BACTERIAL CONTAMINATION OF ELEMENTARY SCHOOL CLASSROOM SURFACE

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Infectious bacteria are all around us at all times. They are on every surface and are microscopic. These microorganisms are the cause of disease among elementary school children. This research analyzes the impact that infectious bacteria have on children in elementary schools. The methods used to obtain the data from desks in elementary schools are microbiology techniques. The bacteria are then cultured and five of the most common infectious bacteria are identified. The purpose of this research is to increase awareness of the amount of microorganisms present on these surfaces. Cleaning solutions should reduce this number and therefore reduce the number of children getting ill.

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Chapter 1

INTRODUCTION

Infectious diseases are one of the main causes of death in the United States (Pruitt, 1994). They add to the already increasing costs of health care as well as take away days from work and school. Too often the focus is on treatment rather than prevention. Most of the infectious diseases, however, can be prevented by simple personal hygiene techniques. The focus of this study is to determine if the cleaning of desks of elementary school students will reduce the microorganisms that have invaded those areas, therefore reducing the number of infectious diseases.

Statement of the Problem

The problem is to determine if cleaning techniques used by teachers can reduce the number of microorganisms growing on students' desks in public elementary schools. The researcher will include in the study a four week long trial period of a control group and an intervention group to determine if hygiene techniques were useful in reducing the bacteria found on the desks. The study will also include microbiology techniques to swab the desks and grow the bacteria cultures to determine what was found on the desks as well as appropriate statistical tests to determine differences in contamination levels.

Purpose of the Study

If cleaning and hygiene techniques reduce the number of microorganisms on students' desks, the rate of infectious diseases may decrease, therefore reducing the number of days absent from school and work. This reduction will allow children to learn better and participate in activities as well as prevent health care costs and loss of income for working parents.

Significance of the Study

Children tend to be more susceptible to bacterial infections because of the modes of transmissions of the bacteria and the child's immune system. The immune systems of children are not as developed as those of adults (Patten, 1992). Therefore, it is easier for the bacteria to enter the body systems of children..

The mode of transmission of bacteria can also aid in the susceptibility of children. Bacteria can be transmitted either by direct contact, by droplet infection, or by inanimate vectors called fomites (Fuerst, 1983). Some common fomites in classrooms would be desks, faucets, and writing utensils. Bacteria are invisible unless seen under a microscope so "you can never really tell where they are and when they are being transmitted from one person to another" (Dashefsky, 1995). Children work very closely with one another during the school day and tend to sneeze and cough without covering their mouths or washing their hands. This is the reason bacterial infections are so contagious. Whenever children touch things that an infected child has touched and then that child does not wash his/her hands, the bacteria are being passed from one child to another. If children wash their hands or teachers wipe off the contaminated desks in classrooms, the risk of the bacteria passing form one child to another is greatly reduced.

There are a few studies that have examined this problem but most of the studies examine child day care centers, not elementary schools. The children in the studies were below the age of 6. The students in this study will be between the ages of 5-12. The problem that the researcher intends to address will deal primarily with the transfer of infectious agents by way of fomites. The studies found in the literature did not deal with this type of transfer. In the Thacker (1992) study, children in the day care setting had a two to four times greater risk of infectious disease than pre-school aged children taken care of in the home setting. This study had two limitations. First, the study could not be

generalized to day-care services in the entire United States due to the rapidly changing and evolving day-care centers. Second, the results may be enhanced relative to other settings which would result in inflated risk estimates (Thacker, 1992).

Mohle-Boetani (1995), attempted to determine (1) if handwashing would control a community outbreak of shigellosis, (2) risk factors in day-care centers, and (3) if shigellosis was attributable to attendance at a day-care center (Mohle-Boetani, 1995).

Another study examined Group A streptococcus bacteria, one of the microorganisms expected to be found in this project. Wheeler (1991) examined this bacteria in children in the general population rather than only the school setting (Wheeler, 1995).

The growing increase of infectious diseases in children is related to an increase in days absent from school as well. With the increasing number of absent children and therefore missed work days for parents needing to stay home with the sick children, an analysis of infectious diseases in the public school setting appears to be necessary.

Infectious diseases account for 25% of all visits to doctors each year (Documents, 1994). Not only are trips to the doctor a result of infectious diseases, but also loss of money in the economy. Over 60% of days absent from work are by parents with sick children at home. "By valuing each day at minimum wage, in 1980, the economic impact of absenteeism associated with illness or injury in a child was $12.7 billion" (Thacker, 1992). In the present study, an effort was made to (1) determine the types of bacteria causing the illnesses in children, and (2) determine if cleaning and hygiene techniques would reduce the number of children acquiring the illnesses.

Delimitations

This study was delimited to the following:

1. One Bryan/College Station elementary school.
2. Five classrooms selected at random.
3. Five student desks within each selected at random.

Limitations

The study was limited to the following factors:

1. The purposive sample is not representative of other classrooms or schools in the state.
2. The children may have obtained the illness from other sources other than the school environment.
3. Teachers may not be consistent in cleaning the desks every day.

Assumptions

The study was based upon the following assumptions:

1. Microorganisms exist on the desks in elementary school classrooms.
2. Infectious bacteria are the cause of certain infectious diseases.

Hypotheses

The study was designed to test the following null hypotheses:

1. There is a relationship between the microorganisms in classrooms and the number of children getting sick.
2. Cleaning the desks will reduce the number of microorganisms present.

Chapter 2

REVIEW OF THE LITERATURE

The literature related to the microorganisms found in classrooms and the effect of these microorganisms is reported in this chapter. For organizational purposes, the literature is presented under the following topics: (1) infectious diseases and the microorganisms that cause them, (2) the immune system of children, (3) absenteeism rates from school and work, and financial costs for the parents, (4) effects of absenteeism on school performance, (5) infectious diseases found in day care facilities and among children, (6) ways to control infectious diseases in schools, and (7) summary.

Infectious Diseases and the Bacteria That Cause Them

Infectious diseases are an important health concern for parents of children, especially for those parents with children who attend public schools. These diseases are defined as the "disruption of a tissue or organ caused by microbes or their products" (Talaro, 1996). They are a serious threat to school children between the ages of 5 and 14 and they are the cause of 5% of deaths for children in this age range (Hardy, 1991). The five leading diagnoses made during visits to doctors are infectious diseases, and account for 40 percent of all office visits for illnesses (Hardy, 1991). According to the Centers for Disease Control and Prevention (1994), infectious diseases are the leading cause of death worldwide. The six most common infectious diseases (repeated ear infection, repeated tonsillitis, pneumonia, frequent diarrhea or colitis, bladder or urinary tract infection, and mononucleosis) have significant effects on children, including: (1) between 29 and 82 percent of affected children were limited in their usual activities in the past year as a result of the illnesses, (2) children with these conditions had from 1.2 to 7.6

bed days per year as a result, (3) the conditions mentioned above resulted in about 2 million school days lost and over 40 million physician contacts per year, and (4) 46-93 percent of children with infectious conditions took medication prescribed by a doctor for the condition (Hardy, 1991).

Infectious diseases are caused by pathogens and they can infect the respiratory tract and the gastrointestinal tract of children. Pathogens are disease causing agents and are transmitted either directly from man to man or by droplets of saliva in the air that fall onto inanimate objects (fomites), such as desks, writing utensils, and faucets, or vectors (Briody, 1974). Portals of entry for the pathogen often include the nose and throat of the respiratory tract. About two-thirds of infectious diseases enter or exit the body by way of the respiratory tract (Briody, 1974). The gastrointestinal tract is also a major concern with infectious diseases. When the disease is restricted to the respiratory or gastrointestinal tracts, the incubation period is usually short (1974). The incubation period of the disease is when the pathogen or infectious agent has invaded the host and normally the host is not symptomatic nor is the disease communicable during this time (Pruitt, 1994). It is for this reason that children pass the pathogens so easily to other children. The children do not show symptoms of the diseases, therefore they do not realize they are sick and are unknowingly contagious to other children, making it difficult to control the disease.

When controlling the infectious diseases that can occur in children of school-age, the key is prevention. One of the major ways for prevention is the disinfection of contaminated materials (Briody, 1974). However, disinfecting the materials comes with certain problems when dealing with the prevention and control of infectious diseases. Some of these problems are biological factors such as short incubation periods of the host, the host is invaded by the pathogen, but is usually asymptomatic. The pathogen

spreading before the observable disease is present is also a problem faced when preventing and controlling infectious diseases (Briody, 1974).

The prolonged survival of the causative agent in nature is another problem when dealing with prevention. Some infectious agents can survive outside of the host for an extended period of time, longer than other infectious agents (Briody, 1974). This is due to the different nutritional needs of the microorganisms and the adaptability of some bacteria to live in certain temperatures while others will die.

There are socioeconomic factors as well that are included in the problems when controlling or preventing infectious diseases. These include such techniques as failure to apply the prevention and control techniques (Briody, 1974). Because there are so many different ways to control the different bacterial agents, it makes it difficult to continue the techniques.

The agents of infectious diseases belong to five groups of organisms, including bacteria, fungi, protozoa, helminths, and viruses (Levinson, 1996). Some common infectious bacteria include *Streptococcus pneumonia, staphylococcus aureus, pneumococci,* and *mycoplasma pneumoniae.* Some infectious diseases that these and other agents lead to include staphylococcal diseases, streptococcal diseases, pneumonia, and many gastrointestinal disorders (Beneson, 1995). These bacteria and diseases can be found in the respiratory and gastrointestinal tract of school-age children.

Respiratory illnesses are one of the main types of infectious diseases found in schools, being described as "the most common acute illness in the United States with an especially high incidence among young children" (Presser, 1988). Infectious diseases of the respiratory tract account for both the "majority of all human illness and the bulk of human infection" (Briody, 1974). The causative agents of respiratory infections are spread from man to man by droplet infection primarily during the late fall, winter, and

early spring, during the period known as the "respiratory season" (Briody, 1974). The portals of entry for respiratory bacteria are the oral and nasal cavities (Talaro, 1996). Respiratory bacteria can infect any one at any time, but the primary victims of the respiratory infectious agents are children, who are then responsible for spreading the infection into the family unit (Briody, 1974). "Young children of school age (5 to 9 years) are adept at acquiring infection in the school environment and transporting it to the home setting where it can spread rapidly to preschool siblings and to adults" (Briody, 1974). Once in the family unit, the infection can spread to other families throughout the community. "With the exception of influenza virus, the causative agents appear to be constantly present and circulating within the community" (Briody, 1974).

Respiratory illnesses fall into two categories, upper and lower respiratory tract infections. Upper respiratory diseases are often caused by *streptococci*, and *mycoplasma* bacterias, while lower respiratory diseases are frequently caused by *mycoplasma*, a common cause of bronchitis in children, and *pneumococci* (Briody, 1974). These bacteria are possibly found in classrooms and can infect school children of elementary age. The respiratory bacteria can cause specific diseases within the respiratory system and often occur in children of school age. They are found on fomites, such as desks, in the classrooms where children attend school. Some of the common infections found in school children are the streptococcal diseases (group A) and pneumonia. Clinical symptoms of the streptococcal diseases include sore throat, fever, skin infections, and cellulitis; the causative agents being *streptococcus pyrogenes* (Beneson, 1995). The clinical symptoms of pneumonia are different from the streptococcal diseases and include chill, fever, dyspnea, cough, and pleural pain. The causative agents are *pneumococci, Mycoplasma pneumoniae*, *Klebsiella pneumonia*, *Moraxella catarrhalis*, *Escherichia coli*, *pseudomonas airuginosa*, *S. pyogenes*, and *H. influenzae* (Beneson, 1995).

Other bacterial agents found in the classroom infect the gastrointestinal tract, which is the portal of entry for many pathogens found in food, drink, and other ingested substances (Talaro, 1996). The most common pathogens that are found in the GI tract include *Salmonella*, *Shigella*, and *E. coli* (Talaro, 1996). Salmonella's clinical symptoms include diarrhea, headache, abdominal pain, nausea, and vomiting with the infectious agents including *salmonella typhimurium* and *salmonella enteritidis* (Beneson, 1995). *Shigella* and *E. coli* also have clinical symptoms of diarrhea, nausea and vomiting. The infectious agents of *Shigella* include *shigella dysenteriae*, *shigella flexneri*, *shigella boydii*, and *shigella sonnei*, while the infectious agents of *E. coli* include several strains of *escherichia coli* (Beneson, 1995). Because the diseases of the GI tract are more related to ingested substances rather than inhaled droplets into the lungs, they are not as commonly found on fomites as the respiratory illnesses, but are more often found in the food that is served in the school cafeterias.

The Immune Systems of Children

Children tend to be more susceptible to bacterial infections because of the ways the bacteria are transferred and the children's immune systems. The main function of the immune system in humans is to prevent or limit infections by microorganisms such as bacteria. This protection is provided by the cell-mediated and antibody-mediated parts of the immune system (Levinson, 1996), The cell-mediated part is directed primarily toward fungi, parasites, and certain intracellular bacteria. It is also involved in killing cells infected with viruses and tumors (Levinson, 1996). The antibody-mediated arm has other functions, including neutralizing toxins and viruses and making bacteria easier to phagocytize (Levinson, 1996).

The immune systems of children are not as developed as those of adults, making

it easier for the microorganisms to enter the child's body without being destroyed or fought off, and eventually allowing the microorganism to cause an illness (Patten, 1992).

A study done by Begovac (1996) found that children are more likely to have group A streptococcus in their throats then adults. In the study, conducted from 1985-1994, 55 patients whose blood cultures showed positive for group A streptococcus were identified. Twenty-seven were children and twenty-eight were adults. The researchers also found that 18 out of the 27 children had respiratory tract infections compared to 3 out of the 28 adults in the study (Begovac, 1996). The fact that infectious diseases are more common in children than adults, combined with the close contact children have throughout the long school day, illustrates why children are more susceptible to infectious diseases. As previously mentioned, infectious diseases also tend to be asymptomatic in the first phase of the disease, the incubation period. The symptoms often go unnoticed, even in an infected child, and the children can pass the bacteria to other children before they even show any symptoms of a disease. In addition to the reasons mentioned above, children are more likely to contract infectious diseases in schools because they have poor personal hygiene and frequently place their hands and other objects in their mouths. They also do not cover their mouths when they cough or sneeze, causing bacteria to spread.

Absenteeism Rates from School and Work and Financial Costs for the Parents

Children are exposed to infectious agents every day in the schools that they attend. Bacteria are everywhere, on desks, faucets, and writing utensils. "The body surfaces are constantly exposed to microbes" (Talaro, 1996). These infectious agents are causing children to become ill and therefore resulting in absenteeism from school. Seventy-five percent of these school absences are health related (Kozinetz, 1995). Acute

health conditions are one of the major reasons for children being absent from school and parents staying home from work to care for them (Klerman, 1988). Acute health conditions are defined as a "type of illness or injury that ordinarily lasts less than 3 months, was first noticed less than 3 months before the reference date of the interview, and was serious enough to have had an impact on behavior" (Klerman, 1988). In 1988, The National Health Interview Survey estimated that health conditions were the cause for 226.4 million days of school to be lost, or 5.0 days per child 5-17 years of age (Klerman, 1988). Efforts to develop prevention measures have been delayed due to lack of "scientific data on the efficacy, practicality, and cost-effectiveness of alternative strategies" (Thacker, 1992). It is apparent form the absence rates that some form of prevention is necessary. From the years 1980 to 1986, school-loss days per person were 29.4 days for acute conditions only (Klerman, 1988). The annual incidence rate per 100 children for certain infectious diseases, such as repeated ear infection, is 8.5 for children ages 5-11. For repeated tonsillitis, the rate is 5.7, 1.4 for pneumonia, 1.7 for bladder or urinary tract infection, 0.7 for diarrhea or colitis, and 0.2 for mononucleosis (Hardy, 1995). The average number of school days lost per child ages 5-11 with certain infectious diseases is 2.9 children with ear infections, 5.2 with tonsillitis, 5.0 with children with pneumonia, 1.6 with children with bladder or urinary tract infections, 2.0 with children with frequent diarrhea or colitis, and 8.4 with children with mononucleosis (Hardy, 1995). Children with mononucleosis and pneumonia have more lost school days than children with other infectious diseases. In total, the number of days lost from the six most common infectious diseases, ear infections, pneumonia, mononucleosis, bladder or urinary tract infections, tonsillitis, and diarrhea or colitis, resulted in a loss of 28 million days of school per year (Hardy, 1995). This is a significant number considering each child only goes to school 180 days out of the year.

Not only do infectious diseases force children to miss days from school, parents must also stay home with a sick child, resulting in lost work days and therefore lost income. At first one might think this is simply a loss of goods and services the worker produces, that is, the daily wage. However, this is minimal considering the amount the organization must put forth for "working employees overtime, reassigning workers from other positions, or hiring temporary employees" (Allen, 1983). This is assuming that the temporary employee or other workers can do the same job with the same results as the original employee. If not, it may result in further loss of money for the organization. "Each parent may be absent from 1 to 4 weeks annually to care for a sick child" (Thacker, 1992). In 1980, 472.1 million days of absenteeism for working parents were the result of an illness or injury. If each day were valued at minimum wage, the economic impact of the absent workers would result in a $12.7 billion loss (Thacker, 1992). However, if the absence rates of working parents fell by one day per year per worker, it would increase income $1.1 billion (Allen, 1983). If children were absent from school one day per year less, this would significantly increase the income of the parents.

Bell, Gleiber, Mercer, Phiffer, Guinter, Cohen, Epstein, and Narayanan (1989), examined the mean monthly cost of illness per child in day care settings, and found that the average cost per month of medical care, including prescription drugs for children in day care settings, mother's day out programs, and multiple child care settings was $32.94 compared with $19.78 for other children. The lost monthly parental income was $72.76, for days per month absent from work for a sick child (Bell, 1989). Children missing school due to infectious diseases is more than just a loss of days from school - the parents have financial costs as well, such as physician, medications, and the working parents missing days from work to stay at home and care for the ill child.

Effects of Absenteeism on Performance

School is the place where children and youth go to acquire the academic and social skills that are necessary to function in the ever-changing world. If they miss an excessive amount of days, then they will not acquire these skills. Excessive school absences reduce the quantity and the quality of the education the child should be receiving. Children can be absent for many reasons. They can have a serious illness which will require a doctor's care. They can have a not-so-serious illness that would allow them to go to school but they will spread the disease in the process. They may also be truant, where the parent is not aware of the child missing school. Illnesses that require a doctor's care and ones that are not that severe are the focus in this study.

Research is being done on the effects of children being absent from school and their achievement in school activities. Achievement is an example of cognitive development and is influenced by the time spent in school (Wolfe, 1985). High correlations were found between absence and performance due to absence from illness (Ohlund, 1994). Absence due to illness, rather than other causes, was more related to the complaints of the individual child and the child was absent more often because of illnesses caused by infectious agents. "Even the simplest health problem may contribute significantly to a child's ability to learn and participate in extracurricular activities" (Kozinetz, 1995). Consecutive absences from school can influence the amount and the intensity of the education the sick child should be receiving.

Wolfe (1985) noted that different types of health problems that the child exhibits will have a different effect on whether or not the child will have a decrease in achievement and therefore an increase in absences from school. If the illness creates concentration problems, then there will be no significant effect on achievement. If the illness interferes with physical activity or the ability to communicate with peers, then the

number of days absent will increase and indirectly decrease achievement. If the illness causes problems with strenuous activities, then there will be a big increase in days absence and indirectly decrease achievement. If the child has problems with ordinary activities, then there will be no effects, but the more often a child is absent from school, the more likely there will be a decrease in achievement.

Ohlund and Ericsson examined 604 children whose absence rates were recorded in first through sixth grades and performance rates recorded in second through sixth grades. According to the study, absence was more frequent in the early years rather than the later years. Also, there were negative associations between performance and absence in second through fourth grades and there were significant correlations in fifth through sixth grades for both verbal and arithmetic performances (Ohlund, 1994). Student absenteeism does appear to be an important indicator in performance. A child who has continual short absences of a few days here and there, has greater difficulty filling in the gaps of the missed lessons. The teacher may not even realize the child is missing so much school (Tyson, 1981). In addition, children who are often sick and miss school because of illness, may be lethargic when they do attend (Wolfe, 1985). This is also contributible to the decrease in performance. Because of the lack of performance, the child may be emotionally unhealthy, weakening the body by causing the immune system to not function at its optimal level and eventually letting microorganisms that cause disease into the body.

A New York study examined the average number of days that students were absent during the year and their resulting standardized test scores. For every three additional days students on average were absent, the percentage of students who pass the test falls by about 1.0 to 2.5 percentage points (Ehrenberg, 1991). This can be compared to the average pass rates on various tests that range from 82 to 93 percent (Ehrenberg,

1991). It can be concluded that excessive student absenteeism does affect the students' performance on standardized tests.

In addition to decreased academic performance, absenteeism also results in limited physical activity. For children ages 5-11 years, the percent of children with selected infectious diseases in the past year who had resulting activity limitation was 52.1 for repeated ear infections, 59.8 for repeated tonsillitis, 87.1 for pneumonia, 71.7 for bladder or urinary tract infection, 38.2 for diarrhea or colitis, and 47.2 for mononucleosis (Hardy, 1995). The decrease in physical activity is another indicator that infectious diseases affect more than the child simply loosing from school.

Excessive school absences have also been linked to school dropout. This link is derived from "the educational implications of missing large amounts of school" (Weitzman, 1992). Absence beyond a certain amount of days makes it very difficult for the student to be taught. Excessive short absences may precipitate or lead to difficulties in school that may, in extreme cases, lead to school failure or dropout (Wietzman, 1992).

Infectious Diseases Found in Day Care Facilities and Among Children

Infectious agents are most contagious in day-care settings and public schools where children are in close contact with one another for hours during the day. Studies suggest that the largest risk factor for children getting infectious diseases in a day-care center is the number of children in the room (Bell, 1989). The number of children in child-care centers has increased dramatically due to the increase in working mothers with children under the age of five. In 1988, 60 percent of children 5 years or younger were placed in child day-care centers (Thacker, 1992). With the increase in children in day-care comes an increase in children with infectious diseases. When a child is less than 6 years old, the day-care center is a risk factor for infectious diseases. Child-care outside

the home increases the risk of children contracting infectious diseases (Presser, 1988). "Placing children for care outside the home, particularly in group care settings and particularly when the children are not toilet trained, may contribute to the spread of infection, whether transmitted by fecal-oral or respiratory means" (Presser, 1988). It is only in day-care centers that a significant amount of contagious children are clustered together. But what types of infectious diseases are found in child day-care centers? The most common illness found in child-care settings are respiratory illnesses. This is the major cause of absence from child care outside the home for children, and results in work loss for parents as well as physician costs (Presser, 1988).

A 1991 study examined an outbreak of *Shigellosis sonnei* in child day-care centers (Mohle-Boetani, 1995). The study examined the control of the outbreak and risk factors that are found in child day-care settings. The cases were not just found in day-care settings, however, but were among elementary school children as well. Out of 219 persons with culture-confirmed shigellosis in the community, all but 37 had some contact with a child who attended day-care centers or an elementary school (Mohle-Boetani, 1995). A staff was soon developed to aid in controlling the outbreak. This group consisted of health department staff from public health clinics, the public health laboratory, the field service section, the school health section, and the environment health division (Mohle-Boetani, 1995). All patients were instructed in hand-washing to decrease the outbreak. Children were instructed to wash their hands when arriving at school, after using the restroom, and before eating lunch (Mohle-Boetani, 1995). Within three weeks, the number of cases of shigellosis decreased dramatically, from 219 cases in January to 42 confirmed cases in June and 10 cases in July. Cases continued at a low rate through November (Mohle-Boetani, 1995). This decrease is due to the children washing their hands after using the toilet. A simple technique, such as hand-washing, can and

does reduce an infection in day-care centers.

Infectious diseases have a possibility of increasing the organisms' virulence. Wheeler, Roe, Kaplan, Schlievert, and Todd conducted a study at the Children's Hospital in Denver, Colorado. The objective of the study was to determine the "epidemiological, clinical, and microbiological features of group A streptococcus septicemia in children" (Wheeler, 1991). The participants in the study were 34 positive blood cultures for group A streptococcus.

The study was done because of an increase in the number of patients with group A streptococcus bacteremia during the early months of 1989 (Wheeler, 1991). The study included all patients with one or more positive blood cultures for group A streptococcus and questionnaires asking parents about potential contacts the children had or common source exposures. The ages of the patients with positive blood cultures for group A streptococcus were between 3 days to 19 years with the average age being 3.8 years. Fever was an accompanying symptom of the bacterial infection with the duration of the fever being 2.0 days (Wheeler, 1991).

The results of this study were significant because of the children with the infectious diseases and the increase in the incidence of the group A streptococcus bacteria. The yearly incidence of the bacterial infection increased significantly from 1980 through 1990 and is possibly due to the increases of the organism's virulence or harmfulness (Wheeler, 1991). Group A streptococcus is one of the infectious agents possibly found on students' desks in elementary schools and is a common cause of sore throat, fever, skin infections, and cellulitis (Beneson, 1995).

As these studies suggest, children who attend day care, or children who are in hospital or elementary school settings, are susceptible to a variety of infectious diseases. For some of these diseases, the child day-care setting may facilitate transmission of the

infectious agent(s). The children then pass the infection to family members, day-care workers, and other children, causing a cycle of illness (Thacker, 1992).

There are four factors that are attributable to children in day-care centers being more susceptible to infectious diseases. First, large numbers of children may be in close and direct physical contact (Thacker, 1992). Children can also be in close contact in elementary schools as well, causing the pathogens to be spread. The second factor is young children often have poor personal hygiene, are incontinent of feces, and continuously place their hands and other objects into their mouths (Thacker, 1992). This problem would be solved if children learn simple hand-washing techniques and are taught not to put anything into their mouths. The third factor is young children are more susceptible to contracting a variety of infectious organisms (Thacker, 1992). This is due to children's underdeveloped immune system as compared with adults. The final reason of why children in day-care centers are more susceptible to infectious agents is children may be highly contagious with the infectious diseases before the onset of symptoms (Thacker, 1992). They are asymptomatic and pass the disease to other children without even knowing it.

The transmission of infectious agents is enhanced by the poor infection control methods of the day-care centers, which may not be equipped to care for the mildly-ill child. "These constraints may be compounded by understaffing, low pay for child-care providers, high rates of staff turnover, and lack of adequate training in infection control" (Thacker, 1992). All of the factors mentioned here can and do contribute to the onset of infectious diseases in children cared for in day-care centers.

The transmission routes of infectious diseases in child day-care settings are grouped in three groups. Two refer to person-to-person contact and the other to droplets in the air. These groups are: (1) person-to-person spread by the fecal-oral route, (2)

person-to-person contact with skin, excretions, or bodily fluids, and (3) transmission by aerosols or respiratory droplets (Thacker, 1992). The types of bacteria that are spread by the fecal-oral route are the main causes of diarrhea. These bacteria include *Shigella, Salmonella,* and *Escherichia coli* (Beneson, 1995). Data indicate that an average of 1.4 to 3.0 outbreaks of diarrhea occur in day-care centers each year (Thacker, 1992). These diseases can spread to family members, then to other schools by siblings, causing an endless circle. The circle can be prevented, however, if proper hand-washing techniques are taught after using the bathroom.

Transmission by aerosols and respiratory droplets is also significant in day-care centers. This type of transmission causes the most common medical problem among children attending day-care centers, acute upper respiratory tract illness (Thacker, 1992). "By age 2 years, children attending day-care centers have an estimated seven or eight episodes of acute respiratory illness per year, an incidence up to 1.6 times greater than among children not attending day-care centers" (Thacker, 1992). Respiratory illnesses are passed more often by this way because of the infectiousness of the disease before the onset of symptoms. In addition to droplets in the air and the asymptomatic part of the disease, fomites and person-to-person contact may also contribute to transmission of respiratory pathogens (Thacker, 1992).

Prevention of respiratory illnesses can be as simple as hand-washing and regular disinfection of toys and other possible fomites (Thacker, 1992). Possible fomites in schools, other than day-care centers, include desks, writing utensils, and faucets.

Ways to Control Infectious Diseases in Schools and Day-Care Centers

There are ways to control infectious diseases and the key to control is prevention of contamination. Day-care centers can not only be the sources of disease transmission,

but also the settings for prevention of disease and control (Mohle-Boetani, 1995). The forms of prevention within day-care centers or schools can be at the child, parent, or staff levels. Addis (1994) recommends that directors of day-care centers or schools should be required to report diarrhea and measles cases to a health agency to increases the awareness of the infectious diseases. This practice is not as widely implemented like some of the other practices, such as drying hands with paper towels. Other practices include the staff washing hands after every diaper change and the diaper changing surfaces being adjacent to sinks and these areas being sanitized after every use (Addiss, 1994). The children have a responsibility as well when developing practices to reduce bacterial agents spread. These include using paper towels to dry hands with and washing their hands after using the toilet (Addiss, 1994). If these techniques are implemented, the number of bacterial agents will decrease, therefore reducing the number of infectious diseases affecting children.

In addition to physical personal hygiene practices for the staff members and the children, educational practices are also a form of prevention. More data are needed on health risks to children to help parents make more informed decisions on the type of care children should receive when it comes to care outside the home (Presser, 1988).

Parents need to be informed when making these decisions and the information should be easily accessible and available. Medical historys of the children should be available as well. Past exposure to respiratory illnesses among children may create an immunity from present exposure and this should be known by the day-care center (Presser, 1988). Parents should also be aware of how infectious their children are. Parents who do not work may notice early signs of their child's illness sooner than employed parents and proceed to medicate the child (Presser, 1988). Also parents who work may send their child back to school while they are still infectious so as to minimize

lost work days for them (Presser, 1988). Parents need to be informed that keeping the child home until the entire infection is gone will reduce the chances that other children will contract the infection.

Another technique for controlling infectious diseases is to pay attention to the environment within the day-care center. Attention needs to be towards the design of the physical environment. For example, one should separate the areas where food is handled from the areas where the toilet is used (Presser, 1988).

Children also tend to not cover their mouths when coughing or sneezing. They need to be educated and taught to apply this technique to prevent respiratory droplets from infecting any one else (Presser, 1988). Applying these techniques or educating children and adults may not eliminate infectious diseases, but they will certainly reduce the number of cases.

Summary

The literature that was reviewed related to the topic of infectious diseases. The majority of the information was applicable. However, much of the information examined infectious diseases within day-care centers and with children below the age of 6. What about children above age 6 and below age 12? What about infectious diseases that occur within elementary schools?

There was only one author that examined the result of an intervention to prevent the pathogens that cause the infectious diseases. Mohle-Boetani (1995), was the only author that considered hand-washing as a form on intervention to determine if this would reduce the number of pathogens that are present. However, this intervention occurred in a day-care center, not an elementary school.

To sum up the information, more research needs to be done in order to formulate

any generalizations concerning students' desks in elementary schools. An intervention of the cleaning of desks and other fomites accompanied by a control group would aid in formulating these generalizations.

Chapter 3

PROCEDURES FOR COLLECTING DATA

The problem of the study was to determine if cleaning techniques used by teachers could reduce the number of pathogens growing on students' desks in public elementary schools. Data were obtained by swabbing the desks and culturing the bacteria on different nutritional media to identify five specific types of disease-causing bacteria. These bacteria include *Streptococcus pyogenes*, *Streptococcus-Enterococcus*, *Staphylococcus aureus*, *E. coli* or other gastrointestinal bacteria, and *Pseudomonas*. The methods of the study are arranged in the following organizational steps: 1) arrangements for conducting the study, 2) selection of subjects, 3) procedures for testing and gathering data, and 4) treatment of data.

Arrangements for Conducting the Study

The study was conducted in Sam Houston Elementary School located in Bryan, Texas. The objectives, purposes, and details of the study were presented to the principal of the school. The selectoin of the school used in the study was based upon the following facts: (a) contacting the Bryan Independent School District head office and obtaining permission from them; (b) contacting Sam Houston Elementary School and obtaining permission from the principal; and (c) obtaining a sufficient number of classrooms within the school. Arrangements with the housekeeping personel of the school were also made in order to conduct the research within the school and determine the materials and methods used to clean the desks. The desks were all cleaned prior to the beginning of the study. Consulting with the principal and the housekeeping personnel resulted in the approval for conducting the study. The head office and the principal were also consulted

when determining appropriate times in which to gather the data that did not interfere with special schedules and school events. The classroom numbers and names of teachers were obtained to aid in organizing the data.

Selection of Subjects

Once permission from the principal was obtained, classrooms in which to conduct the study were selected. Ten classrooms were selected at random within Sam Houston Elementary School. Once the classrooms were selected, five student desks were then selected, also at random. These criteria were selected to be the instruments on which the data for the study will be collected. This school was selected because the principal volunteered her school and because of other previous problems the school has had with mold and other microorganisms.

Procedures for Testing and Gathering the Data

Once permission was obtained and the classrooms were selected, the data were then gathered. Materials used to obtain the data included 50 test tubes filled with thioglycollate broth, a common medium for culturing microorganisms, 50 sterile cotton swabs, and sterile water. Procedures included labeling the test tubes by teacher name and number of desk, placing a numbered sticker on each desk to identify the desk, dipping the swabs in the sterile water, swabbing the desks, and placing the swabs into the thioglycollate broth test tubes according to the organizational procedures. The desks were swabbed five times horizontally and then five times vertically. The tubes were then transported to the microbiology lab at Texas A&M University and placed in an incubator for 24 hours.

Once the tubes were incubated for 24 hours, blood and MacConkey nutritional

media were used to grow the results of the data collections from the desks. Tryptic Soy Agar (TSA) media was also used to obtain total numbers of bacteria. The spread-plated technique was used on the TSA media and the streak-plate technique was used on the blood and MacConkey media. The spread-plate technique is a method for spreading the bacteria on a plate in which a small volume of dilute bacterial mixture containing 100 to 200 cells or less is transferred to the center of an agar plate and is spread evenly over the surface with an L-shaped rod that has been sterilized by dipping it in alcohol and flaming it to burn off the alcohol (Talaro, 1996). The streak-plate technique is a method in which the bacterial mixture is transferred to the edge of an agar plate with an inoculting loop and then streaked out over the surface in a pattern where the bacteria cultures can be isolated (Talaro, 1996). The blood meda was used to identify *Staphylococcus aureus* and other gram (+) cocci while the MacConkey media would only allow gram (-) gastrointestinal bacteria to grow. The media were streaked to isolate colonies. These plates were then incubated for 24 hours

After the plates were incubated for the specified 24 hours, the bacteria cultures that were isolated due to the streak technique and grown on the blood plates were placed onto microscope slides for gram staining. Each culture was placed onto a labled slide, dried to it using heat, and then dipped into the primary dye (crystal violet), the mordant (iodine), decolorizer, and the counterstain (safranin). Each slide was then viewed under a microscope for stain results and shape of the bacteria.

Once the gram stain results and the shape of bacteria were determined, the gram (-) and the gram (+) cocci and rod bacteria were run through an assortment of secondary tests to distinguish if certain bacteria were present. A catalase test was used to distinguish between *Staphylococcus* and *Streptococcus* gram (+) bacteria. If the test was positive, *Staphylococcus* was present and if it was negative, *Streptococcus* was present.

Once these results were determined, the catalase positive bacteria were given a manitol salts agar test (MSA) to distinguish between pathogenic and nonpathogenic *Staphylococcus*. The positive MSA tests results in a pathogenic *Staphylococcus* and a negative MSA test results in nonpathogenic *Staphylococcus*. The positive MSA tests were given a coagulase test to identify *Staphylococcus aureus*. A positive coagulase tests would result in *Staphylococcus aureus*.

The catalase negative bacteria were given the Bile Esculin test (BEA) to distinguish between the two varieties of *Streptococcus*: *Enterococcus* and *Pyogenic*. The hemolysis on the blood media growth were also used to distinguish between these two bacteria. A positive BEA test results in *Streptococcus-Enterococcus* and a negative BEA test results in a *Streptococcus pyogenes*.

The gram (-) rods would also be given certain tests to identify if certain bacteria were present. The oxidase test will distinguish certain enteric bacteria. A positive oxidase bacteria will be given the Triple Sugar Iron test (TSI), which, if nonfermentive, results in the assumption that *Pseudomonas* is present.

An oxidase negative bacteria and a fermentative TSI test results in enteric or gastrointestinal bacteria.

The bacteria that grows on the tryptic soy agar media will be counted and recorded to determine total numbers of bacteria that are present on the desks.

Once all the data are collected, they will be analyzed according to the different tests that are run and the bacteria will be identified.

The same data collecting procedures and tests were conducted four weeks later after the housekeeping staff had cleaned half the desks and did not clean the other half. However, the desks were swabbed after school where children had exposed them to new bacteria whereas the original swabbing was done on a holiday where the children had no

contact with them. The germicidal detergent, Tor, was used to clean the group of 25 desks that were in the intervention group. The detergent contains 1.6% ammonia chloride, 1.6% R-alky, and 96.8% of a cleaning ingredient. Paper towels were used to spread the detergent once it had been sprayed on the desks.

Treatment of the Data

To test the hpothesis that there is a significant decrease in the number of microorganisms growing on elementary school desks, a comparison analysis for the pre- and post-test results will be conducted. Also, pie charts using percentages will be used to compare the amount of growth on the desks of the five organisms that the study is interested in.

Chapter 4

ANALYSIS OF DATA AND DISCUSSION OF RESULTS

The problem of the study was to determine if cleaning techniques used on elementary school desks would reduce the number of microorganisms growing on these surfaces. An intervention group of desks that were cleaned everyday for a month and a control group that were not cleaned were included in the study.

Two null hypothesis were tested in the study. The hypotheses are:

1. There is a relationship between the microorganisms in classrooms and the number of children getting sick.

2. Cleaning the desks will reduce the number of microorganisms present.

Data were collected from one elementary school at two different times throughout a four week trial period that included a control group and an intervention. The control group consisted of desks that were not cleaned daily and the intervention group consisted of desks that were cleaned daily. The data were compared with a pre-test and a post-test.

The study included culturing the bacteria that were found and specifically identifying five of the most common types of bacteria that cause illness in children in elementary schools. These bacteria include two types of *Streptococcus*: *Enterococcus* and *Pyogenic*, *Staphylococcus aureus*, *Enterics*, and *Pseudomonas*.

In the pre-test intervention group, the *Enterococcus* variety of *Streptococcus* were found on 4% of the fifty desks that were swabbed. *Streptococcus pyogenes* were found on 8% of the fifty desks and the *Enterics* were found on 2% of the fifty desks. *Staphylococcus aureus* and the *Pseudomonas* were not found in the pre-test intervention group.

Control group findings for the pre-test were similar. The *Enterococcus* variety of

Streptococcus were found on 8% of the fifty desks, the *Pyogenic* variety were found on 2% of the fifty and the *Staphylococcus aureus* were found on 2% of the fifty desks. *Pseudomonas* and *Enterics* were not found on the desks for the control groups pre-test.

The post-test data were collected four weeks after the original swabbing of the desks and where the intervention group of twenty-five desks were cleaned on a daily basis. The *Enterococcus* variety of *Streptococcus* were found on 8% of the fifty desks. The *Staphylococcus aureus* were found on 4% of the fifty. *Pseudomonas* were found on 2% of the fifty desks and *Enterics* were found on 10% of the fifty desks. *Streptococcus pyogenes* were not found on any of the desks during the post-test.

The control group post-test data were also collected and the findings were similar to the intervention group findings. The *Enterococcus* variety of *Streptococcus* were found on 10% of the fifty desks. *Streptococcus pyogenes* were found on 2% of the fifty desks, and the *Staphylococcus aureus* were also found on 2% of the fifty desks. *Enterics* were found on 10% of the fifty desks and *Pseudomonas* were not found on any of the desks during the post-test for the control group.

At pre-test, the *Streptococcus* variety *Enterococcus* were found on 24% of the desks and *Streptococcus pyogenes* were found on 25% of the desks, *Staphylococcus aureus* were found on 4% of the desks, *Pseudomonas* had 0 growth, and *Enterics* had 4% of the desks covered.

At post-test, the *Streptococcus* variety *Enterococcus* were found on 36% of the desks, *Streptococcus pyogenes* were found on 4% of the desks, *Staphylococcus aureus* had growth on 12% of the desks, *Pseudomonas* had 4% of the desks covered, and *Enterics* had growth on 40% of the desks.

In addition to the percentage of the specific organisms that were found on the desks, data were analyzed according to how many out of the five desks that were

swabbedhad some type of pathogen growing on them. In the control group pre-test, 2 of the 5 classrooms had growth on all of the desks that were swabbed. One of the classrooms had growth on 4 out of the 5 desks that were swabbed and two of the classrooms had growth on 3 out of the 5 desks. All of the pathogens that were found on these desks were not identified because the study is only interested in the five specific pathogens that are known to cause illness in elementary school children.

In the intervention group pre-test, 2 out of the 5 classrooms had growth on all of the desks that were swabbed.two of the classrooms had growth on 4 out of the 5 desks that were swabbed and in one of the classrooms there was growth on 3 out of the 5 desks.

In the control group post-test, 3 out of the 5 classrooms had growth on all of the desks that were swabbed. In two of the classrooms there was growth on 3 out of 5 desks that were swabbed.

In the intervention group post-test, 4 out of the 5 classrooms had growth on all of the desks that were swabbed. In one of the classrooms, there was growth on 4 out of the 5 desks that were swabbed.

In addition to the pathogen count that was present on the desks, a test was conducted to determine total numbers of bacteria, whether the specific microorganisms the study was looking for or any other type of bacteria that were present on the desks that were swabbed. For the pre-test, dilutions were made at 10-5. Despite the dilution, the majority of the samples yielded counts that were too many to count in both the control and intervention groups. Dilutions for the post-test data were made at 10-7. The majority of the desks in this group had below a hundred bacteria cultures present on them. Nevertheless, the problems and pre-test dilutions precluded conducting parameter pre- and post-tests.

Discussion of Findings

The results from the pre- and post-tests do not support the hypothesis which states that cleaning techniques would reduce the number of microorganisms that are present on elementary school desks. Despite the fact the hypothesis was not supported, there were a significant amount of bacteria present on the desks in the elementary school that was studied. For the overall pre-test, 24% of the desks had the *Enterococcus* variety of *Streptococcus* present on them, 25% had *Streptococcus pyogenes* present, 4% had *Staphylococcus aureus* present, and 4% of the desks had *Enterics* present on them. For the post-test, 36% of the desks studied had *Streptococcus-Enterococcus* present on them, 4% had *Streptococcus pyogenes* present, 12% had *Staphylococcus aureus* present, 4% had *Pseudomonas* present on them, and 40% of the desks had *Enterics* present on them. So despite the fact that the hypothesis did not result in a positive, there was still a significant amount of growth of infectious bacteria present on the elementary school desks that were studied.

Other studies that have been done have also found a significant amount of microorganisms on the surfaces that were studied. These other studies, however, were not found to include elementary schools. They were mainly concerned with day-care centers and hospitals. The children in these studies were below the age of 6 and were susceptible to different types of illnesses that are not found in elementary schools. The children in this study were between the ages of 6 and 12 and were susceptible to certain types of respiratory and gastrointestinal diseases.

One interesting fact found in the study was the amount of total bacteria growing on the surfaces. In the pre-tests, the majority of the numbers were too many to count. In other words, there were so many microorganisms present that they were not able to get an exact number. In the post-test, most of the surfaces had less than 100 colonies present,

however, they had to be diluted several times to get the exact numbers.

Even though the study focused on 5 specific types of infectious bacteria, others were identified as well. In the pre-test results, *Staphylococcus saprophyticus* was found to be present. This bacteria may be responsible for urinary tract infections, especially in females. In the post-test results, the familiar infectious *Pneumonia* was found to be present. *Staphylococcus saprophyticus* was also present during the post-test.

The desks were supposed to be cleaned every day. However, there were still many microorganisms present four weeks after the original swabbing and after the desks had been cleaned with a germicidal agent. Gemicidal means killing, not stopping. Even the control group, which were supposed to be cleaned every day, had numerous microorganisms present four weeks after the original swabbing. Despite the cleaning, there were still numerous disease-causing microorganisms present on the elemenatary school desks. School children are exposed to these infectious agents every day when they lay their heads down on their desks or touch their desks with their hand and then placing their hands in their mouth without washing them first.

Despite the fact that the hypothesis was not supported by the results, there were still numerous infectious bacteria present on the elementary school desks. Children are exposed to these disease-causing agents every day. They are exposed, become sick, miss school, spread the disease, and come back to school having to make up the work that they missed while absent. Even though the hypothesis was not proved to be true, this report has increased awareness of what types of microorganisms elementary school children are exposed to every day in the schools that they attend. These microorganisms cause many types of respiratory and gastrointestinal infections. If increased awareness will help the cleaning of the desks improve as well as improving the education of the children in certain hygiene techniques, such as washing their hands and covering their mouths when

they cough or sneeze, then the study has been successful.

Chapter 5

SUMMARY, FINDINGS, CONCLUSIONS, IMPLEMENTATIONS, AND RECOMMENDATIONS

Summary

The problem of the study was to determine if cleaning techniques used on elementary school desks would reduce the number of microorganisms growing on these surfaces. Control and intervention groups were included in the study. The control group consisted of 25 desks in an elementary school that were not to be cleaned for four weeks. The intervention group consisted of 25 desks in an elementary school that were to be cleaned for a period of four weeks. Also included were microbiology methods that were used to swab the desks in the elementary school and transport the data to a microbiology lab. In the lab, several tests were run on the data to determine if 5 specific types of bacteria were present on the surfaces in the elementary school. These bacteria included two forms of *Streptococcus*: *Enterococcus* and *Pyogenic*, *Staphylococcus aureus*, *Pseudomonas*, and *Enterics*.

The surfaces from which the data were collected for the study consisted of 50 desks in an elementary school in Bryan, Texas. The desks were selected at random from 10 classrooms-5 desks from each classroom. The classrooms were also selected at random. The data were collected during the months of February and March, 1997.

The data were analyzed by comparing pre and post intervention bacteria counts.

Findings

The analysis of the data revealed the following significant findings:

1. The cleaning techniques used by the housekeeping staff to kill the bacteria

were apparently not effective in reducing the number of microorganisms present on the elementary school surfaces.

2. The five types of bacteria, two varieties of *Streptococcus*: *Enterococcus* and *Pyogenic*, *Staphylococcus aureus*, *Pseudomonas*, and *Enterics*, were all present on the surfaces. Other types of infectious bacteria were also found to be present on the surfaces.

3. There were significant colonies present on the growth medium that was used to count total numbers of bacteria. Many of the plates had so much growth that there were too many to count.

Conclusions

Within the limitations of the study the following conclusions are warranted:

1. Significant numbers of microorganisms are present on children's desks in the elementary school classrooms in this study.

2. Certain infectious bacteria that cause respiratory and gastrointestinal diseases are present in elementary schools.

3. Not all cleaning solutions are effective in killing the microorganisms.

4. The methods used to clean the desks may not have been effective techniques.

Implementations

The findings of the study may be implemented into either a professional practice situation or a research setting in the following ways:

1. If keeping elementary school children healthy, which allows them to attend school to their fullest, is a major goal for parents and staff of the schools, then awareness of the types of disease-causing agents that are present in the schools will be of significance. The children can be educated on hygiene techniques in order to decrease

the number of children who are infected.

2. The study can be used in any setting, other than an elementary school, to increase awareness of the infectious bacteria that are present. For example, the study could be increased to include high schools, universities, or the work environment. Increasing awareness may indirectly increase hygiene techniques, such as washing hands and covering mouths when sneezing, that will decrease the number of people who are infected by the disease-causing agents.

Recommendations for Further Study

The following recommendations are made for further research in the subject of infectious microorganisms in elementary schools:

1. The present study should be extended to include a longer time period in between the original data gathering and the follow-up.

2. The study should include common viruses, molds, and fungi in the identification of the microorganisms.

3. The cleaning of the surfaces needs to be more consistent and more control needs to be exerted over the methods and techniques used to clean the surfaces as well as the types of cleaning solutions used. For example, was the solution a bactericide, which destroys bacteria, or was it bacteriostatic, which simply prevents the growth on objects in the environment.

4. The time to do the study needs to not include a week of vacation in which the desks in the intervention were not cleaned on a daily basis.

5. The study needs to include more than one elementary school and more than 50 desks to get a more accurate reading of the types of bacteria present.

6. The study should include actual counts of the number of children absent

during the time of cleaning. Absentee rates need to be taked before and after the collection of the data to determine if the cleaning methods were useful in decreasing the number of children that are getting sick from the infectious bacteria.

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