the highest completed grade level for participants ranged from grade 9 through Master's degrees, with a mode of grade 12 (completion of high school; n = 50, 50.0%). Additionally, 45 (45.0%) either started or completed a college degree. Therefore, the modes of the two versions of the MSDS test were similar.

For all participants, English was the native language for the majority (n =166, 83.42%) followed by Spanish (n = 29, 14.57%). In comparison, for those who took Version A of the MSDS test, English was the native language for the majority (n = 83, 83.84%) followed by Spanish (n = 14, 14.14%). English was also the native language for the majority for those who took Version B of the MSDS test (n = 84, 83.17%) followed by Spanish (n = 15, 14.85%). Among those few who listed *Other* as their response, the native languages were French, Vietnamese, Hmong, and Serbo-Croatian. Table 6 displays summaries of highest level of education and native language for all 200 participants.

Table 6

Demographic Characteristics for Highest Grade Level and Native Language

Highest Grade Level Completed	*Frequency*	*Percent*
Grade 4	1	.50
Grade 6	1	.50
Grade 9	3	1.51
Grade 10	7	3.52
Grade 11	5	2.51
High School	99	49.75

Some College	17	8.54
Associate's Degree	34	17.09
Bachelor's Degree	25	12.56
Master's Degree	7	3.52
Total	199	100.00

First Language	*Frequency*	*Percent*
English	166	83.42
Spanish	29	14.57
Other	4	2.01
Total	199	100

Table 7 displays frequency and percent for the demographic characteristic job category for all 200 participants. For all participants, transportation was the job category with the greatest number of participants (n = 62, 31.16%) followed by healthcare support (n = 20, 10.05%), and healthcare practitioners and technical (n = 17, 8.54%). Four participants (2.01%) listed *Other* as their job category. Of these in the *Other* category, the jobs listed were printing, zoo animal care, pest control, and "this job". In comparison, for those who took Version A of the MSDS test, transportation was also the job category for the greatest number of participants (n = 34, 34.34%) followed by an equal number in healthcare support (n = 10, 10.1%), and healthcare practitioners and technical (n = 10, 10.1%). In comparison, for those who took Version B of the MSDS test, transportation was also the job category for the greatest number of participants (n = 29, 28.71%) followed by an equal number in healthcare support (n = 10, 9.9%) and installation, maintenance, and repair (n = 10, 9.9%).

Table 7

Demographics Characteristics by Job Category

Job Category	*Frequency*	*Percent*
Transportation and Material Moving	62	31.16
Healthcare Support	20	10.05
Healthcare Practitioners and Technical	17	8.54
Installation, Maintenance, and Repair	17	8.54
Education, Training, and Library	12	6.03
Business and Financial Operations	10	5.03
Management	10	5.03
Office and Administrative Support	10	5.03
Building and Grounds Cleaning And Maintenance	8	4.02
Construction and Extraction	6	3.02
Food Preparation and Serving Related	6	3.02
Sales and Related Occupations	5	2.51
Life, Physical, and Social Science	4	2.01
Production	4	2.01
Other (please specify)	4	2.01
Protective Service	2	1.01
Architecture and Engineering	1	0.50
Arts, Design, Entertainment, Sports, and Media	1	0.50
Total	199	100.00

Note. Six other categories from the Bureau of Labor Statistics Standard Occupational Classification each had a frequency of zero; these were Computer and Mathematical; Community and Social Services; Legal; Personal Care and Service; Farming, Fishing, and Forestry; and Military Specific.

Statistical Results

An MSDS test was constructed by the investigator by selecting seven verbatim passages from MSDSs for sodium hypochlorite listed above in Table 3. Following each passage were five multiple-choice questions based on each passage. The test was scored as a “1” for correct or a “0” for incorrect. In order to assess for internal consistency and reliability, item analysis was performed for each example and for each test question within that example. According to Linn and Gronlund (1995), once the test has been scored, the effectiveness of each item should be assessed by means of item analysis. One way of doing this is by

determining the index of item difficulty, which is the percentage of participants who scored correctly on the item (Linn and Gronlund, 1995). The Percent Correct on each question ranged from 52.0% for example #5, question #24 to 93.0% for example #4, question #20. Cronbach Coefficient Alpha for individual questions within an example ranged from 0.45 for example #3, question #12 to 0.69 for example #5, question #24 while Cronbach Coefficient Alpha for all questions within an example ranged from 0.55 for example #3 to 0.70 for example #7.

In addition, item analysis was also performed for the STOFHLA. The STOFHLA consists of 36 reading comprehension items in two passages with every fifth to seventh word omitted. The subject selects a word to fill in the blank from a list of four multiple-choice options for each blank. Each selection is scored a “1” for correct or a “0” for incorrect. Scores are added to create a total score from 0 to 36. Scores between 23 and 36 indicate adequate health literacy, between 17 and 22 indicate marginal health literacy, and between 0 and 16 indicate inadequate health literacy. The Percent Correct ranged from 46.0% to 98.0% with an Alpha for all 36 items of 0.94.

For both the MSDS test and the STOFHLA, there was no evidence of any poorly performing items. All instruments and scales demonstrated adequate internal consistency and reliability. See Tables 8-15 for item analysis of the STOFHLA and the MSDS Test examples 1-7.

Table 8

Item Analysis for STOFHLA Scores

STOFHLA Question	*Percent Correct*	*Correlation With Total**
1	94.00	0.33
2	96.00	0.38
3	84.00	0.32
4	95.00	0.33
5	97.00	0.48
6	95.00	0.34
7	95.00	0.58
8	97.00	0.40
9	93.00	0.60
10	97.00	0.50
11	94.00	0.71
12	98.00	0.61
13	96.00	0.47
14	95.00	0.54
15	97.00	0.48
16	98.00	0.58
17	97.00	0.52
18	97.00	0.73
19	80.00	0.20
20	95.00	0.50
21	92.00	0.59
22	93.00	0.59
23	96.00	0.56
24	84.00	0.48
25	91.00	0.67
26	87.00	0.53
27	92.00	0.69
28	94.00	0.71
29	87.00	0.60
30	88.00	0.71
31	89.00	0.55
32	90.00	0.54
33	92.00	0.71
34	46.00	0.27
35	93.00	0.68
36	91.00	0.71
Total Score	32.85	

Note. Alpha for all 36 items = 0.94.
STOFHLA = Short Test of Functional Health Literacy in Adults.
*Total score with item removed.

Table 9

Item Analysis for MSDS Test Example #1

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
1	74.00	0.55	0.51
2	85.00	0.33	0.62
3	78.00	0.36	0.61
4	60.00	0.31	0.63
5	81.00	0.44	0.57
All questions			0.64

Note. SD all questions = +/1.36.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 10

Item Analysis for MSDS Test Example #2

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
6	80.00	0.34	0.59
7	76.00	0.32	0.60
8	73.00	0.40	0.56
9	71.00	0.48	0.51
10	89.00	0.35	0.58
All questions			0.62

Note. SD all questions = +/-1.31.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 11

Item Analysis for MSDS Test Example #3

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
11	90.00	0.36	0.46
12	81.00	0.38	0.45
13	72.00	0.33	0.48
14	60.00	0.33	0.48
15	73.00	0.33	0.48
All questions			0.55

Note. SD all questions = +/-1.24.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 12

Item Analysis for MSDS Test Example #4

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
16	70.00	0.42	0.60
17	69.00	0.42	0.60
18	89.00	0.52	0.55
19	56.00	0.32	0.65
20	93.00	0.37	0.63
All questions			0.66

Note. SD all questions = +/- 1.31.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 13

Item Analysis for MSDS Test Example #5

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
21	84.00	0.57	0.51
22	76.00	0.50	0.54
23	67.00	0.35	0.61
24	52.00	0.19	0.69
25	77.00	0.41	0.59
All questions			0.65

Note. SD all questions = +/- 1.40.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 14

Item Analysis for MSDS Test Example #6

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
26	81.00	0.49	0.61
27	71.00	0.37	0.66
28	71.00	0.40	0.65
29	76.00	0.46	0.62
30	90.00	0.46	0.62
All questions			0.68

Note. SD all questions = +/- 1.35.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

Table 15

Item Analysis for MSDS Test Example #7

MSDS Question	*Percent*	*Correlation With Total**	*Alpha**
31	82.00	0.53	0.61
32	80.00	0.45	0.65
33	78.00	0.41	0.66
34	67.00	0.37	0.68
35	78.00	0.50	0.63
All questions			0.70

Note. SD all questions = +/- 1.41.
MSDS = Material Safety Data Sheet.
*Parameter estimate with item removed.

In order to verify reliability, two parallel forms of the investigator-made test were distributed (Version A and Version B) and compared. The two versions were identical except that the arrangement of the MSDS passages was in reverse order in the second version. The STOFHLA scores of the participants who completed Version A of the MSDS test were compared to those who completed Version B to determine if there were any significant differences between them (see table 16). The mean for Version A was 33.13 *(SD* = 4.43) and for Version B was 32.57 *(SD* = 5.91). The difference in means between the two versions was only 0.56. A score falling between 23 and 36 on the STOFHLA indicates adequate functional health literacy. Therefore, the mean scores for both versions fell within the category of adequate.

Table 16

Descriptive Statistics for STOFHLA Scores by Version A and B of the MSDS Test

STOFHLA Scores	*MSDS Test Version*	*N*	*Mean*	*Standard Deviation*	*Standard Error Mean*
	A	99	33.13	4.43	0.44
	B	101	32.57	5.91	0.59
Total STOFHLA Scores		200	32.85	5.22	

Note. STOFHLA = Short Test of Functional Health Literacy in Adults, MSDS = Material Safety Data Sheet.

Next, an independent-samples t-test on the two versions of STOFHLA scores evaluated whether their mean scores were significantly different. No significant difference was found ($t_{(185.29)} = 0.76$, $p = 0.45$). Therefore, the STOFHLA scores from the two versions were aggregated for all subsequent analysis. After aggregating both versions of the MSDS test, the minimum score on the STOFHLA was 7.00 with a maximum of 36.00. The mean was 32.85 (*SD* = 5.22).

The majority of the STOFHLA scores (95.5%) fell within the adequate functional health literacy level (scored between 23-36). People who have adequate functional health literacy levels “should be able to read, understand and interpret most health texts” (Nurss, Parker, Williams and Baker, 2001). Eight of the scores (4.0%) fell within the inadequate functional health literacy level (scored between 0-16), while one of the scores (0.5%) fell within the marginal functional health literacy level (scored between 17-22). People who have inadequate or marginal functional health literacy levels “will have difficulty reading, understanding, and interpreting most health materials” (Nurss et al., 2001). Table 17 displays the descriptive statistics for the literacy level of the

participants. STOFHLA scores are categorized as adequate, marginal, or inadequate (Nurss et al., 2001). Operational definitions for each category are provided in Chapter 1.

Table 17

Literacy Level of Participants

STOFHLA Functional Health Literacy Level	*Frequency*	*Percent*
Inadequate (0-16)	8	4.0
Marginal (17-22)	1	0.5
Adequate (23-36)	191	95.5
Total	200	100.0

Note. STOFHLA = Short Test of Functional Health Literacy in Adults.

The scores on the MSDS test overall ranged from 4.0 to 35.0 with a mean of 26.4 (SD = 7.49). Each MSDS test example had a minimum score of 0.0 and a maximum score of 5.0. The passage with the lowest mean score of 3.54 *(SD* = 1.40) was #5 (SMOG 13.49; FKGL 12.61), while the passage with the highest mean score of 3.89 *(SD* = 1.35) was passage #6 (SMOG 16.69; FKGL 17.97). Therefore, there was not an exceptionally large variation in scores across the 7 passages. Table 18 displays the descriptive statistics for each MSDS test passage.

Table 18

Descriptive Statistics for the MSDS Test Passages

MSDS Test Example	*N*	*Minimum*	*Maximum*	*Mean*	*Standard Deviation*
#1	200	.00	5.00	3.77	1.36
#2	200	.00	5.00	3.88	1.31
#3	200	.00	5.00	3.75	1.24
#4	200	.00	5.00	3.76	1.31
#5	200	.00	5.00	3.54	1.40
#6	200	.00	5.00	3.89	1.35
#7	200	.00	5.00	3.84	1.41

Note. MSDS = Material Safety Data Sheet.

Research Hypothesis Number 1

To test the first hypothesis, “Literacy levels of participants will be significantly related to the score on the MSDS test,” a Pearson correlation coefficient from scores on the STOFHLA and MSDS test was used. A positive correlation of .571, which was significant at the 0.01 level (2-tailed) was obtained. This indicates that as the total STOFHLA scores increased, so did the scores on the MSDS test. In other words, as a higher STOFHLA score indicates a higher functional health literacy level, those who scored higher on the STOFHLA, did better on the MSDS test. This demonstrated support of the first hypothesis.

Research Hypothesis Number 2

The second hypothesis, “Scores of participants on the MSDS test will indicate a relationship with the readability level of the examples on the MSDS test,” was addressed by calculating each participant’s score for each of the seven examples on the MSDS test. The means of the participants’ scores were then compared to readability level by examining ranks of both measures. The results revealed there was no consistent relationship between the readability level of

each example with either measure (the SMOG and the FKGL) and the participant's overall performance on the MSDS test. A Pearson correlation coefficient from ranked readability levels and MSDS test example scores was used. A positive correlation of .179, which was not significant at the 0.05 level (2-tailed was obtained). Therefore, alternate explanations were sought. This was because of many items being correctly answered by the overwhelming majority of participants well beyond that expected by chance. Table 19 displays the MSDS Test Examples with their readability levels while Table 20 displays the descriptive statistics for the rankings of the MSDS Test Examples.

Table 19

MSDS Test Examples with their Readability Levels

MSDS Test Example	*SMOG*	*FKGL*	*Mean Readability Level*
1	11.89	13.01	12.45
2	11.46	13.86	12.66
3	11.74	11.50	11.62
4	15.25	16.05	15.65
5	13.49	12.61	13.05
6	16.69	17.97	17.33
7	10.98	11.14	11.06

Note. MSDS = Material Safety Data Sheet
SMOG = Simplified Measure of Gobbledygook
FKGL = Flesch-Kincaid Grade Level
Readability Level is based on the entire MSDS example.

Table 20

Descriptive Statistics for the Rankings of MSDS Test Examples

MSDS Test Example	*RL Rank*	*Mean Score*
7	1	3.84
3	2	3.75
1	3	3.77
2	4	3.88
5	5	3.54
4	6	3.76
6	7	3.89

Note. MSDS = Material Safety Data Sheet
SMOG = Simplified Measure of Gobbledygook
FKGL = Flesch-Kincaid Grade Level
RL = Readability Level
Rank 1 represents the lowest readability level (i.e., easiest to read) and Rank 7 represents the highest readability level (i.e., hardest to read). Readability Level is based on the entire MSDS example.

Specifically, the percentage of participants who scored correctly on each question was examined. From this, it appears that some of the questions were too easy because of the high percentage of participants who scored correctly. Therefore, a supplementary data collection method was utilized whereby an additional 12 people took the MSDS test (version A) without the examples being provided. In other words, these 12 people were given the MSDS test with only the test questions provided and had to guess at the correct answer. The results are presented in Table 21.

Table 21

Demographic Characteristics for Twelve Additional MSDS Tests

MSDS Test Question	Frequency Correct	Percent Correct
1	2	16.67
2	12	100.00
3	4	33.33

MSDS Test Question	Frequency Correct	Percent Correct
4	2	16.67
5	8	66.67
6	1	8.33
7	5	41.67
8	9	75.00
9	7	58.33
10	10	83.33
11	12	100.00
12	6	50.00
13	10	83.33
14	0	0.00
15	11	91.67
16	3	25.00
17	2	16.67
18	11	91.67
19	2	16.67
20	11	91.67
21	8	66.67
22	9	75.00
23	1	8.33
24	9	75.00
25	3	25.00
26	10	83.33
27	2	16.67
28	8	66.67
29	4	33.33
30	11	91.67
31	7	58.33
32	5	41.67
33	10	83.33
34	6	50.00
35	10	83.33

Note. MSDS = Material Safety Data Sheet

On the basis of this supplementary data collection, one question was selected from each MSDS Test example where these participants had difficulty

guessing. For the purpose of this study, it was assumed that if at least 6 participants, or 50%, chose the incorrect answer that it was a difficult question. See Table 22 for the question, or item, chosen from each MSDS example.

Table 22

Item Chosen From Each MSDS Test Example

MSDS Test Example	MSDS Test Question
1	1
2	6
3	12
4	17
5	23
6	27
7	32

Note. MSDS = Material Safety Data Sheet

These questions, or items, were then examined in terms of readability level. Again, there was no consistent relationship with readability level utilizing both the SMOG and the FKGL. The results are presented in Table 23 for the SMOG and in Table 24 for the FKGL. The relationship between test scores and readability of the examples is also illustrated in Figures 1 for the SMOG and 2 for the FKGL.

Table 23

Comparisons of Item Test Score with Readability Level of Examples (SMOG)

Readability Index	MSDS Test Question	SMOG	% Correct
1	*32*	10.98	41.67
2	*6*	11.46	8.33
3	*12*	11.74	50.00
4	*1*	11.89	16.67
5	*23*	13.49	8.33
6	*17*	15.25	16.67
7	*27*	16.69	16.67

Note. MSDS = Material Safety Data Sheet. SMOG = Simplified Measure of Gobbledygook. Level 1 represents the lowest readability index (i.e., easiest to read) and Level 7 represents the highest readability index (i.e., hardest to read). Readability Index is based on the entire MSDS example.

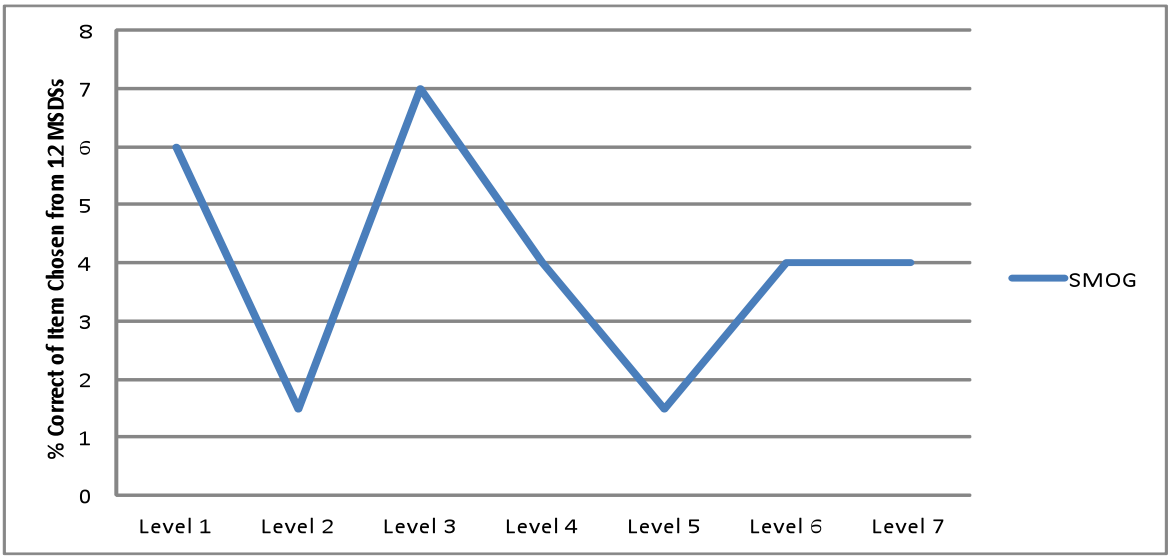

Figure 1. % Correct of the individual item chosen from the 12 MSDSs by readability level utilizing the SMOG. MSDS = Material Safety Data Sheet. SMOG = Simplified Measure of Gobbledygook. Level 1 represents the lowest readability index (i.e., easiest to read) and Level 7 represents the highest readability index (i.e., hardest to read). Negative correlation of 0.24, not significant at the 0.05 level (2-tailed).

Table 24

Comparisons of Item Test Score with Readability Level of Examples (FKGL)

Readability Index	MSDS Test Question	FKGL	% Correct
1	32	11.14	41.67
2	12	11.50	50.00
3	23	12.61	8.33
4	1	13.01	16.67
5	6	13.86	8.33
6	17	16.05	16.67
7	27	17.97	16.67

Note. MSDS = Material Safety Data Sheet. FKGL = Flesch-Kincaid Grade Level. Level 1 represents the lowest readability index (i.e., easiest to read) and Level 7 represents the highest readability index (i.e., hardest to read). Readability Index is based on the entire MSDS example.

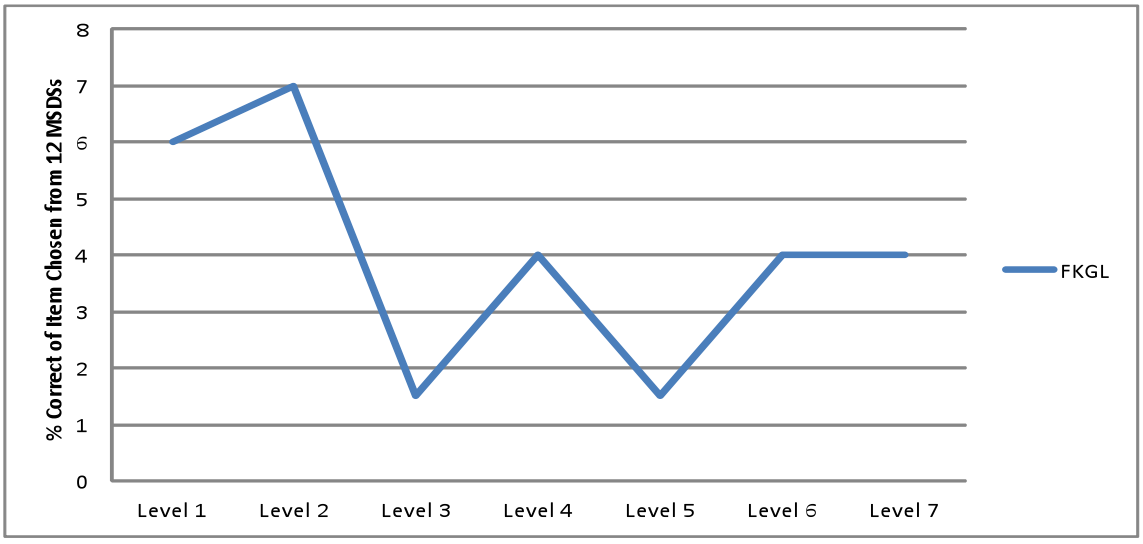

Figure 2. % Correct of the individual item chosen from the 12 MSDSs by readability level utilizing the FKGL. MSDS = Material Safety Data Sheet. FKGL = Flesch-Kincaid Grade Level. Level 1 represents the lowest readability index (i.e., easiest to read) and Level 7 represents the highest readability index (i.e., hardest to read). Negative correlation of 0.45, not significant at the 0.05 level (2-tailed).

On the basis of these results, another measure of complexity and comprehension of the material was examined by considering the number of lines in a sentence. From the length of each sentence, it appears that there is, at least, some evidence of better performance when the information is presented in shorter sentences. The results are presented in Table 25. The relationship between test scores and number of lines/sentence of the examples is also illustrated in Figure 3.

Table 25

Comparisons of MSDS Test Examples by Length of Longest Line

Level	MSDS Test Example	Length of Longest Line	% Correct
1	4	2	16.67
2	3	3	50.00
3	1	4	16.67
4	7	4	41.67
5	2	5	8.33
6	6	6	16.67
7	5	9	8.33

Note. MSDS = Material Safety Data Sheet.
Both MSDS Test Examples 1 and 7 had 4 lines as their longest line (number of lines/sentence).
Level 1 represents the MSDS example with the shortest number of lines and Level 7 represents the MSDS example with the greatest number of lines.

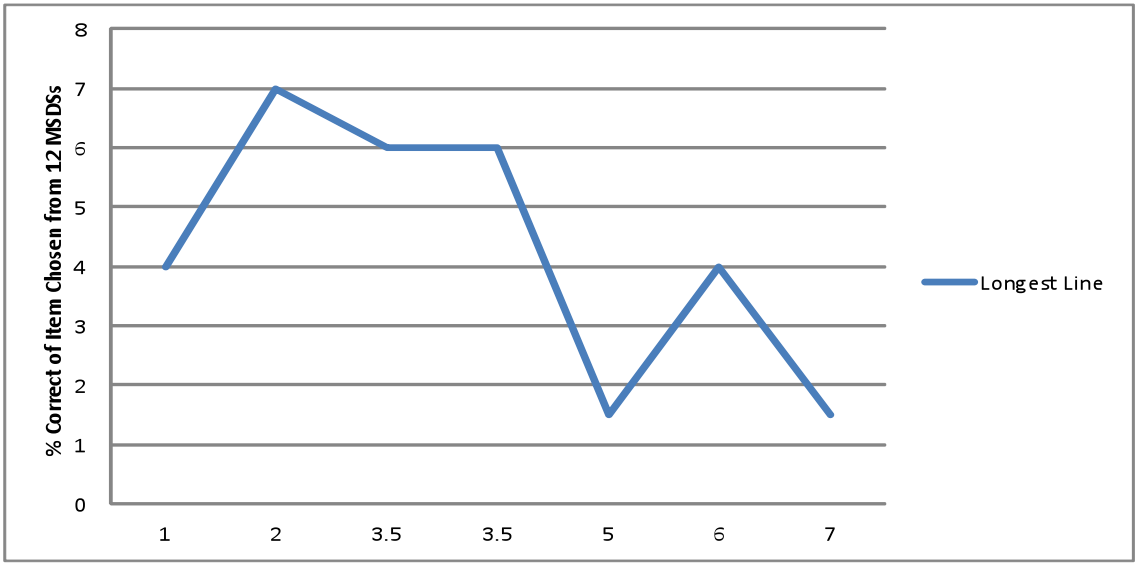

Figure 3. % Correct of the individual item chosen from the 12 MSDSs by longest line (number of lines/sentence). MSDS = Material Safety Data Sheet. Both MSDS Test Examples 1 and 7 had 4 lines as their greatest number of lines. Level 1 represents the MSDS example with the shortest number of lines and Level 7 represents the MSDS example with the greatest number of lines. Negative correlation of 0.64, not significant at the 0.05 level (2-tailed).

Since the SMOG takes into account the number of words that are 3 syllables or more and the FKGL the number of words overall, it was decided to consider the number of average words in a sentence as well as the number of average words of 3 syllables or more in a sentence. From the number of average words of 3 syllables or more in each sentence, it appears that there is some evidence of better performance when the information is presented in fewer words containing 3 or more syllables.The results are presented in Tables 26 and 27. The relationship between test scores and number of average words in a sentence in the examples is also illustrated in Figure 4.

Table 26

Comparisons of MSDS Test Examples by Average Words/Sentence

Level	MSDS Test Example	Average words/sentence	% Correct
1	2	5.6	8.33
2	3	6.0	50.00
3	1	7.9	16.67
4	7	7.9	41.67
5	4	8.8	16.67
6	6	11.1	16.67
7	5	12.6	8.33

Note. MSDS = Material Safety Data Sheet.
Both MSDS Test Examples 1 and 7 had 7.9 average words/sentence.
Level 1 represents the MSDS example with the smallest number of average words/sentence and Level 7 represents the MSDS example with the greatest number of average words/sentence.

Table 27

Comparisons of MSDS Test Examples by Average Words of 3 Syllables or More/Sentence

Level	MSDS Test Example	Average words of 3 syllables or more/sentence	% Correct
1	3	1.5	50.00
2	7	1.7	41.67
3	2	2.0	8.33
4	4	2.0	16.67
5	1	2.3	16.67
6	5	3.0	8.33
7	6	3.4	16.67

Note. MSDS = Material Safety Data Sheet.
Both MSDS Test Examples 2 and 4 had 2.0 average words of 3 syllables or more/sentence.
Level 1 represents the MSDS example with the smallest number of average words of 3 syllables or more/sentence and Level 7 represents the MSDS example with the greatest number of average words of 3 syllables or more/sentence.

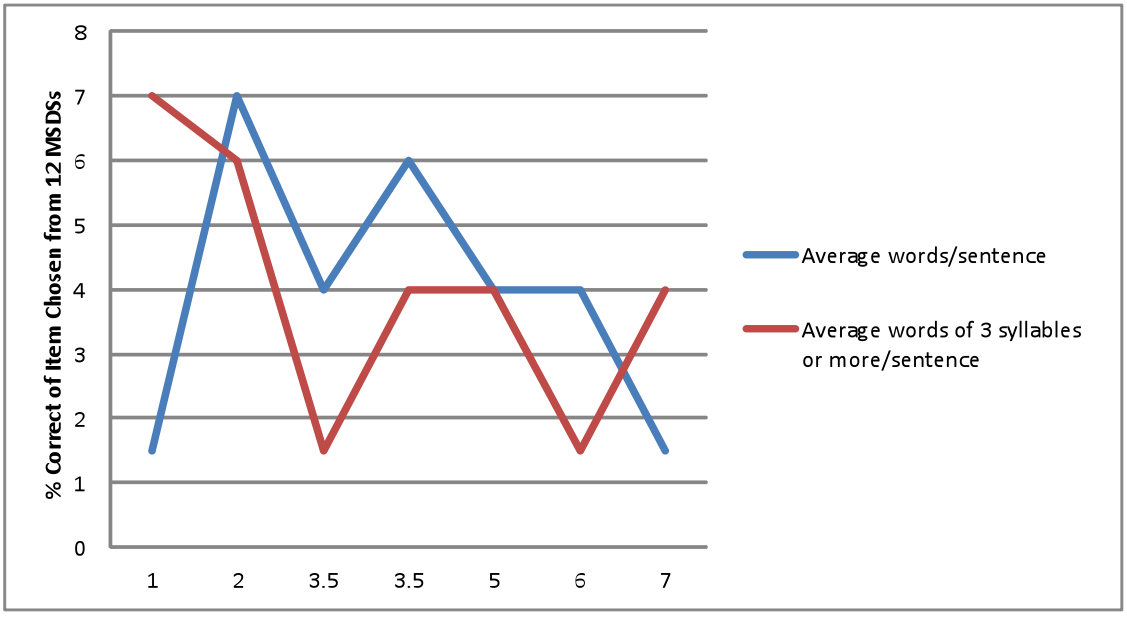

Figure 4. % Correct of the individual item chosen from the 12 MSDSs by words/sentence. MSDS = Material Safety Data Sheet. Both MSDS Test Examples 1 and 7 had 7.9 average words/sentence. Level 1 represents the smallest number of average words/sentence and Level 7 represents the MSDS example with the greatest number of average words/sentence. Average words/sentence negative correlation of .26, not significant at the 0.05 level (2-tailed). Average words of 3 syllables of more/sentence negative correlation of .63, not siginificant at the 0.05 level (2-tailed).

Chapter Summary

The demographic characteristics of the study sample and analytical results of this correlational cross-sectional study were presented. There was a significant positive correlation between the total STOFHLA scores and the readability of MSDS hazards identification passages. Therefore, hypothesis number 1 was supported. Findings on the readability level of the examples of the MSDSs to the participant's overall MSDS score were inconclusive. However, the format of the MSDS, specifically the number of lines/sentence and number of words of 3 syllables or more/sentence, may influence comprehension. The next and final chapter provides the discussion of findings.

Chapter Five: Discussion

This final chapter presents a synthesis of the research results, with a discussion of the findings, study limitations, implications for practice, and future research recommendations. This study aimed to demonstrate that as functional health literacy scores increase, so does the readability level of the passages on the *MSDS test*. This study also sought to demonstrate that the total scores on the *MSDS test* were related to the pre-determined readability level of each example. A summary of all research findings and interpretations will conclude the chapter.

Summary of the Study and Findings

This study used a single administration, cross-sectional design to examine functional health literacy level as a hypothesized moderator of MSDS test scores of employees presenting to one occupational health clinic. The sample consisted of 200 employees who completed a booklet consisting of the STOFHLA, the MSDS test, and a brief demographic questionnaire. Only one booklet was missing age and grade level (the same participant). Ninety-nine participants completed Version A of the MSDS test, while 101 completed Version B. The two versions were identical except that the passages were in reverse order from each other.

Descriptive data were obtained for the demographic data reflecting means, percentages, ranges, frequencies, and standard deviations. Ages of the sample of participants who completed the study ranged from 18 to 68 with a

mean age of 43.07 (*SD* = 12.452) years. Highest grade level completed was a master's degree (n = 7, 3.52%) with the lowest grade level completed being grade 4 (1 participant or 0.50%). Ninety-nine (49.75%) of participants had completed high school (grade 12). English was the native language for 166 participants, or 83.42% of the sample.

To determine whether the functional health literacy level of participants was related to the readability of passages on the MSDS test, two hypotheses were proposed.

Hypothesis 1. Hypothesis 1 predicted that the functional health literacy level of the participants, as measured by the STOFHLA, would be significantly related to the score on the MSDS test.

Hypothesis 2. Hypothesis 2 predicted that the scores of participants on the MSDS test would indicate a relationship with the readability level of the examples on the MSDS test.

The first hypothesis was tested using correlation analysis. Pearson *r* coefficient was calculated and it showed that there was a positive correlation (*r* = .571), significant at the 0.01 level (2-tailed). This finding indicates that as the total STOFHLA scores increases, so did the scores on the MSDS test. In other words, a high STOFHLA score also had a high score on the MSDS test.

The second hypothesis was examined by calculating each participant's score for each of the seven examples on the MSDS test. The means of the participants' scores were then compared. The results of this examination showed that there was no consistent relationship between the readability level of each

example with either measure (the SMOG and the FKGL) and the participant's overall performance on the MSDS test. Therefore, alternate explanations were sought.

First, the percentage of participants who scored correctly on each question was examined. From this, it appeared that some of the questions were too easy because of the high percentage of participants who scored correctly. Therefore, a supplementary data collection method was utilized whereby an additional 12 people took the MSDS test (version A) without the examples being provided. In other words, these 12 people were given the MSDS test with only the test questions provided and had to guess at the correct answer.

Second, on the basis of this supplementary data collection, a single question was selected from each example where these participants had difficulty guessing. For the purpose of this study, it was assumed that if at least 6 participants, or 50%, chose the incorrect answer it was a difficult question. These questions, or items, were examined only in terms of readability level. Again, there was no consistent relationship with readability level utilizing both the SMOG and the FKGL.

Then a third measure of complexity and comprehension of the material was examined by considering the number of lines in a sentence. On the basis of the length of the sentence, it appears that there is, at least, some evidence of better performance when the information is presented in shorter sentences.

Lastly, since the SMOG takes into account the number of words that are 3 syllables or more and the FKGL the number of words overall, it was decided to

consider the number of average words in a sentence as well as the number of average words of 3 syllables or more in a sentence. From the number of average words of 3 syllables or more in each sentence, it appears that there is some evidence of better performance when the information is presented in fewer words containing 3 or more syllables.

Conclusions

Low literacy levels can pose a serious problem in any setting. When dealing with the occupational setting and potentially hazardous chemicals, a low literacy level can be life threatening. According to OSHA, “employees must be made aware of the hazards to which they are exposed, know how to obtain and use information on labels and MSDSs, and know and follow appropriate work practices” (1998). OSHA’s Hazard Communication Standard requires MSDSs to be “readily accessible to employees.” This is defined by OSHA as meaning “immediate access to MSDSs. The employer has flexibility to determine how this will be accomplished and may provide the data sheets via paper copies, computer terminal access, or some other means of providing readable copy on-site” (OSHA, 2007). In order for the employee to have immediate access to the MSDSs, the employee has to know where the MSDSs are located and also how to retrieve them in a timely manner, especially if an exposure has already occurred and the employee is attempting to minimize the extent of this exposure. For example, if sodium hypochlorite splashed into the employee’s eyes, the employee would need to know that the eyes need to be flushed with water for 15 minutes with eyelids lifted and to obtain immediate medical attention.

According to the Hazard Communication Standard, MSDSs shall be in English, although employers may keep MSDSs in languages other than English (OSHA, 1994). In addition, OSHA states that it "is not sufficient to either just read material to the workers, or simply hand them material to read. You want to create a climate where workers feel free to ask questions. This will help you to ensure that the information is understood" (OSHA, 1994). Although asking questions will ensure that the employee understands more of the information on the MSDS, there is no guarantee that the employee will understand all of the information on the MSDS. Some of the information that the employee may not understand could be information that the employee would need to know in an instant such as after an exposure occurs. In addition, what of those employees who do not feel comfortable asking questions for fear of appearing ignorant? Those could be the employees that would need the most help. It has been found that there is a significant relationship between the employee's literacy level and his or her understanding of written hazard communication material, for which readability level is known. Since it is unlikely that the literacy level of the employees will be known, the readability level of written material should be considered in all occupational settings which involve hazardous chemicals. Especially since there is a positive relationship between an employee's literacy level and his or her understanding of written hazard communication materials. In other words, as the value of one variable increases so does the second variable.

Similarly, in conjunction with the literature review, in order to meet the needs of workers with low literacy levels, it is imperative that occupational safety

and health professionals, including nurses and nurse practitioners, provide workers with hazard communication materials that they are able to understand. In addition, it is imperative that assessment of understandability occur, so that additional training can take place, if needed. The results of the study confirmed this contention and indicate that as the examples or communication examples are made easier to read the more the people who will read them would be able to understand what they mean.

In addition, it appears that line length and number of words of 3 syllables or more have an effect on how well one does in relation to MSDS examples. Therefore, written hazard communication material should be written in short sentences with words that are less than 3 syllables. This way the likelihood of the material being understood by the worker will be increased.

Study Limitations

An important limitation of this study was that the MSDS Test examples had a somewhat restrictive range in terms of readability levels and test performance. This may have attenuated estimates of the association between reading grade level and comprehension of data safety sheets (i.e. hypothesis number 2). Further studies might choose MSDS Test examples with a broader range of readability levels.

A second limitation of this study is that it was a convenience sample of employees presenting to a single occupational health clinic. A random sampling at multiple clinics might have produced a better representation of the population, and might have decreased any selection bias that existed. In addition, although

the Demographic Questionnaire asked about first language, it did not take into consideration ethnicity. Healthy People 2020 (2010b) reports that “the workforce, like the U.S. population at large, is becoming increasingly diverse. These demographic changes result in new safety and health issues.”

Obtaining a better representation of the population would have allowed for greater generalizability of the findings. Another option might be to actually go out to different work sites and obtaining a random sampling of the employees who worked there.

Measurement bias was less of a concern of this study, since the principal investigator was the only person collecting the data. Although at times this, in and of itself, was problematic when multiple employees showed up agreeing to participate in the study. Having multiple participants at different points of the study made it difficult to accurately time the seven minutes that were allowed for the administration of the STOFHLA. A potential solution would have been to have a trained assistant to assist with the data collection or to have multiple stop watches to time the seven minutes.

While prospective participants were told ahead of time how long it could take them to complete the study, a few participants mentioned afterwards that they did not spend any time reading the questions and that they just circled any answers. Their reason for doing so was that they wanted to be entered into the drawing for the $100.00 gift cards. The net consequence of this is bias towards no association for hypothesis number 2. A way of preventing this in future would be to stress to the prospective participant the importance of obtaining a response

which reflects their true capacity by taking the time to read each example fully prior to answering the questions that followed. Another way of preventing this would have been to ascertain ahead of time that each participant was willing to spend the time needed to read each MSDS example. A simple way of doing this would be to actually ask the prospective participant if he or she was willing to do so and then excluding those who were not willing to do so.

While participation was voluntary, a limitation of the study may be that those employees with lower reading skills may have self-selected themselves out of the study due to the stigma associated with low literacy levels. Future studies might stress to all prospective participants the importance of obtaining results from employees from a wide range of literacy levels, that all booklets would be filled out in a private room with a closeable door, and that all data collected would not be able to be traced back to the individual participant.

Similarly, employees who were familiar with MSDSs and other forms of chemical safety information sheets may have agreed to participate in the study. Since prospective participants were recruited by the clinic staff, a way of combating this would have been to inform potential participants that experience working with MSDSs was not mandatory for participation in the study.

In addition, the participants in this study may not be representative of employees who would actually work with sodium hypochlorite. Although since sodium hypochlorite is a common household cleaner and disinfectant, the likelihood of the participants never having come into contact with it would be unlikely. This can be seen by the following, whereby the 2006 Annual Report of

the American Association of Poison Control Centers' National Poison Data System related that household cleaning substances were the third leading substances most frequently involved in human exposures. Of these exposures, 35,199 were due to bleach, or hypochlorite (Bronstein et al., 2007).

Implications for Practice

In this study, there was a positive (direct) correlation between health literacy, as measured by the STOFHLA scores, and the participant's overall score on the MSDS test. Those who had higher health literacy scores scored better overall on the MSDS test. Implications for practice include adjusting the readability of the hazard communications for the anticipated literacy of the learners. The field of health literacy focuses not so much on a grade level approach, but more on a "universal precautions" approach. Since it is unlikely that a healthcare professional will know an employee's literacy level, in order to reach as many employees as possible, it is recommended that all employees be approached as if they will have difficulty understanding hazard communication materials, such as MSDSs (U.S. DHHS, 2010). That being said, it is recommended that these materials be written in plain language. Plain language (U.S. DHHS, 2011) encompasses utilizing:

- common, everyday words, except for necessary technical terms
- use of personal pronouns and the active voice
- logical organization
- easy-to-read and understand design features, such as bullets and tables

There was also an indication that line length and number of syllables per sentence affected the participant's comprehension of MSDS examples. Specifically, longer line length and words of 3 or more syllables appear to be associated with poorer comprehension of hazardous material warnings. Therefore, a recommendation is that MSDSs and other hazard communication materials be written in shorter sentences and in words of less than 3 syllables.

Although the majority of the participants in this study fell within the adequate functional health literacy range, research has shown that even literate workers understand only about 60% of the health and safety information on the MSDSs associated with the hazardous chemical (Sattler, Lippy, & Jordan, 1997).

People with adequate functional health literacy should be able to read, understand, and interpret most health texts while those who have marginal or inadequate functional health literacy will have difficulty reading, understanding, and interpreting most health materials (Nurss, Parker, Williams, & Baker, 2001). For those who have lower levels of health literacy, modifications could be made in the occupational health setting in order to accommodate these workers. Recommendations include the following: a) rewriting MSDSs into plain language, b) incorporating the use of pictures, graphic directions, or symbols whenever possible, c) rewriting MSDSs and other hazard communication materials in shorter sentences and in words with fewer than 3 syllables, and d) providing hazard communication training in person and, when unable to do so, providing important information on CD or DVD format.

Future Research Recommendations

Additional research is required to determine whether the results reported as significant in this study can be generalized to other clinics and to the work-site. It would also be of interest to have a more diverse population and to repeat the study with non-native English speakers. An example would be to repeat the study with all materials written in Spanish.

Future studies could also include randomly assigning participants to groups with each group having an MSDS test based on different passages in the MSDS and not merely the Hazards Identification passage. In addition, future studies could include a much wider range of readability level of MSDSs and a much wider range of question difficulty. These features would help to derive precise estimates of the relationship between reading grade level and comprehension of MSDS information.

Since OSHA has proposed aligning its Hazard Communication Standard (HCS) with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), future research could include comparing the GHS safety data sheets with the MSDSs. In addition, studies could include comparing one manner of delivery (signs, for example) versus written safety data sheets.

Although the data collection tools were tested on four individuals prior to the start of data collection to confirm usability and clarity, it would be beneficial in the future to pilot test the MSDS test questions for item difficulty in addition to usability and clarity. This way, the test questions could be revised as needed prior to its administration to the participants.

Chapter Summary

Low literacy levels can pose a serious problem in any setting. When dealing with the occupational setting and potentially hazardous chemicals, a low literacy level can be life threatening. This study did indicate that there was a significant relationship between literacy levels of participants and the overall score on the MSDS test. It also suggested that as line length and number of words of 3 syllables or more increased, the participants' comprehension decreased. Therefore, written hazard communication material should be written in short sentences using words that are less than 3 syllables. This way the likelihood of the material being understood by the worker will be increased. Further research aimed at understanding exactly how reading grade level and sentence structure impacts comprehension of hazardous materials information is needed.

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Appendices

Appendix A: Institutional Review Board Approvals

USF
UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

September 2, 2008

Christine Bouchard, PhD
Nursing
[redacted]

RE: **Expedited Approval** for Initial Review
IRB#: 107198 G
Title: *Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic*
Study Approval Period: 08/29/2008 to 08/28/2009

Dear Dr. Bouchard:

On August 29, 2008, Institutional Review Board (IRB) reviewed and **APPROVED** the above protocol **for the period indicated above.** It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number seven (7).

Also approved were the informed consent forms.

Please note, if applicable, the **enclosed informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form.** Valid consent must be documented on a copy of the most recently IRB-approved consent form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Integrity and Compliance. In addition, we have enclosed an Institutional Review Board (IRB) Quick Reference Guide providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human participant research. Please read this guide carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-9343.

Sincerely,

[redacted]

Paul G. Stiles, J.D., Ph.D., Chairperson
USF Institutional Review Board

Enclosures: (If applicable) IRB-Approved, Stamped Informed Consent/Assent Documents(s)
IRB Quick Reference Guide

Cc: Anna Davis/cd, USF IRB Professional Staff
Candace Burns, PhD

SB-IRB-Approved-EXPEDITED-0601

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

August 26, 2009

Christine Bouchard, MS, MPH
College of Nursing
MDC 22

RE: **Expedited Approval** for Continuing Review
IRB#: 107198 G
Title: *Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic*
Study Approval Period: 08/24/2009 to 08/23/2010

Dear Ms. Bouchard:

On August 24, 2009, Institutional Review Board (IRB) reviewed and **APPROVED** the above protocol **for the period indicated above.** It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number **seven (7)**.

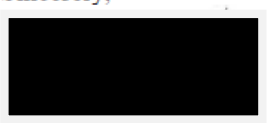
Status: Still analyzing data.

Please note, if applicable, **only use the IRB-Approved and stamped consent forms for participants to sign.** The enclosed informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Integrity and Compliance. In addition, you can find the Institutional Review Board (IRB) Quick Reference Guide providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human participant research on our website. Please read this guide carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-2036.

Sincerely,



Krista Kutash, Ph.D., Chairperson
USF Institutional Review Board

Cc: Anna Davis/cd, USF IRB Professional Staff
Candace Burns, PhD

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

September 3, 2010

Christine Bouchard MS,MPH
[redacted]

RE: **Expedited Approval** for Continuing Review
IRB#: 107198
Title: *Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic*
Study Approval Period: 08/17/2010 to 08/17/2011

Dear Ms Bouchard:

On August 17, 2010, Institutional Review Board (IRB) reviewed and **APPROVED** the above protocol **for the period indicated above.** It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number **7**.

> **Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.**

Please note, if applicable, **only use the IRB-Approved and stamped consent forms for participants to sign.** The enclosed informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Integrity and Compliance. In addition, you can find the Institutional Review Board (IRB) Quick Reference Guide providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human participant research on our website. Please read this guide carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-7104.

Sincerely,

Krista Kutash, Ph.D., Chairperson
USF Institutional Review Board

Cc: Anna Davis/bb, USF IRB Professional Staff
Candace Burhs PhD,ARNP, Faculty Advisor

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

August 3, 2011

Christine H . Bouchard, MS, MPH
College of Nursing
[redacted]

RE: **Expedited Approval** for Continuing Review
IRB#: 107198
Title: *Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic*
Study Approval Period: 08/17/2011 to 08/17/2012

Dear Christine H. bouchard, MS, MPH:

On 06/17/2011, Institutional Review Board (IRB) reviewed and **APPROVED** the above protocol **for the period indicated above.** It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number 7.

Please note, if applicable, **only use the IRB-Approved and stamped consent forms for participants to sign.** The enclosed informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Integrity and Compliance. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

[redacted]

John Schinka, Ph.D., Chairperson
USF Institutional Review Board

Cc: Anna Davis/am, USF IRB Professional Staff

Appendix B: Research Site Consent

Occupational Medical Centers, Inc.
Richard F. Johnson MD, MPH, MRO
Medical Director

CORPORATE OFFICE
7557 Ulmerton Road
Largo, FL 33771
TEL: (727) 586-0138
FAX: (727) 586-6954

LARGO
1400 East Bay Drive
Largo, FL 33771
TEL: (727) 586-0047
FAX: (727) 585-7867

MEDICAL REVIEW SERVICES
7527 Ulmerton Road
Largo, FL 33771
TEL: (727) 585-4833
FAX: (727) 588-2625

PALM HARBOR
2323 Curlew Road
Suite 2A
Dunedin, FL 34698
TEL: (727) 781-3480
FAX: (727) 781-3912

PLANT CITY
2303 N. Airport Road
Plant City, FL 33567
TEL: (813) 752-1195
FAX: (813) 754-4478

TAMPA
1750 North 50th Street
Tampa, FL 33619
TEL: (813) 247-4489
FAX: (813) 247-4480

TEMPLE TERRACE
10320 North 56th Street
#110
Temple Terrace, FL 33617
TEL: (813) 980-3151
FAX: (813) 980-3731

TOWN & COUNTRY
4899-C W Waters Ave
Tampa, FL 33634
TEL: (813) 887-3639
FAX: (813) 886-3170

ST PETERSBURG
3745 33rd St N
St. Petersburg, FL 33713
TEL: (727) 231-0154
FAX: (727) 231-0158

ORLANDO
2314 North Orange Blossom Trail
Orlando, FL 32804
TEL: (407) 428-9233
FAX: (407) 428-9667

University of South Florida
Institutional Review Board
Tampa, FL 33610

April 22,2008

To Whom It May Concern:

Christine Bouchard has described her proposed research to me, titled: Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic."

As President and Medical Director of Lakeside Occupational Medical Centers, I approve of this research involving our patients and grant permission for data collection. I will rely on the USF IRB's approval of this study for our facility.

Contact person: Arlene Guzik, MSN, ARNP-BC
Telephone number: 727-586-0138
Email address: aguzik@lakesideoccmed.com

[redacted]
Richard F. Johnson, MD, MPH
President, Medical Director

Appendix C: Informed Consent Form

USF
UNIVERSITY OF
SOUTH FLORIDA

IRB Approval
FWA 00001669
IRB Number: 107198
From 8/29/08
Thru 8/28/09

Informed Consent to Participate in Research

Information to Consider Before Taking Part in this Research Study

Researchers at the University of South Florida (USF) study many topics. To do this, we need the help of people who agree to take part in a research study. This form tells you about this research study.

We are asking you to take part in a research study that is called:
Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic

The person who is in charge of this research study is Christine Bouchard. This person is called the Principal Investigator.

The research will be done at the Lakeside Occupational Medical Centers, Downtown Clinic in Tampa, Florida.

Purpose of the study

The purpose of this study is to assess how clearly safety information sheets are written.

- this study is being conducted by a student for her dissertation

Study Procedures

If you take part in this study, you will be asked to complete a booklet containing 3 parts:

- PART 1 is a timed test, lasting seven minutes, to gage your reading level. We are using this test because we need to know if the information sheets are written so that typical people (not lawyers or chemical engineers) can understand them.
- In PART 2 you will read seven examples of safety information about a chemical found in cleaning supplies and then answer a few questions about what you have read. You are to read one example, turn the page to answer questions, and then go on to the next example. You will be asked to please not look back at an example once you have read it.
- PART 3 contains a few questions about your background (your age, your highest grade level completed in school, your first language, and your job category).
- It should take you between 15 to 30 minutes to complete the booklet.
- You will meet with the Principal Investigator one time.
- The study will take place at Lakeside Occupational Medical Centers, Downtown Clinic, in Tampa, Florida while you are there for a physical examination, immunization, drug screen, or follow-up appointment.

Alternatives

You have the alternative to choose not to participate in this research study.

Benefits

We don't know if you will get any benefits by taking part in this study.

Risks or Discomfort

There are no known risks to those who take part in this study.

Compensation

We will not pay you for the time you volunteer while being in this study. However, as a token of appreciation for your participation, you have the chance to enter a drawing to win one of three $100.00 Visa gift cards. If you would like to be entered into the drawing, you will be asked to complete a short form which asks about how best to contact you if you win. If you do win, we will mail the gift card to you. The drawing will occur at the end of the study. The drawing information sheet will be kept totally separate from the booklet. This will keep your responses to the booklet 100% anonymous and private.

Confidentiality

We must keep your study records confidential. We will not be collecting any information that could identify you personally.

However, certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are:

- The Principal Investigator and her dissertation committee.
- Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety. These include:
    - the University of South Florida Institutional Review Board (IRB) and the staff that work for the IRB. Other individuals who work for USF that provide other kinds of oversight may also need to look at your records.
    - the Department of Health and Human Services (DHHS).

We may publish what we learn from this study. If we do, we will not let anyone know your name. We will not publish anything else that would let people know who you are.

Voluntary Participation / Withdrawal

You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study, to please the investigator. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Decision to participate or not to participate will not affect your service or relationship with Lakeside Occupational Medical Centers, or with your potential, or current employer.

Questions, concerns, or complaints

If you have any questions, concerns or complaints about this study, call Christine Bouchard at [redacted]

APPROVED
USF INSTITUTIONAL REVIEW BOARD FWA00001669

If you have questions about your rights as a participant in this study, general questions, or have complaints, concerns or issues you want to discuss with someone outside the research, call the Division of Research Integrity and Compliance of the University of South Florida at (813) 974-9343.

Consent to Take Part in this Research Study

It is up to you to decide whether you want to take part in this study. If you want to take part, please sign the form, if the following statements are true.

I freely give my consent to take part in this study. I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

_____ _____

Signature of Person Taking Part in Study Date

_____

Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect.

I hereby certify that when this person signs this form, to the best of my knowledge, he or she understands:

- What the study is about.
- What procedures/interventions will be used.
- What the potential benefits might be.
- What the known risks might be.

I also certify that he or she does not have any problems that could make it hard to understand what it means to take part in this research. This person speaks the language that was used to explain this research.

This person reads well enough to understand this form or, if not, this person is able to hear and understand when the form is read to him or her.

This person does not have a medical/psychological problem that would compromise comprehension and therefore makes it hard to understand what is being explained and can, therefore, give informed consent.

This person is not under any type of anesthesia or analgesic that may cloud their judgment or make it hard to understand what is being explained and, therefore, can be considered competent to give informed consent.

_____ _____

Signature of Person Obtaining Informed Consent Date

_____

Printed Name of Person Obtaining Informed Consent

APPROVED
USF INSTITUTIONAL REVIEW BOARD FWA00001669

Appendix D: STOFHLA

Test of Functional Health Literacy in Adults

Short Test of Functional Health Literacy in Adults (STOFHLA)

STOFHLA
Large Print Version
English, 14 point font

Short Test of Functional Literacy in Adults

STOFHLA

READING COMPREHENSION

HAND PATIENT THE READING COMPREHENSION PASSAGES TO BE COMPLETED. FOLD BACK THE PAGE OPPOSITE THE TEXT SO THAT THE PATIENT SEES ONLY THE TEXT.

PREFACE THE READING COMPREHENSION EXERCISE WITH:

> "Here are some other medical instructions that you or anybody might see around the hospital. These instructions are in sentences that have some of the words missing. Where a word is missing, a blank line is drawn, and 4 possible words that could go in the blank appear just below it. I want you to figure out which of those 4 words should go in the blank, which word makes the sentence make sense. When you think you know which one it is, circle the letter in front of that word, and go on to the next one. When you finish the page, turn the page and keep going until you finish all the pages."

STOP AT THE END OF 7 MINUTES

PASSAGE A: X-RAY PREPARATION

PASSAGE B: MEDICAID RIGHTS AND RESPONSIBILITIES

PASSAGE A

A1	(1)	(0)
a.		
b.		
c.		
d.		

A2	(1)	(0)
a.		
b.		
c.		
d.		

A3	(1)	(0)
a.		
b.		
c.		
d.		

A4	(1)	(0)
a.		
b.		
c.		
d.		

A5	(1)	(0)
a.		
b.		
c.		
d.		

Sub-Total

PASSAGE A

Your doctor has sent you to have a _____ X-ray.

a. stomach
b. diabetes
c. stitches
d. germs

You must have an _____ stomach when you come for _____.

a. asthma
b. empty
c. incest
d. anemia

a. is.
b. am.
c. if.
d. it.

The X-ray will _____ from 1 to 3 _____ to do.

a. take
b. view
c. talk
d. look

a. beds
b. brains
c. hours
d. diets

A6	(1)	(0)	A7	(1)	(0)
a.			a.		
b.			b.		
c.			c.		
d.			d.		

A8	(1)	(0)	A9	(1)	(0)
a.			a.		
b.			b.		
c.			c.		
d.			d.		

A10	(1)	(0)	A11	(1)	(0)
a.			a.		
b.			b.		
c.			c.		
d.			d.		

Sub-Total

THE DAY BEFORE THE X-RAY.

For supper have only a _____ snack of fruit, _____ and jelly,

a. little	a. toes
b. broth	b. throat
c. attack	c. toast
d. nausea	d. thigh

with coffee or tea.

After _____ , you must not _____ or drink

a. minute,	a. easy
b. midnight,	b. ate
c. during,	c. drank
d. before,	d. eat

anything at _____ until after you have _____ the X-ray.

a. ill	a. are
b. all	b. has
c. each	c. had
d. any	d. was

A12	(1)	(0)
a.		
b.		
c.		
d.		

A13	(1)	(0)
a.		
b.		
c.		
d.		

A14	(1)	(0)
a.		
b.		
c.		
d.		

A15	(1)	(0)
a.		
b.		
c.		
d.		

A16	(1)	(0)
a.		
b.		
c.		
d.		

Sub-Total

THE DAY OF THE X-RAY.

Do not eat _____.

a. appointment.
b. walk-in.
c. breakfast.
d. clinic.

Do not _____, even _____.

a. drive,	a. heart.
b. drink,	b. breath.
c. dress,	c. water.
d. dose,	d. cancer.

If you have any _____, call the X-ray _____ at 616-4500.

a. answers,	a. Department
b. exercises,	b. Sprain
c. tracts,	c. Pharmacy
d. questions,	d. Toothache

B17	(1)	(0)
a.		
b.		
c.		
d.		

B18	(1)	(0)
a.		
b.		
c.		
d.		

B19	(1)	(0)
a.		
b.		
c.		
d.		

B20	(1)	(0)
a.		
b.		
c.		
d.		

B21	(1)	(0)
a.		
b.		
c.		
d.		

B22	(1)	(0)
a.		
b.		
c.		
d.		

B23	(1)	(0)
a.		
b.		
c.		
d.		

Sub-Total

PASSAGE B

I agree to give correct information to _____ if I can receive Medicaid.

a. hair
b. salt
c. see
d. ache

I _____ to provide the county information to _____ any

a. agree
b. probe
c. send
d. gain

a. hide
b. risk
c. discharge
d. prove

statements given in this _____ and hereby give permission to

a. emphysema
b. application
c. gallbladder
d. relationship

the _____ to get such proof. I _____ that for

a. inflammation
b. religion
c. iron
d. county

a. investigate
b. entertain
c. understand
d. establish

Medicaid I must report any _____ in my circumstances

a. changes
b. hormones
c. antacids
d. charges

B24 (1) (0)	B25 (1) (0)
a.	a.
b.	b.
c.	c.
d.	d.

B26 (1) (0)	B27 (1) (0)
a.	a.
b.	b.
c.	c.
d.	d.

B28 (1) (0)	B29 (1) (0)
a.	a.
b.	b.
c.	c.
d.	d.

B30 (1) (0)
a.
b.
c.
d.

B31 (1) (0)	B32 (1) (0)
a.	a.
b.	b.
c.	c.
d.	d.

Sub-Total

within _____ (10) days of becoming _____ of the change.

a. three	a. award
b. one	b. aware
c. five	c. away
d. ten	d. await

I understand _____ if I DO NOT like the _____ made on my

a. thus	a. marital
b. this	b. occupation
c. that	c. adult
d. than	d. decision

case, I have the _____ to a fair hearing. I can _____ a

a. bright	a. request
b. left	b. refuse
c. wrong	c. fail
d. right	d. mend

hearing by writing or _____ the county where I applied.

a. counting
b. reading
c. calling
d. smelling

If you _____ TANF for any family _____ , you will have to

a. wash	a. member,
b. want	b. history,
c. cover	c. weight,
d. tape	d. seatbelt,

B33	(1)	(0)	B34	(1)	(0)
a.			a.		
b.			b.		
c.			c.		
d.			d.		

B35	(1)	(0)	B36	(1)	(0)
a.			a.		
b.			b.		
c.			c.		
d.			d.		

READING COMPREHENSION RAW SCORE

Sub-Total

_____ a different application form. _____ , we will use

a. relax
b. break
c. inhale
d. sign

a. Since,
b. Whether,
c. However,
d. Because,

the _____ on this form to determine your _____ .

a. lung
b. date
c. meal
d. pelvic

a. hypoglycemia.
b. eligibility.
c. osteoporosis.
d. schizophrenia.

Short Test of Functional Health Literacy in Adults (STOFHLA)

Joanne R. Nurss, Ph.D., Ruth M. Parker, M.D., Mark V. Williams, M.D., & David W. Baker, M.D., M.P.H.

TOFHLA is a measure of the patient's ability to read and understand health care information, their functional health literacy. TOFHLA Numeracy assesses their understanding of prescription labels, appointment slips, and glucose monitoring. TOFHLA Reading Comprehension assesses their understanding of health care texts such as preparation for a diagnostic procedure and Medicare Rights & Responsibilities.

Date ____/____/____

Name _____ ____ M ____ F

Birthdate ____/____/____ Age ____ SSN or ID# _____

Hospital or Health-care Setting _____

City, State _____

Short Form Administered: ___English ___Spanish

STOFHLA - Score

TOFHLA Total Score:
Reading Comprehension Raw Score (0-36) | |

Functional Health Literacy Level:

0 - 16 -- Inadequate Functional Health Literacy

17 - 22 -- Marginal Functional Health Literacy

23 - 36 -- Adequate Functional Health Literacy | |

July 1995

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STOFHLA: Reading Comprehension
Scoring Key

14 Point Font

Passage A	Passage A	Passage A	Passage B	Passage B	Passage B
A1 a	A6 a	A12 c	B17 c	B24 d	B33 d
A2 b	A7 c	A13 b	B18 a	B25 b	B34 c
A3 d	A8 b	A14 c	B19 d	B26 c	B35 b
A4 a	A9 d	A15 d	B20 b	B27 d	B36 b
A5 c	A10 b	A16 a	B21 d	B28 d	
	A11 c		B22 c	B29 a	
			B23 a	B30 c	
				B31 b	
				B32 a	

Test of Functional Health Literacy in Adults

Short Test of Functional Health Literacy in Adults (STOFHLA)

STOFHLA Directions for Administration, Scoring & Technical Data

STOFHLA - English & STOFHLA - Spanish

Directions For Administration & Scoring

I. Introduction

A. Background

A review of existing literacy assessment instruments shows that most concentrate on word recognition or narrative text comprehension skills. To answer the need for a more comprehensive evaluation of literacy, and a different conceptual framework for understanding the impact of low literacy on health status and/or health care delivery, the Literacy in Health Care Project developed the Test of Functional Health Literacy in Adults (TOFHLA). TOFHLA is a functional literacy assessment tool designed to evaluate adult literacy in the health care setting. The instrument measures functional literacy on the assumption that more than classroom reading ability is necessary to understand and negotiate the health care system adequately. TOFHLA is especially directed toward capturing numeracy and reading comprehension skills in the middle to low levels of literacy ability.

B. Short TOFHLA

Initial use of the TOFHLA indicated that healthcare professionals found a need for a shorter version for screening patient literacy in clinical and educational settings. While the full TOFHLA provides a more complete estimate of patients' functional health literacy, the Short TOFHLA is a quicker, more efficient way of determining patient functional health literacy. It measures understanding of functional health literacy tests, a more effective measure of literacy than simple word recognition. It decreases administration time to 7 minutes (from 22 minutes for the full TOFHLA) and eliminates the need for visual acuity screening. Administration is also simplified as the tasks involve no manipulatives and may be given as a group test.

C. Special Considerations for Testing Low Literate Patients

An important part of health literacy features personal ability. Those with few or reduced skills often feel vulnerable when literacy inability is brought to their attention or to the attention of those around them. The force of this vulnerability is heightened by peer and social pressure. Consequently, low literate persons employ sophisticated mechanisms to conceal their literacy skill level and to prevent subsequent discovery or embarrassment, not to mention outright anger.

You very likely will encounter some of these low literacy behaviors:

- pointing to the text with a finger, while reading
- lifting the text closer to be read
- claiming "the light's not good"

- complaining about "having trouble seeing"
- expressing fatigue
- explaining that they don't have time
- stating that they don't think the material is interesting

When you encounter low literacy, soften the impact of unmasking by stating compassionately, "I am not here to embarrass you, frustrate you, or make you feel uncomfortable. I am willing to stop if you want to, but the information you can give me is very special and valued highly by all of us here. (PAUSE) May I continue?" Honor the dignity to which every human is entitled.

II. Preliminary Procedures

A. Informed Consent

Your hospital or health-care setting may require you to obtain a signed Informed Consent from the patient before testing may begin. Your institution may have a standard form and/or a procedure for developing one. The informed consent must be read orally verbatim. Paraphrasing is allowed, but not as a substitute for verbatim reading. When the respondent signs the consent, in effect he/she gives you permission to ask them questions, but they do not commit themselves to answering the questions. It is normal, however, for the respondent to answer all questions asked. Typically, the informed consent provides the respondent with information about procedures, risks and discomforts, expected benefits, withdrawal of consent, confidentiality and project disclaimer of financial reliability in the event of injury. Manage the consent procedure with the same diligence you use to administer a data collection tool.

B. Visual Acuity

Routinely, low literate persons will mask reading problems by saying that they cannot see the materials they are given. This test is printed in 14 point font (large print) appropriate for persons with visual acuity at least 20/50. If the respondent wears glasses, ask them to put them on for this test.

C. Language Preference

If the patient's dominant language is Spanish, administer the Spanish-version of Short TOFHLA (STOFHLA-Spanish). However, it is important to remember this gives information on the patient's literacy in Spanish, not English. The health care facility needs to provide written material in Spanish as well as English for these patients.

III. STOFHLA: Reading Comprehension

A. Description

STOFHLA (Reading Comprehension) tests a patient's ability to read passages using real materials from the health care setting. The test of 36 items uses a modified Cloze procedure. Passages are selected from instructions for preparation for an upper GI series and the patient rights and responsibilities section of a Medicaid application form. Readability levels on the Gunning Fog index are grades 4.3 and 10.4 respectively. The passages are ordered by increasing difficulty.

B. Directions for Administration

It is important to present the reading comprehension section verbatim from the scripted introduction. Once introduced, fold the preceding pages back so that the respondent sees only the text passages. Turn one or two pages to show the respondent what you mean, and turn them in a way that only shows the text passages. If the respondent asks about the score columns, tell them that the boxes are for use in the office. Do not tell the respondent that they are score columns. This is a timed test and should be stopped at the end of 7 minutes. Do not inform the respondent in advance that the test is timed. When 7 minutes have elapsed, tell the respondent that "That should give us what we are looking for. Thank you for your cooperation." and remove the test materials.

C. Directions for Scoring STOFHLA: Reading Comprehension

Score the results immediately on the spot, after the respondent has left. You will need to do six things to confirm and transcribe respondent data to appropriate boxes in the column of boxes appearing on the page opposite the text:

1. For each blank, circle the letter in the box corresponding to the letter selected by the respondent.
2. Compare the answers by page and variable name to the appropriate scoring key provided below.
3. In the score box, circle "1" for correct or "0" for incorrect for each blank.
4. Sum correct answers for each page, and record total at bottom of page.
5. Sum the subtotals for all pages and record total on the last scoring column page as the Reading Comprehension Raw Score. Record in the appropriate box on the back cover of the test booklet (STOFHLA Total Score).

STOFHLA: Reading Comprehension Score Key
English: 14 Point Font

Passage A	Passage A	Passage A	Passage B	Passage B	Passage B
A1 a	A6 a	A12 c	B17 c	B24 d	B33 d
A2 b	A7 c	A13 b	B18 a	B25 b	B34 c
A3 d	A8 b	A14 c	B19 d	B26 c	B35 b
A4 a	A9 d	A15 d	B20 b	B27 d	B36 b
A5 c	A10 b	A16 a	B21 d	B28 d	
	A11 c		B22 c	B29 a	
			B23 a	B30 c	
				B31 b	
				B32 a	

STOFHLA: Reading Comprehension Score Key
Spanish: 14 Point Font

Passage A	Passage A	Passage B	Passage B	Passage B
A1 b	A10 c	B17 a	B24 a	B34 a
A2 a	A11 a	B18 b	B25 c	B35 d
A3 c	A12 c	B19 a	B26 b	B36 b
A4 c	A13 a	B20 b	B27 c	
A5 a	A14 b	B21 a	B28 b	
A6 d	A15 a	B22 d	B29 b	
A7 c	A16 a	B23 c	B30 a	
A8 c			B31 a	
A9 b			B32 d	
			B33 c	

IV. STOFLHA: Functional Health Literacy Level

A. Functional Health Literacy Level

Look up the Total STOFHLA Score on the table below. Record the patient's Functional Health Literacy Level on the back cover of the test booklet.

TOFHLA Functional Health Literacy Levels

Level	TOFHLA Score	Functional Health Literacy Description
Inadequate Functional Health Literacy	0-16	Unable to read and interpret health texts.
Marginal Functional Health Literacy	17-22	Has difficulty reading and interpreting health texts.
Adequate Functional Health Literacy	23-36	Can read and interpret most health texts.

B. Functional Interpretation of STOFHLA Scores

1. Patients who have **Adequate Functional Health Literacy** should be able to read, understand, and interpret most health texts.

2. Patients who have **Marginal** or **Inadequate Functional Health Literacy** will have difficulty reading, understanding, and interpreting most health materials. They are not going to be able to read and understand directions for their health care. They are likely to take their medications incorrectly or to fail to follow prescribed diets or treatment regimens. Modifications must be made in the health care setting in order to accommodate these persons. Recommendations include the following:

   - Suggest the person bring someone along with them to read and interpret health texts.
   - Suggest the person use someone at home to read and interpret health texts.
   - Rewrite health materials, including prescription bottle labels at a lower literacy level (below 5th grade readability level).
   - Use pictures, graphic directions, symbols to indicate directions, information, and procedures.

- Have staff available to assist patients whose functional health literacy level is low.
- Provide important information on audio-tape and/or video-tape.

Remember that persons with low functional health literacy often are ashamed of their literacy status. They will be unlikely to volunteer that they can not read or to ask for assistance. Low literacy does not mean low intelligence. Treat them with dignity and respect, offering literacy help but not talking down to them.

V. STOFHLA: Technical Report

The STOFHLA (English & Spanish) consists of two functional health reading comprehension passages. In a group of 211 patients given the STOFHLA at the Urgent Care Center and Medical Clinic at Grady Memorial Hospital in Atlanta, Chronbach's Alpha (internal consistency) was 0.97 (0.94 for passage A & 0.97 for Passage B). The correlation (Spearman) with the REALM was 0.81 and with the full TOFHLA 0.91. For further information on the development of the Short TOFHLA, see Baker, Williams, Parker, Gazmarian, & Nurss, 1998.

When Should You Use:

Short TOFHLA
- Screening patients in a medical clinic.
- Determining literacy level for a health variable in education program.
- Including literacy level as a descriptive variable.

Full TOFHLA
- Including literacy as a dependent or independent research.

Appendix E: Consent to Use STOFHLA

PEPPERCORN BOOKS & PRESS INC

TOFHLA
TEST OF FUNCTIONAL HEALTH LITERACY IN ADULTS

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Appendix F: Material Safety Data Sheet Test Versions A and B

Material Safety Data Sheet Reading Comprehension Questionnaire

Version A

Thank you for agreeing to participate in our research. Please do not put your name on this booklet. The purpose of this study is to assess how clearly safety information sheets are written. This is not a test of what you know. We are interested in the best way to write safety information sheets so that they are easy for people to understand.

This booklet contains three parts:

PART 1 is a timed test, lasting seven minutes, to gage your reading level. We are using this test because we need to know if the information sheets are written so that typical people (not lawyers or chemical engineers) can understand them.

In PART 2 you will read seven examples of safety information about a chemical found in cleaning supplies and then answer a few questions about what you have read. You are to read one example, turn the page to answer questions, and then go on to the next example. Please do not look back at an example once you have read it.

PART 3 contains a few questions about your background (your age, your job category, etc.).

Please answer all questions, even if you have to guess. When you are finished, please return the booklet to the researcher. If you have any questions while completing the booklet please ask the researcher.

Thank you again for your help with our research study.

Example #1

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:NO Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE: HARMFUL IF VAPORS INHALED; CAUSES RESPIRATORY IRRITATION. CONTACT WITH SKIN & EYES MAY CAUSE IRRITATION. HARMFUL IF SWALLOWED. CHRONIC: PROLONGED EXPOSURE MAY CAUSE PULMONARY EDEMA.
Explanation of Carcinogenicity:NO INGREDIENT OF A CONCENTRATION OF 0.1% OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.
Effects of Overexposure:INHALED-COUGHING, SNEEZING, SHORTNESS OF BREATH. SKIN-IRRITATION. EYES-IRRITATION. INGESTED-NONE STATED, HARMFUL.
Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

Questions on Example #1

PLEASE DO NOT look back at the example while answering the questions below.

1. Routes of Entry: Inhalation:YES _____:NO Ingestion:YES

    a. Injection
    b. Exhalation
    c. Skin
    d. Intoxication

2. CHRONIC: PROLONGED EXPOSURE MAY _____ PULMONARY EDEMA.

    a. PREVENT
    b. CAUSE
    c. IMPAIR
    d. STOP

3. Explanation of Carcinogenicity:NO INGREDIENT OF A CONCENTRATION OF _____ OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.

    a. 0.01%
    b. 0.1%
    c. 1.0%
    d. 10.0%

4. Effects of Overexposure:INHALED-COUGHING, _____, SHORTNESS OF BREATH.

    a. CHOKING
    b. ITCHING
    c. SNORTING
    d. SNEEZING

5. Medical Cond _____ by Exposure:NONE SPECIFIED BY MANUFACTURER.

    a. Aggravated
    b. Ameliorated
    c. Improved
    d. Interrupted

Example #2

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

LD50 LC50 Mixture:NO DATA PROVIDED BY MANUFACTURER
Routes of Entry: Inhalation:YES Skin:YES Ingestion:NO
Health Hazards Acute and Chronic:HARMFUL IF INHALED. CAUSES SKIN AND EYE IRRITATION. EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT. INHALATION. MAY CAUSE IRRITATION TO RESPIR ATORY TRACT.
Explanation of Carcinogenicity:NO DATA PROVIDED BY MANUFACTURER
Effects of Overexposure:EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT. INHALATION. MAY CAUSE IRRITATION TO RESPIRATORY TRACT.
Medical Cond Aggravated by Exposure:NO DATA AVAILABLE.

Questions on Example #2

PLEASE DO NOT look back at the example while answering the questions below.

6. LD50 LC50 Mixture: _____ DATA PROVIDED BY MANUFACTURER

a. SOME
b. PARTIAL
c. NO
d. TOTAL

7. Routes of Entry: _____: YES Skin: YES Ingestion: NO

a. Inhalation
b. Expiration
c. Exhalation
d. Intoxication

8. Health Hazards Acute and Chronic: _____ IF INHALED.

a. RISK-FREE
b. NONTOXIC
c. HARMLESS
d. HARMFUL

9. INGESTION: MAY CAUSE _____ DISCOMFORT.

a. MUSCULOSKELETAL
b. GASTROINTESTINAL
c. RESPIRATORY
d. NEUROLOGICAL

10. Effects of Overexposure: EYES: MAY CAUSE _____.

a. SCALING
b. BLISTERING
c. ITCHING
d. IRRITATION

Example #3

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

EMERGENCY OVERVIEW

Appearance: clear light yellow green liquid.
Warning! Causes eye and skin irritation and possible burns.
Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects
Eye: May cause irreversible eye injury. Causes eye irritation and possible burns.
Skin: May cause severe irritation and possible burns.
Ingestion: Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.
Inhalation: May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema.
Chronic: Chronic inhalation and ingestion may cause effects similar to those of acute inhalation and ingestion. Human systemic effects by ingestion: somnolence, blood pressure lowering, corrosive to skin, nausea or

Questions on Example #3

PLEASE DO NOT look back at the example while answering the questions below.

11. Appearance: clear light _____ green liquid.

    a. yellow
    b. orange
    c. brown
    d. blue

12. **Eye:** May cause _____ eye injury.

    a. reversible
    b. semi-permanent
    c. irreversible
    d. temporary

13. **Ingestion:** Causes severe digestive tract burns with abdominal pain, vomiting, and possible _____.

    a. relapse
    b. death
    c. recovery
    d. discovery

14. **Inhalation:** May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and _____ lung edema.

    a. immediate
    b. acute
    c. instant
    d. delayed

15. **Chronic:** Chronic inhalation and ingestion may cause effects _____ to those of acute inhalation and ingestion.

    a. dissimilar
    b. similar
    c. unlike
    d. different

Example #4

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:NO Skin:YES Ingestion:NO
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.

Questions on Example #4

PLEASE DO NOT look back at the example while answering the questions below.

16. Routes of Entry: Inhalation:NO Skin:YES Ingestion:_____

a. YES
b. STOMACH
c. NO
d. SKIN

17. Reports of Carcinogenicity: NTP:NO _____:NO OSHA:NO

a. IARC
b. AIRC
c. ASSE
d. NIOSH

18. Health Hazards Acute and Chronic: SKIN: PROLONGED CONTACT _____ CAUSE CHEMICAL BURN.

a. DOES NOT
b. WILL NOT
c. CANNOT
d. CAN

19. _____ of Carcinogenicity:NONE

a. Extrapolation
b. Explanation
c. Evidence
d. Elaboration

20. Effects of _____:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.

a. Overexposure
b. Underexposure
c. Disclosure
d. Revelation

Example #5

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:Yes Skin:Yes Ingestion:Yes
Reports of Carcinogenicity:NTP:No IARC:No OSHA:No
Health Hazards Acute and Chronic:Ingestion: May cause irritation of the membranes of the mouth and throat, stomach pain and possible ulceration., Inhalation: May cause irritation to the mucous membranes of the respiratory tract., Skin: May cause moderate skin irritation and reddening of the skin., Eyes: May cause severe irritation., Summary of Chronic Health Hazards: Irritating effects increase with strength of solution and time of exposure. NFPA Rating: Health - 2; Fire - 0; Reactivity - 1 0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

Questions on Example #5

PLEASE DO NOT look back at the example while answering the questions below.

21. Health Hazards Acute and Chronic: Ingestion: May cause irritation of the _____ of the mouth and throat, stomach pain and possible ulceration.

    a. tonsils
    b. teeth
    c. maxilla
    d. membranes

22. Inhalation: May cause irritation to the _____ membranes of the respiratory tract.

    a. allergic
    b. inflamed
    c. mucous
    d. swollen

23. Skin: May cause _____ skin irritation and reddening of the skin.

    a. moderate
    b. minor
    c. severe
    d. slight

24. Summary of Chronic Health Hazards: Irritating effects _____ with strength of solution and time of exposure.

    a. decrease
    b. lessen
    c. increase
    d. abate

25. NFPA Rating: Health - _____; Fire - 0; Reactivity - 1 0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

    a. 1
    b. 2
    c. 3
    d. 4

Example #6

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:HARMFUL IF INGESTED, INHALED/ABSORBED THROUGH SKIN. EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES & UPPER RESPIRATORY TRACT, EYES/SKIN. INHALATION: FATAL, RESULTING IN EDEMA OF THE LARYNX, B RONCHI, CHEMICAL PNEUMONITIS & PULMONARY EDEMA.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SPASM, INFLAMMATION, BURNING SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA, VOMITING.

Questions on Example #6

PLEASE DO NOT look back at the example while answering the questions below.

26. Health Hazards Acute and Chronic: HARMFUL IF INGESTED, INHALED/_____THROUGH SKIN.

a. EXPIRED
b. EXHALED
c. ABSORBED
d. APPENDED

27. _____ DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES & UPPER RESPIRATORY TRACT, EYES/SKIN.

a. HIGHLY
b. MODERATELY
c. SLIGHTLY
d. EXTREMELY

28. INHALATION: FATAL, RESULTING IN EDEMA OF THE LARYNX, B RONCHI, CHEMICAL _____ & PULMONARY EDEMA.

a. PNEUMONITIS
b. POLIOMYELITIS
c. ARTHRITIS
d. PNEUMOTHORAX

29. Explanation of _____:NONE

a. Toxicity
b. Mutagenicity
c. Carcinogenicity
d. Genotoxicity

30. Effects of Overexposure:SPASM, INFLAMMATION, _____ SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA, VOMITING.

a. COOL
b. BURNING
c. NUMB
d. FREEZING

Example #7

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Health Hazards Acute and Chronic:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
Effects of Overexposure:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.

Questions on Example #7

PLEASE DO NOT look back at the example while answering the questions below.

31. Routes of _____: Inhalation:YES Skin:YES Ingestion:YES

a. Exhaust
b. Exit
c. Egress
d. Entry

32. Health Hazards Acute and Chronic: CAUSES _____ BURNS.

a. STATIC
b. CAUSTIC
c. VAPOR
d. STEAM

33. MAY BE _____ BY INHALATION, INGESTION, OR SKIN ABSORPTION.

a. HARMFUL
b. HELPFUL
c. USEFUL
d. HARMLESS

34. CAUSES EYE _____ SKIN IRRTANT.

a. OR
b. NOR
c. AND
d. NOT

35. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND _____ RESPIRATORY TRACT.

a. LOWER
b. MIDDLE
c. UPPER
d. INTERIOR

When you are done answering the questions, please turn in your papers to the investigator. Thank you for your time.

Answer Key Version A

Example #1

Question	Answer
1	c (Skin)
2	b (CAUSE)
3	b (0.1%)
4	d (SNEEZING)
5	a (Aggravated)

Example #2

Question	Answer
6	c (NO)
7	a (Inhalation)
8	d (HARMFUL)
9	b (GASTROINTESTINAL)
10	d (IRRITATION)

Example #3

Question	Answer
11	a (yellow)
12	c (irreversible)
13	b (death)
14	d (delayed)
15	b (similar)

Example #4

Question	Answer
16	c (NO)
17	a (IARC)
18	d (CAN)
19	b (Explanation)
20	a (Overexposure)

Example #5

Question	Answer
21	d (membranes)
22	c (mucous)
23	a (moderate)
24	c (increase)
25	b (2)

Example #6

Question	Answer
26	c (ABSORBED)
27	d (EXTREMELY)
28	a (PNEUMONITIS)
29	c (Carcinogenicity)
30	b (BURNING)

Example #7

Question	Answer
31	d (Entry)
32	b (CAUSTIC)
33	a (HARMFUL)
34	c (SKIN)
35	c (UPPER)

Material Safety Data Sheet Reading Comprehension Questionnaire

Version B

Thank you for agreeing to participate in our research. Please do not put your name on this booklet. The purpose of this study is to assess how clearly safety information sheets are written. This is not a test of what you know. We are interested in the best way to write safety information sheets so that they are easy for people to understand.

This booklet contains three parts:

PART 1 is a timed test, lasting seven minutes, to gage your reading level. We are using this test because we need to know if the information sheets are written so that typical people (not lawyers or chemical engineers) can understand them.

In PART 2 you will read seven examples of safety information about a chemical found in cleaning supplies and then answer a few questions about what you have read. You are to read one example, turn the page to answer questions, and then go on to the next example. Please do not look back at an example once you have read it.

PART 3 contains a few questions about your background (your age, your job category, etc.).

Please answer all questions, even if you have to guess. When you are finished, please return the booklet to the researcher. If you have any questions while completing the booklet please ask the researcher.

Thank you again for your help with our research study.

Example #1

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Health Hazards Acute and Chronic:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
Effects of Overexposure:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.

Questions on Example #1

PLEASE DO NOT look back at the example while answering the questions below.

1. Routes of _____: Inhalation:YES Skin:YES Ingestion:YES

   e. Exhaust
   f. Exit
   g. Egress
   h. Entry

2. Health Hazards Acute and Chronic: CAUSES _____ BURNS.

   e. STATIC
   f. CAUSTIC
   g. VAPOR
   h. STEAM

3. MAY BE _____ BY INHALATION, INGESTION, OR SKIN ABSORPTION.

   e. HARMFUL
   f. HELPFUL
   g. USEFUL
   h. HARMLESS

4. CAUSES EYE _____ SKIN IRRTANT.

   e. OR
   f. NOR
   g. AND
   h. NOT

5. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND _____ RESPIRATORY TRACT.

   e. LOWER
   f. MIDDLE
   g. UPPER
   h. INTERIOR

Example #2

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:HARMFUL IF INGESTED, INHALED/ABSORBED THROUGH SKIN. EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES & UPPER RESPIRATORY TRACT, EYES/SKIN. INHALATION: FATAL, RESULTING IN EDEMA OF THE LARYNX, B RONCHI, CHEMICAL PNEUMONITIS & PULMONARY EDEMA.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SPASM, INFLAMMATION, BURNING SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA, VOMITING.

Questions on Example #2

PLEASE DO NOT look back at the example while answering the questions below.

6. Health Hazards Acute and Chronic: HARMFUL IF INGESTED, INHALED/_____THROUGH SKIN.

e. EXPIRED
f. EXHALED
g. ABSORBED
h. APPENDED

7. _____ DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES & UPPER RESPIRATORY TRACT, EYES/SKIN.

a. HIGHLY
b. MODERATELY
c. SLIGHTLY
d. EXTREMELY

8. INHALATION: FATAL, RESULTING IN EDEMA OF THE LARYNX, B RONCHI, CHEMICAL _____ & PULMONARY EDEMA.

a. PNEUMONITIS
b. POLIOMYELITIS
c. ARTHRITIS
d. PNEUMOTHORAX

9. Explanation of _____:NONE

a. Toxicity
b. Mutagenicity
c. Carcinogenicity
d. Genotoxicity

10. Effects of Overexposure:SPASM, INFLAMMATION, _____ SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA, VOMITING.

a. COOL
b. BURNING
c. NUMB
d. FREEZING

Example #3

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:Yes Skin:Yes Ingestion:Yes
Reports of Carcinogenicity:NTP:No IARC:No OSHA:No
Health Hazards Acute and Chronic:Ingestion: May cause irritation of the membranes of the mouth and throat, stomach pain and possible ulceration., Inhalation: May cause irritation to the mucous membranes of the respiratory tract., Skin: May cause moderate skin irritation and reddening of the skin., Eyes: May cause severe irritation., Summary of Chronic Health Hazards: Irritating effects increase with strength of solution and time of exposure. NFPA Rating: Health - 2; Fire - 0; Reactivity - 1 0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

Questions on Example #3

PLEASE DO NOT look back at the example while answering the questions below.

11. Health Hazards Acute and Chronic: Ingestion: May cause irritation of the _____ of the mouth and throat, stomach pain and possible ulceration.

    e. tonsils
    f. teeth
    g. maxilla
    h. membranes

12. Inhalation: May cause irritation to the _____ membranes of the respiratory tract.

    a. allergic
    b. inflamed
    c. mucous
    d. swollen

13. Skin: May cause _____ skin irritation and reddening of the skin.

    e. moderate
    f. minor
    g. severe
    h. slight

14. Summary of Chronic Health Hazards: Irritating effects _____ with strength of solution and time of exposure.

    a. decrease
    b. lessen
    c. increase
    d. abate

15. NFPA Rating: Health - _____; Fire - 0; Reactivity - 1 0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

    a. 1
    b. 2
    c. 3
    d. 4

Example #4

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:NO Skin:YES Ingestion:NO
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.

Questions on Example #4

PLEASE DO NOT look back at the example while answering the questions below.

16. Routes of Entry: Inhalation:NO Skin:YES Ingestion:_____

e. YES
f. STOMACH
g. NO
h. SKIN

17. Reports of Carcinogenicity: NTP:NO _____:NO OSHA:NO

a. IARC
b. AIRC
c. ASSE
d. NIOSH

18. Health Hazards Acute and Chronic: SKIN: PROLONGED CONTACT _____ CAUSE CHEMICAL BURN.

a. DOES NOT
b. WILL NOT
c. CANNOT
d. CAN

19. _____ of Carcinogenicity:NONE

a. Extrapolation
b. Explanation
c. Evidence
d. Elaboration

20. Effects of _____:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL BURN.

a. Overexposure
b. Underexposure
c. Disclosure
d. Revelation

Example #5

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

EMERGENCY OVERVIEW

Appearance: clear light yellow green liquid.
Warning! Causes eye and skin irritation and possible burns.
Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects
Eye: May cause irreversible eye injury. Causes eye irritation and possible burns.
Skin: May cause severe irritation and possible burns.
Ingestion: Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.
Inhalation: May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema.
Chronic: Chronic inhalation and ingestion may cause effects similar to those of acute inhalation and ingestion. Human systemic effects by ingestion: somnolence, blood pressure lowering, corrosive to skin, nausea or

Questions on Example #5

PLEASE DO NOT look back at the example while answering the questions below.

21. Appearance: clear light _____ green liquid.

    a. yellow
    b. orange
    c. brown
    d. blue

22. **Eye:** May cause _____ eye injury.

    e. reversible
    f. semi-permanent
    g. irreversible
    h. temporary

23. **Ingestion:** Causes severe digestive tract burns with abdominal pain, vomiting, and possible _____.

    a. relapse
    b. death
    c. recovery
    d. discovery

24. **Inhalation:** May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and _____ lung edema.

    e. immediate
    f. acute
    g. instant
    h. delayed

25. **Chronic:** Chronic inhalation and ingestion may cause effects _____ to those of acute inhalation and ingestion.

    e. dissimilar
    f. similar
    g. unlike
    h. different

Example #6

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

LD50 LC50 Mixture:NO DATA PROVIDED BY MANUFACTURER
Routes of Entry: Inhalation:YES Skin:YES Ingestion:NO
Health Hazards Acute and Chronic:HARMFUL IF INHALED. CAUSES SKIN AND EYE IRRITATION. EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT. INHALATION. MAY CAUSE IRRITATION TO RESPIR ATORY TRACT.
Explanation of Carcinogenicity:NO DATA PROVIDED BY MANUFACTURER
Effects of Overexposure:EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT. INHALATION. MAY CAUSE IRRITATION TO RESPIRATORY TRACT.
Medical Cond Aggravated by Exposure:NO DATA AVAILABLE.

Questions on Example #6

PLEASE DO NOT look back at the example while answering the questions below.

26. LD50 LC50 Mixture: _____ DATA PROVIDED BY MANUFACTURER

a. SOME
b. PARTIAL
c. NO
d. TOTAL

27. Routes of Entry: _____: YES Skin: YES Ingestion: NO

a. Inhalation
b. Expiration
c. Exhalation
d. Intoxication

28. Health Hazards Acute and Chronic: _____ IF INHALED.

e. RISK-FREE
f. NONTOXIC
g. HARMLESS
h. HARMFUL

29. INGESTION: MAY CAUSE _____ DISCOMFORT.

e. MUSCULOSKELETAL
f. GASTROINTESTINAL
g. RESPIRATORY
h. NEUROLOGICAL

30. Effects of Overexposure: EYES: MAY CAUSE _____.

e. SCALING
f. BLISTERING
g. ITCHING
h. IRRITATION

Example #7

Please read the following information sheet carefully and then turn the page to answer the questions without looking back.

Routes of Entry: Inhalation:YES Skin:NO Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE: HARMFUL IF VAPORS INHALED; CAUSES RESPIRATORY IRRITATION. CONTACT WITH SKIN & EYES MAY CAUSE IRRITATION. HARMFUL IF SWALLOWED. CHRONIC: PROLONGED EXPOSURE MAY CAUSE PULMONARY EDEMA.
Explanation of Carcinogenicity:NO INGREDIENT OF A CONCENTRATION OF 0.1% OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.
Effects of Overexposure:INHALED-COUGHING, SNEEZING, SHORTNESS OF BREATH. SKIN-IRRITATION. EYES-IRRITATION. INGESTED-NONE STATED, HARMFUL.
Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

Questions on Example #7

PLEASE DO NOT look back at the example while answering the questions below.

31. Routes of Entry: Inhalation:YES _____:NO Ingestion:YES

    e. Injection
    f. Exhalation
    g. Skin
    h. Intoxication

32. CHRONIC: PROLONGED EXPOSURE MAY _____ PULMONARY EDEMA.

    a. PREVENT
    b. CAUSE
    c. IMPAIR
    d. STOP

33. Explanation of Carcinogenicity:NO INGREDIENT OF A CONCENTRATION OF _____ OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.

    a. 0.01%
    b. 0.1%
    c. 1.0%
    d. 10.0%

34. Effects of Overexposure:INHALED-COUGHING, _____, SHORTNESS OF BREATH.

    a. CHOKING
    b. ITCHING
    c. SNORTING
    d. SNEEZING

35. Medical Cond _____ by Exposure:NONE SPECIFIED BY MANUFACTURER.

    e. Aggravated
    f. Ameliorated
    g. Improved
    h. Interrupted

When you are done answering the questions, please turn in your papers to the investigator. Thank you for your time.

Answer Key Version B

Example #1

Question	Answer
1	d (Entry)
2	b (CAUSTIC)
3	a (HARMFUL)
4	c (SKIN)
5	c (UPPER)

Example #2

Question	Answer
6	c (ABSORBED)
7	d (EXTREMELY)
8	a (PNEUMONITIS)
9	c (Carcinogenicity)
10	b (BURNING)

Example #3

Question	Answer
11	d (membranes)
12	c (mucous)
13	a (moderate)
14	c (increase)
15	b (2)

Example #4

Question	Answer
16	c (NO)
17	a (IARC)
18	d (CAN)
19	b (Explanation)
20	a (Overexposure)

Example #5

Question	Answer
21	a (yellow)
22	c (irreversible)
23	b (death)
24	d (delayed)
25	b (similar)

Example #6

Question	Answer
26	c (NO)
27	a (Inhalation)
28	d (HARMFUL)
29	b (GASTROINTESTINAL)
30	d (IRRITATION)

Example #7

Question	Answer
31	c (Skin)
32	b (CAUSE)
33	b (0.1%)
34	d (SNEEZING)
35	a (Aggravated)

Appendix G: Demographic Sheet

Literacy and Hazard Communication Comprehension of Employees Presenting to an Occupational Health Clinic

Demographic Sheet

Age: _____

Highest Grade Level Completed in school:
_____

What is your first language? English _____

Spanish _____

Other (please specify) _____

Check the category that best describes your job:

Management		Arts, Design, Entertainment, Sports, and Media		Office and Administrative Support	
Business and Financial Operations		Healthcare Practitioners and Technical		Farming, Fishing, and Forestry	
Computer and Mathematical		Healthcare Support		Construction and Extraction	
Architecture and Engineering		Protective Service		Installation, Maintenance, and Repair	
Life, Physical, and Social Science		Food Preparation and Serving Related		Production	
Community and Social Services		Building and Grounds Cleaning and Maintenance		Transportation and Material Moving	
Legal		Personal Care and Service		Military Specific	
Education, Training, and Library		Sales and Related Occupations		Other (please specify)	

Appendix H: Raffle Drawing Sheet

MATERIAL SAFETY DATA SHEET READING COMPREHENSION

QUESTIONNAIRE DRAWING INFORMATION SHEET

Thank you for taking part in our study. As a token of our thanks, you have the chance to win one of three $100.00 Visa gift cards. If you would like to be entered into the drawing, please complete the form below about how best to contact you if you win. The drawing information sheet will be kept totally separate from the booklet. This will keep your responses to the booklet 100% anonymous and private. The drawing will occur at the end of the study.

Please complete the form below, **remove** it from the booklet, and deposit it in the designated box.

Name: _____

Address: _____

City: _____ State: _____

Zip: _____

Phone: _____

e-mail: _____

Appendix I: Material Safety Data Sheet (Aldon Corporation)

ALDON CORPORATION -- SODIUM HYPOCHLORITE SOLUTION -- 6810-00-598-7316

========== Product Identification ==========

Product ID:SODIUM HYPOCHLORITE SOLUTION
MSDS Date:11/02/1992
FSC:6810
NIIN:00-598-7316
MSDS Number: BYRRM
=== Responsible Party ===
Company Name:ALDON CORPORATION
Address:1533 W. HENRIETTA RD.
City:AVON
State:NY
ZIP:14414
Country:US
Info Phone Num:716-226-6177
Emergency Phone Num:800-424-9300 CHEMTREC
Preparer's Name:ALEXANDER A. PICCIRILLI
CAGE:6V042
=== Contractor Identification ===
Company Name:AL-DON CHEMICALS INC
Address:1533 W HENRIETTA RD
Box:City:AVON
State:NY
ZIP:14414-9508
Country:US
Phone:716-226-6177
CAGE:6V042

========== Composition/Information on Ingredients ==========

Ingred Name:SODIUM HYPOCHLORITE (CERCLA)
CAS:7681-52-9
RTECS #:NH3486300
Fraction by Wt: 5%
Other REC Limits:NONE RECOMMENDED
EPA Rpt Qty:100 LBS
DOT Rpt Qty:100 LBS

Ingred Name:WATER
CAS:7732-18-5
RTECS #:ZC0110000
Fraction by Wt: 95%
Other REC Limits:NONE RECOMMENDED

========== Hazards Identification ==========

Routes of Entry: Inhalation:YES Skin:NO Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE: HARMFUL IF VAPORS INHALED;
CAUSES RESPIRATORY IRRITATION. CONTACT WITH SKIN & EYES MAY CAUSE
IRRITATION. HARMFUL IF SWALLOWED. CHRONIC: PROLONGED EXPOSURE MAY
CAUSE PULMONARY EDEMA.
Explanation of Carcinogenicity:NO INGREDIENT OF A CONCENTRATION OF 0.1%
OR GREATER IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN.
Effects of Overexposure:INHALED-COUGHING, SNEEZING, SHORTNESS OF
BREATH. SKIN-IRRITATION. EYES-IRRITATION. INGESTED-NONE STATED,
HARMFUL.

Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

========== First Aid Measures ==========

First Aid:EYES-FLUSH WITH WATER FOR 15 MINUTES, LIFT LIDS. GET IMMEDIATE MEDICAL ATTENTION. SKIN-FLUSH WITH WATER THEN WASH WITH MILD SOAP & WATER. INHALED-REMOVE TO FRESH AIR. ADMINISTER OXYGEN OR ARTIFICIAL R ESPIRATION AS NEEDED. GET MEDICAL ATTENTION. INGESTED-DO NOT INDUCE VOMITING! IF CONSCIOUS, GIVE 1-2 GLASSES WATER. GET IMMEDIATE MEDICAL ATTENTION.

========== Fire Fighting Measures ==========

Flash Point:NON-COMBUSTIBLE
Extinguishing Media:WATER ON FIRES INVOLVING SODIUM HYPOCHLORITE.
Fire Fighting Procedures:IN FIRE CONDITIONS, WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE GEAR. SEE 1990 EMERGENCY REPONSE GUIDEBOOK, P 5800.5, GUIDE PAGE NO.60.
Unusual Fire/Explosion Hazard:WHEN HEATED TO TEMPERATURE OF DECOMPOSITION, EMITS TOXIC FUMES OF CHLORINE. CONTACT WITH HYDROCHLORIC ACID LIBERATES CHLORINE GAS.

========== Accidental Release Measures ==========

Spill Release Procedures:DILUTE WITH LARGE AMOUNT OF WATER AND FLUSH DOWN THE DRAIN.
Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

========== Handling and Storage ==========

Handling and Storage Precautions:STORE IN A COOL, DRY PLACE AND PROTECT FROM SUNLIGHT. KEEP CONTAINER TIGHTLY CLOSED WHEN NOT IN USE. WASH THOROUGHLY AFTER HANDLING.
Other Precautions:AVOID CONTACT WITH SKIN, EYES, AND MUCOUS MEMBRANES. REMOVE AND WASH CLOTHING. FOR LABORATORY USE ONLY. NOT FOR FOOD, DRUG OR HOUSEHOLD USE. KEEP OUT OF REACH OF CHILDREN. DO NOT WEAR CONTACT LENSES W HEN USING THIS PRODUCT.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:NONE NORMALLY REQUIRED. IF ENGINEERING CONTROLS FAIL OR NON-ROUTINE USE OR AN EMERGENCY OCCURS; WEAR AN MSHA/NIOSH APPROVED RESPIRATOR OR AN AIR-SUPPLIED RESPIRATOR OR SCBA, AS REQUIRED. USE IAW 29 CF R 1910.134.
Ventilation:USE ADEQUATE MECHANICAL VENTILATION OR LOCAL EXHAUST TO MAINTAIN EXPOSURE BELOW TLV(S).
Protective Gloves:RUBBER.
Eye Protection:CHEMICAL SAFETY GLASSES W/SIDE SHIELDS.
Other Protective Equipment:SMOCK, APRON, GOGGLES, PROPER GLOVES, VENTILATION HOOD, EYE WASH STATION.
Work Hygienic Practices:WASH HANDS AFTER HANDLING AND BEFORE EATING, DRINKING, OR SMOKING. LAUNDER CONTAMINATED CLOTHES BEFORE REUSE.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

HCC:B3
Boiling Pt:=100.C, 212.F
Melt/Freeze Pt:=0.C, 32.F
Decomp Temp:=100.C, 212.F

Vapor Pres:14
Vapor Density:2.58
Spec Gravity:1.07
Evaporation Rate & Reference:>1 (ETHER=1)
Solubility in Water:COMPLETE
Appearance and Odor:PALE, YELLOWISH, CLEAR LIQUID; ODOR OF HYPOCHLORITE.
Percent Volatiles by Volume:95

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
DO NOT MIX WITH ACIDS, OXIDIZABLE MATERIALS, AMMONIA.
Stability Condition to Avoid:DIRECT SUNLIGHT, HIGH TEMPERATURES.
Hazardous Decomposition Products:CHLORINE GIVEN OFF ON CONTACT WITH ACIDS. THERMAL DECOMPOSITION MAY PRODUCE HYDROGEN CHLORIDE GAS.
Conditions to Avoid Polymerization:WILL NOT OCCUR.

========== Disposal Considerations ==========

Waste Disposal Methods:DISCHARGE, TREATMENT OR DISPOSAL MAY BE SUBJECT TO LOCAL, STATE AND FEDERAL REGULATIONS. FLUSH TO SEWER WITH LARGE AMOUNTS OF WATER.

Disclaimer (provided with this information by the compiling agencies):
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Appendix J: Material Safety Data Sheet (Carolina Biological Supply Co.)

CAROLINA BIOLOGICAL SUPPLY CO -- 88-9640, 19-1025, SODIUM HYPOCHLORITE, 5% -- -

========== Product Identification ==========

Product ID:88-9640, 19-1025, SODIUM HYPOCHLORITE, 5%
MSDS Date:09/05/2000
FSC:NIIN:Submitter:D DG
Status Code:A
MSDS Number: CLCZH
=== Responsible Party ===
Company Name:CAROLINA BIOLOGICAL SUPPLY CO
Address:2700 YORK RD
City:BURLINGTON
State:NC
ZIP:27215-3387
Country:US
Info Phone Num:800-227-1150
Emergency Phone Num:(800)424-9300
Chemtrec Ind/Phone:(800)424-9300
CAGE:59896
=== Contractor Identification ===
Company Name:CAROLINA BIOLOGICAL SUPPLY CO
Address:2700 YORK RD
Box:City:BURLINGTON
State:NC
ZIP:27215-3387
Country:US
Phone:800-227-1150/910-584-0381
CAGE:59896

========== Composition/Information on Ingredients ==========

Ingred Name:SODIUM HYPOCHLORITE
CAS:7681-52-9
RTECS #:NH3486300
= Wt:5.
OSHA PEL:NONE ESTABLISHED
ACGIH TLV:NONE ESTABLISHED
EPA Rpt Qty:100 LBS
DOT Rpt Qty:100 LBS

========== Hazards Identification ==========

LD50 LC50 Mixture:NO DATA PROVIDED BY MANUFACTURER
Routes of Entry: Inhalation:YES Skin:YES Ingestion:NO
Health Hazards Acute and Chronic:HARMFUL IF INHALED. CAUSES SKIN AND
EYE IRRITATION. EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE
IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT.
INHALATION. MAY CAUSE IRRITATION TO RESPIR ATORY TRACT.
Explanation of Carcinogenicity:NO DATA PROVIDED BY MANUFACTURER
Effects of Overexposure:EYES: MAY CAUSE IRRITATION. SKIN: MAY CAUSE
IRRITATION. INGESTION: MAY CAUSE GASTROINTESTINAL DISCOMFORT.
INHALATION. MAY CAUSE IRRITATION TO RESPIRATORY TRACT.
Medical Cond Aggravated by Exposure:NO DATA AVAILABLE.

========== First Aid Measures ==========

First Aid:EYES: FLUSH WITH WATER FOR AT LEAST 15 MINUTES, RAISING AND
LOWERING EYELIDS OCCASIONALLY. GET MEDICAL ATTENTION IF IRRITATION

PERSISTS. SKIN: THOROUGHLY WASH EXPOSED AREA FOR AT LEAST 15 MINUTES. REM OVE CONTAMINATED CLOTHING. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE. GET MEDICAL ATTENTION IF IRRITATION PERSISTS. INGESTION: DO NOT INDUCE VOMITING. IF SWALLOWED, IF CONSCIOUS, GIVE PLENTY OF WATER . IMMEDIATELY CALL A PHYSICIAN OR POISON CONTROL CENTER. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. INHALATION: REMOVE TO FRESH AIR. GIVE OXYGEN IF BREATHING IS DIFFICULT;

========== Fire Fighting Measures ==========

Flash Point:NON-COMBUSTIBLE
Extinguishing Media:WATER SPRAY.
Fire Fighting Procedures:FIREFIGHTERS SHOULD WEAR FULL PROTECTIVE EQUIPMENT AND NIOSH APPROVED SELF-CONTAINED BREATHING APPARATUS.
Unusual Fire/Explosion Hazard:WHEN HEATED TO DECOMPOSITION, EMITS TOXIC FUMES OF CHLORINE. CONTACT WITH HYDROCHLORIC ACID LIBERATES CHLORINE GAS.

========== Accidental Release Measures ==========

Spill Release Procedures:VENITLATE AREA OF SPILL. ELIMINATE ALL SOURCES OF IGNITION. REMOVE ALL NON-ESSENTIAL PERSONNEL FROM AREA. CLEAN-UP PERSONNEL SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND CLOTHING. ABSORB MATERIAL WITH SUITABLE ABSORBENT AND CONTAINERIZE FOR DISPOSAL.
Neutralizing Agent:NO DATA PROVIDED BY MANUFACTURER

========== Handling and Storage ==========

Handling and Storage Precautions:STORE IN A COOL, DRY PLACE PROTECTED FROM SUNLIGHT. WASH THOROUGHLY AFTER HANDLING.
Other Precautions:NO DATA PROVIDED BY MANUFACTURER

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:NIOSH/MSHA CHEMICAL CARTRIDGE RESPIRATOR SHOULD BE WORN IF PEL OR TLV IS EXCEEDED.APPROVED RESPIRATOR.
Ventilation:LOCAL EXHAUST: YES, MECHANCIAL (GENERAL): YES.
Protective Gloves:RUBBER
Eye Protection:SPLASH PROOF CHEMICAL SAFETY GOGGLES SHOULD BE WORN AT ALL TIMES
Other Protective Equipment:LAB COAT, EYE WASH, AND SAFETY SHOWER.
Work Hygienic Practices:WASH THOROUGHLY AFTER HANDLING.
Supplemental Safety and Health
NO DATA PROVIDED BY MANUFACTURER. NOTE FROM DLA-HMIS STAFF: HCC B3 ASSIGNED DUE TO THE INCOMPATIBILITY WITH ACIDS AND THE EXPERIENCE OF THE INDIVIDUAL ENTERING THIS WITH BLEACH.

========== Physical/Chemical Properties ==========

HCC:B3
Boiling Pt:=100.C, 212.F
B.P. Text:DECOMPOSES
Melt/Freeze Pt:=0.C, 32.F
Vapor Pres:14 MM HG
Vapor Density:2.58
Spec Gravity:1.07 @ 20 C
Evaporation Rate & Reference:>1 (ETHER=1)
Solubility in Water:COMPLETE

Appearance and Odor:PALE YELLOWISH , CLEAR LIQUID; ODOR OF HYPOCHLORITES
Percent Volatiles by Volume:95

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
ACIDS, OXIDIZABLE MATERIALS, AMMONIA.
Stability Condition to Avoid:DIRECT SUNLIGHT AND HIGH TEMPERATURES
Hazardous Decomposition Products:CHLORINE GIVEN OFF ON CONTACT WITH ACIDS. THERMAL DECOMPSITION OR BURNING MAY PRODUCE HYDROGEN CHLORIDE GAS.
Conditions to Avoid Polymerization:WILL NOT OCCUR.

========== Toxicological Information ==========

Toxicological Information:TOXICITY DATA: NO INFORMATION FOUND.

========== Ecological Information ==========

Ecological:EPA WASTE NUMBERS: NONE.

========== Disposal Considerations ==========

Waste Disposal Methods:DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS. ALWAYS CONTACT A PERMITTED WASTE DISPOSER (TSD) TO ASSURE COMPLIANCE.

========== MSDS Transport Information ==========

Transport Information:NON-REGULATED.

========== Regulatory Information ==========

SARA Title III Information:HAZARD CATEGORY FOR SARA SECTION 311/312 REPORTING: NONE. SARA TITLE III: SODIUM HYPOCHLORITE: SARA EHS SECTION 302 TPQ: NO, SARA SECTION 313 CHEMICALS NAME LIST: NO, SARA SECTION 313 CHEMICAL CATEGOR Y: NO, CERCLA SECTION 103 RQ (LBS): 100. RCRA SECTION 261.33: NO.
Federal Regulatory Information:EPA TSCA STATUS: ON TSCA INVENTORY.
State Regulatory Information:NO DATA PROVIDED BY MANUFACTURER.

========== Other Information ==========

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Appendix K: Material Safety Data Sheet (Fisher Scientific)

Material Safety Data Sheet
Sodium Hypochlorite Solution, 4-6%

ACC# 40179

Section 1 - Chemical Product and Company Identification

MSDS Name: Sodium Hypochlorite Solution, 4-6%
Catalog Numbers: SS290-1, SS290-4, SS290-4LC
Synonyms: None
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7732-18-5	Water	94.21	231-791-2
7681-52-9	Sodium hypochlorite	4-6.0	231-668-3

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear light yellow green liquid.
Warning! Contact with acids liberates toxic gas. Causes eye and skin irritation. May cause respiratory tract irritation. Corrosive to metal.
Target Organs: Eyes, skin.

Potential Health Effects
Eye: Causes eye irritation.
Skin: Causes skin irritation.
Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea.
Inhalation: May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema.
Chronic: No information found.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid imme diately.

Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.
Ingestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products. Substance is noncombustible.
Extinguishing Media: Use water spray, dry chemical, carbon dioxide, or appropriate foam.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 1

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Use with adequate ventilation. Avoid breathing dust, mist, or vapor. Avoid contact with eyes, skin, and clothing. Keep container tightly closed. Avoid ingestion and inhalation. Discard contaminated shoes.
Storage: Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Water	none listed	none listed	none listed
Sodium hypochlorite	none listed	none listed	none listed

OSHA Vacated PELs: Water: No OSHA Vacated PELs are listed for this chemical. Sodium hypochlorite: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear light yellow green
Odor: chlorine-like
pH: Not available.
Vapor Pressure: 14 mm Hg
Vapor Density: Not available.
Evaporation Rate:>1 (ether=1)
Viscosity: Not available.
Boiling Point: Decomposes.
Freezing/Melting Point:0 deg C
Decomposition Temperature: Not available.
Solubility: Soluble in water.
Specific Gravity/Density:1.1
Molecular Formula: NaOCl
Molecular Weight:74.44

Section 10 - Stability and Reactivity

Chemical Stability: Sodium hypochlorite solutions decompose slowly at normal temperatures releasing low concentrations of corrosive chlorine gas. Decomposition is influenced by temperature, concentration, pH, ionic strength, exposure to light and the presence of metals.
Conditions to Avoid: Incompatible materials, light, combustible materials, heat.
Incompatibilities with Other Materials: Metals, strong reducing agents, strong acids, amines, ammonia, methanol, ammonium salts, phenylacetonitrile, formic acid.
Hazardous Decomposition Products: Hydrogen chloride, chlorine, sodium oxide.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 7732-18-5: ZC0110000

CAS# 7681-52-9: NH3486300
LD50/LC50:
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
.

CAS# 7681-52-9:
Draize test, rabbit, eye: 10 mg Moderate;
Draize test, rabbit, eye: 1.31 mg Mild;
Oral, mouse: LD50 = 5800 mg/kg;
.

Carcinogenicity:
CAS# 7732-18-5: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 7681-52-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information available.
Teratogenicity: No information available.
Reproductive Effects: No information available.
Mutagenicity: No information found.
Neurotoxicity: No information found.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: No data available. No information available.
Environmental: No information found.
Physical: No information found.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	HYPOCHLORITE SOLUTIONS	No information available.
Hazard Class:	8	
UN Number:	UN1791	
Packing Group:	III	

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 7732-18-5 is listed on the TSCA inventory.
CAS# 7681-52-9 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
CAS# 7681-52-9: 100 lb final RQ; 45.4 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 7681-52-9: immediate.
Section 313 No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 7681-52-9 is listed as a Hazardous Substance under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
CAS# 7681-52-9 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
XI
Risk Phrases:
R 31 Contact with acids liberates toxic gas.
R 36/38 Irritating to eyes and skin.

Safety Phrases:
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 37/39 Wear suitable gloves and eye/face protection.
S 50A Do not mix with acids.

WGK (Water Danger/Protection)
CAS# 7732-18-5: No information available.
CAS# 7681-52-9: 2
Canada - DSL/NDSL
CAS# 7732-18-5 is listed on Canada's DSL List.
CAS# 7681-52-9 is listed on Canada's DSL List.
Canada - WHMIS
This product has a WHMIS classification of D2B.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
Canadian Ingredient Disclosure List
CAS# 7681-52-9 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 9/28/1998
Revision #9 Date: 11/19/2008

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Appendix L: Material Safety Data Sheet (Henry Schein Inc.)

HENRY SCHEIN INC. -- SODIUM HYPOCHLORITE - BLEACH -- 6850-00F012205

```
==========  Product Identification  ==========

Product ID:SODIUM HYPOCHLORITE - BLEACH
MSDS Date:01/01/1987
FSC:6850
NIIN:00F012205
MSDS Number: BJBXD
=== Responsible Party ===
Company Name:HENRY SCHEIN INC.
Address:5 HARBOR PARK DRIVE
City:PORT WASHINGTON
State:NY
ZIP:11050
Info Phone Num:(516) 621-4300
Emergency Phone Num:(516) 621-4300
CAGE:64682
=== Contractor Identification ===
Company Name:HENRY SCHEIN INC
Address:5 HARBOR PARK DR
Box:City:PORT WASHINGTON
State:NY
ZIP:11050
Phone:(516) 621-4300
CAGE:64682

==========  Composition/Information on Ingredients  ==========

Ingred Name:SODIUM HYPOCHLORITE  (SARA III)
CAS:7681-52-9
RTECS #:NH3486300
EPA Rpt Qty:100 LBS
DOT Rpt Qty:100 LBS

==========  Hazards Identification  ==========

Routes of Entry: Inhalation:NO  Skin:YES  Ingestion:NO
Reports of Carcinogenicity:NTP:NO    IARC:NO    OSHA:NO
Health Hazards Acute and Chronic:SKIN: PROLONGED CONTACT CAN CAUSE
    CHEMICAL BURN.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SKIN: PROLONGED CONTACT CAN CAUSE CHEMICAL
    BURN.

==========  First Aid Measures  ==========

First Aid:SKIN: REMOVE CONTAMINATED CLOTHING. FLUSH W/WATER. IF BURNED
    CONSULT PHYSICIAN.

==========  Fire Fighting Measures  ==========

Fire Fighting Procedures:NON-FLAMMABLE
Unusual Fire/Explosion Hazard:CONTACT WITH WOOL CAN CAUSE HEAT BUILD-UP
    & RESULTANT BURN.

==========  Accidental Release Measures  ==========

Spill Release Procedures:FLUSH W/WATER. WEAR PROTECTIVE CLOTHING &
```

RESPIRATOR.

========== Handling and Storage ==========

Handling and Storage Precautions:STORE IN COOL, COVERED CONTAINER OF APPROVED MATERIALS. AVOID SPILLAGE & CONTAMINANTS.

========== Exposure Controls/Personal Protection ==========

Protective Gloves:RUBBER, VINYL
Eye Protection:GOGGLES
Other Protective Equipment:PROTECTIVE CLOTHING, RUBBER BOOTS
Work Hygienic Practices:REMOVE CONTAMINATED CLOTHING.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

Boiling Pt:B.P. Text:220F
Spec Gravity:1.210
Appearance and Odor:LIGHT YELLOW WITH CHLORINE ODOR.

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
HEAVY METALS, ACIDS, REDUCING AGENTS, PEROXIDE, AMMONIA, & ORGANIC COMPOUNDS.
Stability Condition to Avoid:HEAT, SUNLIGHT
Hazardous Decomposition Products:CHLORINE & HYPOCHLOROUS ACID

========== Disposal Considerations ==========

Waste Disposal Methods:DILUTE W/WATER.

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Appendix M: Material Safety Data Sheet (Hills Brothers Chemical Co.)

Hill Brothers Chemical Co. -- Sodium Hypochlorite -- -

========== Product Identification ==========

Product ID:Sodium Hypochlorite
MSDS Date:6/17/87
MSDS Number: BVVBX
Kit Part:=== Responsible Party ===
Company Name:Hill Brothers Chemical Co.
Address:1675 No. Main Street
City:Orange
State:CA
ZIP:92867
Country:US
Info Phone Num:714-998-8800
Chemtrec Ind/Phone:800-424-9300
=== Contractor Identification ===
Company Name:Hill Brothers Chemical Co.
Address:1675 No. Main Street
Box:City:Orange
State:CA
ZIP:92867
Country:US
Phone:714-998-8800
CAGE:

========== Composition/Information on Ingredients ==========

Ingred Name:Sodium Hypochlorite
CAS:7681-52-9
Fraction by Wt: 5-15%

========== Hazards Identification ==========

Routes of Entry: Inhalation:Yes Skin:Yes Ingestion:Yes
Reports of Carcinogenicity:NTP:No IARC:No OSHA:No
Health Hazards Acute and Chronic:Ingestion: May cause irritation of the membranes of the mouth and throat, stomach pain and possible ulceration., Inhalation: May cause irritation to the mucous membranes of the respiratory tract., Skin: May cause moderate skin irritation and reddening of the skin., Eyes: May cause severe irritation., Summary of Chronic Health Hazards: Irritating effects increase with strength of solution and time of exposure. NFPA Rating: Health - 2; Fire - 0; Reactivity - 1 0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

========== First Aid Measures ==========

First Aid:Ingestion: Do not give any liquid to an unconscious person. Drink large quantities of gelatin solution or milk. If these are not available, drink large quantities of water. Do NOT give vinegar, baking soda or acidic antidotes. GET MEDICAL ATTENTION IMMEDIATELY. Inhalation: Remove the victim to fresh air at once. Skin: Wash with soap and water, flush with plenty of water. Eyes: Flush with plenty of water for 15 minutes, lifting the lower and upper lids occasionally. GET MEDICAL ATTENTION IMMEDIATELY. Contact lenses should not be worn when working with this chemical.

========== Fire Fighting Measures ==========

Flash Point:Nonflammable
Autoignition Temp:Nonflammable
Lower Limits:Nonflammable
Upper Limits:Nonflammable
Unusual Fire/Explosion Hazard:Heat and acid contamination will produce irritating and toxic fumes. May decompose, generating irritating chlorine gas.

========== Accidental Release Measures ==========

Spill Release Procedures:[Spills may need to be reported to the National Response Center (800/424-8802) DOT Reportable Quantity (RQ) is 100 pounds Ventilate the area of the spill or leak. For large spills, evacuate the hazard area of unprotected personnel. Wear appropriate protective clothing. Dike and contain. Neutralize with sodium sulfite, bisulfite or thiosulfite. Remove with vacuum trucks or pump to storage vessels. Soak up residue with an absorbent such as clay, sand or other suitable material; place in non-leaking containers for proper disposal. Flush area with water to remove trace residue; dispose of flush solutions as above. For small spills, take
Neutralizing Agent:

========== Handling and Storage ==========

Handling and Storage Precautions:Store in vented, closed, clean non-corrosive containers in a cool, dry location away from direct sunlight and not adjacent to chemicals which may react with the bleach if spillage occurs. If closed containers become heated, the containers should be vented to release decomposition products (mainly oxygen under normal decomposition). Do not mix or contaminate with ammonia, hydrocarbons, acids, alcohols or ethers.
Other Precautions:

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:Always use only NIOSH/MSHA-approved respirators with acid type canisters or in the case of a fire use self-contained breathing apparatus.
Ventilation:No special ventilation is required unless bleach is exposed to decomposition conditions, i.e. heat or acidic conditions.
Other Protective Equipment: Avoid contact with the eyes. Wear chemical goggles and/or face shield if there is the likelihood of contact with the eyes. Avoid prolonged or repeated contact with the skin. Wear chemical-resistant gloves and other clothing as required to minimize contact. Safety showers and eyewash fountains should be available in storage and handling areas.
Work Hygienic Practices:All employees who handle sodium hypochlorite should wash their hands before eating, smoking, or using the toilet facilities.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

Boiling Pt:B.P. Text:48-76°C (120-170°F) for 15% (Decomposes)
Vapor Pres:Vapor Density:1
Spec Gravity:1.07-1.26
pH:12

Solubility in Water:100%
Appearance and Odor:Green to Yellow watery liquid with a pungent chlorine odor Physical State: Liquid
Percent Volatiles by Volume:(by volume) Variable-Water plus products of Decomposition
Corrosion Rate:

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:Unstable
Strong acids, strong oxidizers, heavy metals(which act as catalysts), reducing agents, ammonia, ether, and many organic and inorganic chemicals such as paint, kerosene, paint thinners, shellac, etc.
Stability Condition to Avoid:Stability decreases with concentration, heat, light exposure, decrease in pH and contamination with heavy metals, such as nickel, cobalt, copper and iron.
Hazardous Decomposition Products:Chlorine, hydrochloric acid, hypochlorous acid (HOCL). Composition depends upon temperature and decrease in pH. Additional decomposition products which depend upon pH, temperature and time are sodium chloride, sodium chlorate and oxygen.
Conditions to Avoid Polymerization:

========== Toxicological Information ==========

Toxicological Information:Toxicity Data: By ingestion, Grade 1: oral rat LD50=8.91 g/kg IDLH Value: Data not availabe

========== Disposal Considerations ==========

Waste Disposal Methods:Can be neutralized with weak reducing agents such as sodium sulfite, bisulfite, or thiosulfite (DO NOT USE SULFATES OR BISULFATES). Dispose of in accordance with all applicable local, county, state and federal regulations.

========== MSDS Transport Information ==========

Transport Information:DOT Proper Shipping Name: Hypochlorite Solution
DOT Hazard Class/ I.D. No.: 8, UN1791, III

========== Regulatory Information ==========

Federal Regulatory Information:Reportable Quantity: 100 Pounds (45.4 Kilograms) NSF Standard 60 Maximum Use 210 mg/L
State Regulatory Information:

========== Other Information ==========

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Appendix N: Material Safety Data Sheet (Sigma Chemical Company)

SIGMA CHEMICAL COMPANY -- 239305 SODIUM HYPOCHLORITE SOLUTION/CHLORINE 4% MINIMUM -- 6850-00F056266

========== Product Identification ==========

Product ID:239305 SODIUM HYPOCHLORITE SOLUTION/CHLORINE 4% MINIMUM
MSDS Date:01/01/1997
FSC:6850
NIIN:00F056266
MSDS Number: CHMWL
=== Responsible Party ===
Company Name:SIGMA CHEMICAL COMPANY
Address:3050 SPRUCE ST
Box:14508
City:SAINT LOUIS
State:MO
ZIP:63178-5000
Country:US
Info Phone Num:314-771-5765/800-325-3010
Emergency Phone Num:314-771-5765/800-325-3010
CAGE:21076
=== Contractor Identification ===
Company Name:ALDRICH CHEMICAL CO INC
Address:1001 WEST ST PAUL AVE
Box:355
City:MILWAUKEE
State:WI
ZIP:53233
Country:US
Phone:414-273-3850
CAGE:60928
Company Name:FLUKA CHEMICAL CORP
Address:1001 WEST ST PAUL
Box:City:MILWAUKEE
State:WI
ZIP:53233
Country:US
Phone:414-273-3850
CAGE:63181
Company Name:SIGMA CHEMICAL COMPANY
Address:3050 SPRUCE ST
Box:14508
City:ST LOUIS
State:MO
ZIP:63178
Country:US
Phone:314-771-5765
CAGE:21076

========== Composition/Information on Ingredients ==========

Ingred Name:SODIUM HYPOCHLORITE, HYPOCHLOROUS ACID SODIUM SALT
CAS:7681-52-9
RTECS #:NH3486300
EPA Rpt Qty:100 LBS
DOT Rpt Qty:100 LBS

========== Hazards Identification ==========

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:HARMFUL IF INGESTED, INHALED/ABSORBED THROUGH SKIN. EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES & UPPER RESPIRATORY TRACT, EYES/SKIN. INHALATION: FATAL, RESULTING IN EDEMA OF THE LARYNX, B RONCHI, CHEMICAL PNEUMONITIS & PULMONARY EDEMA.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:SPASM, INFLAMMATION, BURNING SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA, VOMITING.

========== First Aid Measures ==========

First Aid:EYES/SKIN: FLUSH W/COPIOUS AMOUNTS OF WATER FOR 15 MINS. INHALATION: REMOVE TO FRESH AIR. GIVE CPR/OXYGEN IF NEEDED. INGESTION: WASH OUT MOUTH W/WATER IF CONSCIOUS. OBTAIN MEDICAL ATTENTION IN ALL CAS ES.

========== Fire Fighting Measures ==========

Flash Point:NONE
Extinguishing Media:DRY CHEMICAL POWDER.
Fire Fighting Procedures:WEAR SCBA & PROTECTIVE CLOTHING.
Unusual Fire/Explosion Hazard:EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

========== Accidental Release Measures ==========

Spill Release Procedures:EVACUATE AREA. WEAR SCBA, RUBBER BOOTS & HEAVY RUBBER GLOVES. ABSORB ON SAND/VERMICULITE & PLACE IN CLOSED CONTAINERS FOR DISPOSAL. VENTILATE AREA & WASH SITE AFTER MATERIAL PICKUP IS COMPLETE.

========== Handling and Storage ==========

Handling and Storage Precautions:REFRIGERATE. DON'T STORE NEAR, NOR ALLOW CONTACT W/CLOTHING & OTHER COMBUSTIBLE MATERIAL. KEEP TIGHTLY CLOSED.
Other Precautions:AVOID CONTACT W/ACID. AVOID PROLONGED/REPEATED EXPOSURE. DON'T GET IN EYES, SKIN/CLOTHING. DON'T BREATHE VAPOR.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:WEAR APPROPRIATE NIOSH/MSHA APPROVED RESPIRATOR.
Ventilation:CHEMICAL FUME HOOD.
Protective Gloves:CHEMICAL RESISTANT
Eye Protection:SAFETY GOGGLES/FACESHIELD (8-INCH MIN)
Other Protective Equipment:PROTECTIVE CLOTHING, SAFETY SHOWER & EYE BATH.
Work Hygienic Practices:REMOVE/LAUNDER CONTAMINATED CLOTHING BEFORE REUSE. DISCARD CONTAMINATED SHOES. WASH THOROUGHLY AFTER HANDLING.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

Vapor Pres:17.5
Spec Gravity:1.097
Appearance and Odor:CLEAR COLORLESS TO PALE-YELLOW LIQUID

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
STRONG ACIDS, ORGANIC MATERIALS, FINELY POWDERED METALS, AMINES,
AMMONIA, METHANOL.
Hazardous Decomposition Products:COMBUSTION: HYDROGEN CHLORIDE GAS,
CHLORINE, SODIUM/SODIUM OXIDES.

========== Disposal Considerations ==========

Waste Disposal Methods:CONTACT A LICENSED PROFESSIONAL WASTE DISPOSAL
SERVICE TO DISPOSE OF, IAW/FEDERAL, STATE & LOCAL REGULATIONS.

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particular situation.

Appendix O: Material Safety Data Sheet (Sultan Chemists Inc.)

SULTAN CHEMISTS INC -- SODIUM HYPOCHLORITE - BLEACH -- 6810-00-900-6276

========== Product Identification ==========

Product ID:SODIUM HYPOCHLORITE - BLEACH
MSDS Date:05/01/1998
FSC:6810
NIIN:00-900-6276
Status Code:A
MSDS Number: CLLCD
=== Responsible Party ===
Company Name:SULTAN CHEMISTS INC
Address:85 W FOREST AVE
City:ENGLEWOOD
State:NJ
ZIP:07631-4001
Country:US
Info Phone Num:201-871-1232
Emergency Phone Num:800-535-5053
CAGE:63536
=== Contractor Identification ===
Company Name:SULTAN CHEMISTS INC
Address:85 W FOREST AVE
Box:City:ENGLEWOOD
State:NJ
ZIP:07631-4001
Country:US
Phone:201-871-1232
CAGE:63536

========== Composition/Information on Ingredients ==========

Ingred Name:SODIUM HYPOCHLORITE
CAS:7681-52-9
RTECS #:NH3486300
< Wt:6.
ACGIH TLV:200MG/M3;8 HR
EPA Rpt Qty:100 LBS
DOT Rpt Qty:100 LBS

========== Hazards Identification ==========

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Health Hazards Acute and Chronic:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.
Effects of Overexposure:CAUSES CAUSTIC BURNS. MAY BE HARMFUL BY INHALATION, INGESTION, OR SKIN ABSORPTION. CAUSES EYE AND SKIN IRRTANT. MATERIAL IS IRRITATING TO MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT.

========== First Aid Measures ==========

First Aid:SKIN AND EYES: FLUSH WELL WITH WARM WATE FOR AT LEAST 15 MINUTES. INGESTION: DO NOT INDUCE VOMITING. DILUTE EITH LARGE QUANTITIES OF MILK OR WATER. INHALATION: REMOVE TO FRESH AIR. IF BREATHING IS DIF FICULT, GIVE OXYGEN. GET MEDICAL ATTENTION.

========== Fire Fighting Measures ==========

Flash Point:NON-FLAMMABLE
Lower Limits:0
Upper Limits:0
Extinguishing Media:NOT REQUIRED.
Fire Fighting Procedures:WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.
Unusual Fire/Explosion Hazard:EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

========== Accidental Release Measures ==========

Spill Release Procedures:FLUSH SMALL AMOUNT TO DRAIN. ADJUST PH TO NEUTRALIZE WITH DILUTE ACIDS FOR LARGE SPILLS. COLLECT AND RETURN LARGE AMOUNTS TO CONTAINER.

========== Handling and Storage ==========

Handling and Storage Precautions:IRRITANT. KEEP TIGHTLY CLOSED. STORE IN A COOL DRY PLACE. WASH THOROUGHLY AFTER HANDLING.
Other Precautions:DO NOT GET IN EYS, ON SKIN, ON CLOTHING.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:WEAR NIOSH/MSHA-APPROVED RESPIRATOR.
Ventilation:LOCAL EXHAUST: FACE VELOCITY 60 FPM. CHEMICAL FUME HOOD. DO NOT BREATHE DUST.
Protective Gloves:CHEMICAL RESISTANT
Eye Protection:CHEMICAL RESISTANT GOGGLES
Other Protective Equipment:SAFETY SHOWER AND EYE BATH.
Work Hygienic Practices:WASH THOROUGHLY AFTER USE.
Supplemental Safety and Health

========== Physical/Chemical Properties ==========

HCC:B1
Boiling Pt:=104.4C, 220.F
Melt/Freeze Pt:=-.8C, 30.5F
Vapor Pres:23 MMHG/25C
Spec Gravity:1.210/25C
pH:11.5
Solubility in Water:MISCIBLE
Appearance and Odor:COLORLESS TO LIGHT YELLOW LIQUID ODOR OF CHLORINE
Percent Volatiles by Volume:93

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
ACIDS AND ACID SOLUTIONS.
Stability Condition to Avoid:CONTACT WITH ACIDS.
Hazardous Decomposition Products:CHLORINE.
Conditions to Avoid Polymerization:WILL NOT OCCUR.

========== Disposal Considerations ==========

Waste Disposal Methods:ADJUST PH TO NEUTRAL. FLUSH THE AQUEOUS SOLUTION DOWN THE DRAIN WITH PLENTY OF WATER. OBSERVE ALL FEDERAL, STATE AND LOCAL LAWS.

========== MSDS Transport Information ==========

Transport Information:PROPER SHIPPING NAME: SODIUM HYPOCHLORITE SOLUTION. HAZARDOUS CLASSIFICATION: CORROSIVE LIQUID. IDENTIFICATION NUMBER:NONE. ADDITIONAL LABELING: CORROSIVE LIQUID.

========== Regulatory Information ==========

SARA Title III Information:THIS PRODUCT CONTAINS THE FOLLOWING TOXIC CHEMICAL SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO- KNOW ACT OF 1986 AND OF CFR 372, SODIUM HYPOCH LORITE: CAS REG NO. 7681-52-9 LESS THAN 6.0%. IT CONTAINS NO OTHER HAZARDOUS INGREDIENTS.

========== Other Information ==========

Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever, expressly or implied, warrants this information to be accurate and disclaims all liability for its use. Any person utilizing this document should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation.

About the Author

Christine Bouchard graduated from the University of South Florida (USF) with a dual Master's in occupational health nursing in May 1999 (MS-Adult Nurse Practitioner, MPH in Environmental and Occupational Health). Immediately after graduation Ms. Bouchard did an 8 week internship at OSHA in Washington, DC. Ms. Bouchard served as Deputy Director of Occupational Health Nursing at USF for 5 years prior to moving to South University, where she served as Nursing Program Director and then Health Sciences Program Director at the Tampa campus. Ms. Bouchard is currently an assistant professor in Health Sciences for South University Online. Ms. Bouchard also works per diem as an Advanced Practice Registered Nurse (ARNP) in occupational health.