1958

A comparison of a stroke handwashing technic with ordinary handwashing methods for the removal of Escherichia Coli

Eckel, Helen Elizabeth
Boston University

http://hdl.handle.net/2144/6446
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A COMPARISON OF A STROKE HANDWASHING TECHNIC WITH
ORDINARY HANDWASHING METHODS FOR THE REMOVAL OF ESCHERICHIA COLI

BY

Helen Elizabeth Eckel
(Bachelor of Arts, Douglass College, 1956)

A field study submitted in partial fulfillment of the requirements
for the Degree of Master of Science
in the School of Nursing
Boston University
August, 1958

First Reader: Lucille M. Sommermeyer
Second Reader: Ernest H. Blaustein

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ACKNOWLEDGMENT

The writer wishes to express her appreciation for the assistance given in the preparation of this study by Lucille Sommermeyer, Assistant Dean of the Boston University School of Nursing and to Dr. Ernest Blaustein, Professor of Biology, College of General Education, for the critical reading of the paper.

Appreciation is also expressed to the graduate nurses, nursing students, and to others who participated in making this study possible.

This study was supported (in part) by a training grant, U.S.P.H.S. MT-52, from the Division of Nursing Resources, Bureau of Medical Services, U.S. Public Health Service.
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CHAPTER I
INTRODUCTION

Statement of the Problem

Routine handwashing is a basic nursing procedure which is so commonplace that it often receives little attention either in practice or in research.

This study is an evaluation of a stroke handwashing technique for the removal of *Escherichia coli* using phisoderm* and phisohex* as compared with ordinary handwashing techniques used by nursing students.

The purposes of the study may be stated as follows:

1. To evaluate a stroke handwashing technique for the removal of *E. coli* by comparing it with handwashing methods ordinarily used by nursing students.

2. To compare the effectiveness of phisoderm and phisohex for the removal of *E. coli*.

3. To determine the location of organisms which remain after handwashing by plotting the location of the colonies on outlines of the hands.

4. To determine from which hand right-handed and left-handed subjects remove more transient organisms.

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2. Manufactured by Winthrop-Stearns, Inc.
5. To evaluate the results and determine a technic of handwashing which could be studied in practical situations such as the newborn nursery involving contamination with enteric organisms.

**Justification of the Problem**

Bacteriologically, hands are considered mechanical means for the transmission of disease. Food and milk supplies may become polluted from the hands of careless food handlers who are carriers of potentially pathogenic organisms. Washing the hands after defecation and urination is only a partial safeguard against disease transmission in this manner.²

In the nursery, the newborn seems susceptible to organisms which may not be pathogenic to adults and older children. Clifford³ states that epidemics of diarrhea have been traced to carriers in nursery personnel. Any infant who is fed milk or fluid from a bottle is peculiarly vulnerable to infection because the person who feeds him and handles the nipples also handles diapers and infant's excreta. Infection by the fecal-oral route may be evidence of faulty handwashing technic.

An epidemic of gastroenteritis in the newborn with a high mortality rate was reported by McClure.⁴ Although the source of the organism was not traced, the epidemic was associated with *Escherichia coli*, type III, B₄.

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The pathogenicity of *E. coli* in their natural habitat, the gastrointestinal tract, is considered very slight, but frequently certain types of these bacteria are associated with intestinal outbreaks of infant diarrhea.

Neter et al. recovered two serotypes of *E. coli* (O111 and O55) from the feces, nasopharynx, and throat of sporadic cases of diarrhea of infants. Epidemiological, clinical, and bacteriological data presented by Neter et al. showed that contact with and multiplication of these types of *E. coli* may be followed by an attack of diarrhea, indicating that these organisms may be considered a cause of this disease.

*E. coli* is a gram-negative, non-sporeforming, aerobic but facultatively anaerobic, non-branching rod. Its motility varies greatly in different cultures. The growth requirements are simple, requiring a temperature between 20° and 40° and a pH of 6.5 - 8.0 on media such as simple peptone solutions or extract agar. *E. coli* is an inhabitant of the gastrointestinal tract and can be a potential pathogenic organism. *E. coli* is used as an indicator of fecal contamination of water supplies in the United States. Strains of this organism have been known to cause diarrhea in infants and, on the hands of food handlers, this organism can be transmitted to food and water. For the reasons cited, *E. coli* was used as the test organism in this study.

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6Ibid. p. 1495.

Scope and Limitations

The participants in this study were basic nursing students enrolled in the science course entitled Human Ecology at Boston University School of Nursing. A total of fifteen nursing students was involved in this study.

At the time this study was begun, all the nursing students had completed the study of bacteriology and had also had instruction in nursing fundamentals, including the procedure for handwashing. Their experience on the wards was limited to two to six hours a week over a period of seven months.

Six graduate nurses in the bachelor's degree program at Boston University School of Nursing volunteered to participate at the request of the writer at a time when it was felt that the nursing students were not being realistic in doing their handwashing in this study as compared with handwashing usually observed in the average hospital ward. In a survey of handwashing conducted by Pfefferkorn, it was concluded that the pressure of work may be a very positive cause in preventing the carrying out of good technique.

This study was carried out in the laboratory where there was no element of pressure to shorten the period of time or change the manner in which the nursing students would carry out the procedure to remove the test organism, E. coli, from their hands. The students were also aware of the specific test organism, and because the name of the organism elicited a response of distaste, they seemed to wash their

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Pfefferkorn, op. cit., p. 353.
hands more diligently than if they had just emptied a bedpan or changed a diaper.

The presence of the investigator made the subjects more aware of their handwashing procedure. In either the laboratory or the actual clinical situation, the presence of an investigator would affect the handwashing technique used by the subjects.

Although the nursing students were instructed to wash their hands as they ordinarily would in a clinical situation, the laboratory conditions did not simulate the former situation with conditions of pressure, time, and the fact that contamination of the hands on a hospital ward is not labelled. This was felt to be a limiting factor.

**Definition of Terms**

**Stroke handwashing technique:** this is a handwashing technique which is based on a numerical count (1-20) using a detergent with friction and a rotating motion. Stroke 1: beginning at the thumb side, apply friction on the dorsal side of the hand with the opposite hand by moving forward to the thumb. Grasp the thumb, rotating it, and return to the dorsal side of the hand with the open hand applying friction. Stroke 2: beginning at the wrist, cover the dorsal side of the hand with friction from the opposite hand, move toward the first finger, grasp it with a rotating motion, and return to the dorsal part of the hand applying friction with the open hand. Strokes 3-5 cover the dorsal surface of the hand and fingers. Strokes 6-10 cover the palmar surface of the hand and fingers. Strokes 11-20 are carried out in the same manner as 1-10 on the opposite hand.

**Transient organisms:** organisms which are not ordinarily found
on the skin or part of the normal flora.

Ordinary handwashing technic: procedure used by nurses to wash their hands.

**EMB agar**: eosin-methylene-blue agar. The abbreviated form will be used throughout this paper. It was used as the medium in this study because *E. coli* colonies usually show a dark center and have a greenish metallic sheen which aids in identification. EMB agar is also inhibitory to the growth of gram-positive organisms.

**Preview of Methodology**

The data for this study was collected in the laboratory over a period of four weeks. The study was divided into four parts. The first two parts were controls measuring the effect of ordinary handwashing methods using pHisoderm and pHisohex to remove a twenty-four hour culture of *E. coli* from the hands. The third and fourth parts were the experimental phase using the stroke handwashing technic with pHisoderm and pHisohex to remove a twenty-four hour culture of *E. coli* from the hands.

All hand cultures were done on EMB agar because it is a selective media for *E. coli*. Only palmar surfaces of the hands were cultured, and all plates were read in forty-eight hours. A record on outlines of the hands was kept in order to study the weak areas in handwashing. Records were also kept of right-handedness and left-handedness to determine whether this had an effect on handwashing.

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9**Difco Manual**: of Dehydrated Culture Media and Reagents for Microbiological and Clinical Laboratory Procedures, p. 34.
Sequence of Presentation

Chapter Two will offer a brief review of some of the literature available and the statement and basis of the hypothesis. Chapter Three will contain a description of the sample and the methodology used to collect the data. Presentation and discussion of the data will be in Chapter Four. In the concluding chapter, the summary, conclusions, and recommendations will be offered.
CHAPTER II
REVIEW OF LITERATURE

The Escherichia-Aerobacter (coliform) group is used as the indicator of pollution of water supplies in the United States. Detection of any fecal bacteria in water supplies is important in determining its suitability for drinking. Because of the occurrence of the Escherichia-Aerobacter group of organisms in feces, the presence of members of this group is used as an indicator of fecal pollution of water.

Some varieties of E. coli have been reported to be pathogenic. McClure reported an epidemic of gastroenteritis in newborn infants with a high mortality rate and attributed it to the variant Escherichia coli, Type III, B1. Neter et al also found evidence that serotypes of E. coli will cause diarrhea in infants.

E. coli was used as the contaminating organism in this study because its presence in water is an indication of fecal contamination, and a review of the literature revealed that strains have been indicted in outbreaks of infant diarrhea.

The Levine EMB agar is recommended by the American Public Health Association for confirmation of presumptive tests of members of the coliform group. The organism, E. coli, was used as the test organism

and because its presence was known, it did not seem necessary to do
the presumptive tests for the presence of E. coli. Dehydrated Levine
EMB agar as prepared by the Difco Laboratories Inc. was used as the
medium in this study. The E. coli colonies can easily be detected
on EMB agar by two criteria.

1. Plates contain the dyes, eosin and methylene blue, which
inhibits the growth of gram positive organisms.
2. Lactose acidification which occurs in the EMB agar beneath
the colonies turns the dyes in the agar a red, blue, or purple
color in and around each colony. There is also a metallic
sheen which aids in recognition.

This is a qualitative test and only estimates of the numbers of coli-
form organisms can be made.

The literature reveals few studies in routine handwashing, i.e.
studies concerned with handwashing in situations other than the surgical
area or the area of communicable disease technic. The primary hand-
washing studies have been done in the area of the surgical scrub.

In 1938, Price developed a quantitative method for the study of
bacterial flora of the skin. This work by Price has led many inves-
tigators, especially surgeons, into reevaluating handwashing. It is

5Difco Manual, p. 34.
6Probisher, Fundamentals of Microbiology, p. 475.
7Ibid., p. 476.
8Price, P. B., "The Bacteriology of the Normal Skin: A New Quantitative
Test Applied to a Study for the Bacterial Flora and the Disinfect-
ant Action of Mechanical Cleansing", The Journal of Infectious
Diseases, 63:307, November-December 1938.
9Ibid., pp. 301-303.
known that the normal flora contains both resident and transient organisms. The latter are more abundant on exposed skin such as the hands, and since these are collected from extraneous sources, there is no limit to the varieties both pathogenic and non-pathogenic. 10

Walter 11 advocates disinfecting the skin for surgery by using a habitual anatomic scrub which covers every area of the skin rather than upon an arbitrary period of scrubbing because the effectiveness of individual scrubs varies tremendously.

Benson 12 developed a handwashing procedure which has proved effective in controlling the spread of infection and reducing the incidence of skin irritation. The technic consists basically of a one to two minute handwashing with Phisohex without a brush but utilizes the principles of mechanical motion, friction and rinsing. An analysis of the data by Benson indicated that the cross infections which did occur could be attributed to causes other than transmission of organisms by the hands. These cross infections had been restricted to three occurrences of illness spread by respiratory secretions. These included one case of measles with a well-known exposure by direct contact, five cases in one outbreak of Type III adenoidal, pharyngeal conjunctival virus respiratory infection traceable to a patient not in isolation before the onset of the disease, and two cases of a virus

10 Ibid., p. 307.
caused respiratory disease which was traced to a similar direct contact with a patient just before development of symptoms of this infection. No bacteriological studies were done concurrently with this study.

Using the investigative technic developed by Price, Allers et al. studied a rapid aseptic scrub technic using phisohex. The results showed that phisohex lowered bacterial flora more than ordinary soap. No differentiation was made between transient and resident flora. The investigators recommend using phisohex for a ninety-second scrub when first coming on duty in the nursery and at all other times simply washing the hands with phisohex. In this study, the number of bacteria which the subject removed from the hands was measured but not the type of bacterial organisms.

In a study by Sommermeyer, conducted in the nursery, the hands of twenty-eight nursery personnel were cultured for E. coli before and after diaper changes using phisohex and ordinary handwashing. Sixteen positive E. coli plates were obtained. This study was compared with Ivory soap, and there was no significant difference in positive plates. It is interesting to note that simply washing the hands with phisohex between diaper changes did not in all cases free the hands of E. coli.

A field in which there have been many studies with little common

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13 Price, op. cit., pp 301-312.
15 Sommermeyer, Lucille, personal communication.
agreement has been the choice of a soap or detergent used in cleansing
the skin.

Hatfield and Lockwood\textsuperscript{16} have established basic criteria which
should be met by any agent and/or method for adequate preoperative
preparation of the skin. These are:

1. effective against resident and transient flora
2. surface tension low enough to allow maximum contact with the
surfaces of the skin
3. be effective against organic material including soap
4. non-irritating to the skin
5. have an action which accomplishes more than a mere formation
of a protective film around skin under which bacteria can multiply
6. inexpensive.

Medrick and Litsky\textsuperscript{17} in reviewing the literature revealed that
phisoHex has become exceedingly popular as a preoperative skin prepara-
tion. These authors also say phisoHex apparently meets the criteria
set up by Hatfield and Lockwood\textsuperscript{18} better than any other substance
currently available for surgical preparation of the skin.

Hexachlorophene, a bis-phenol, is one of the few known antiseptics
which does not lose most of its antibacterial potency in the presence
of soaps. Therefore, hexachlorophene has been added to soaps and

\textsuperscript{16}Hatfield, C.A. and Lockwood, J., "An Evaluation of Some of the
Materials Commonly Used for the Preoperative Preparation of the

\textsuperscript{17}Medrick, T.F. and Litsky, W., "Surgical Antiseptics", \textit{International

\textsuperscript{18}Hatfield and Lockwood, \textit{op. cit.}, p. 931.
detergents and has been recommended for the surgical preparation of the hands.\textsuperscript{19}

Blank and Coolidge\textsuperscript{20} found that a single short scrub with the detergent hexachlorophene preparations did not lower the population of the skin any more than the routine surgical scrub for ten minutes with regular soap followed by an alcoholic dip. Only when the scrub included a two minute immersion of the hands in an alcoholic solution of hexachlorophene was the bacterial count lowered. This was attributed to the alcohol rather than to the hexachlorophene.

Seastone\textsuperscript{21} studied hexachlorophene and its effect on twenty strains of staphylococci cultured from the normal flora of the hands and also on three gram-negative (coliform) organisms. A one per cent alcoholic solution of hexachlorophene was diluted serially in broth. Three strains of staphylococci were completely inhibited at dilutions of $10^{-6}$ with partial inhibition at a dilution of $10^{-7}$. The twenty strains were tested on agar at a $10^{-6}$ dilution, five strains showed a partial or almost complete inhibition of growth and the remaining fifteen failed to grow. The three gram-negative organisms tested in the same manner grow in concentrations of hexachlorophene ten to one hundred times greater. Although this research indicates that gram-negative

\begin{footnotesize}
\begin{enumerate}
\item Price, P.B., "15 Surgical Antiseptics" in Antiseptics, Disinfectants, Fungicides and Sterilization, edited by Reddish, C.F., p. 317.
\end{enumerate}
\end{footnotesize}
organisms are more resistant to the bacteriostatic effect of hexachlorophene than twenty strains of staphylococci from the human skin, this study did not differentiate between the coliform organisms.

**Bases of Hypothesis**

A stroke handwashing technic which could be used to prevent the transmission of pathogenic organisms by the hands of nurses and other health workers is based on Walter's\(^\text{22}\) theory of the habitual anatomic scrub and Price's\(^\text{25}\) work which showed that the most important variable in mechanical cleansing is the vigor used in scrubbing or the amount of friction produced at the skin surface. Since both the habitual anatomic scrub which eliminates blind areas and the mechanical cleansing have proved to be effective in reducing the flora of the skin, it was felt that a modification of the procedure could be made and used in the newborn nursery.

The literature also revealed much disagreement about detergents with hexachlorophene and its effect on gram-negative organisms; therefore, phlisdem and phlischex (phlisdem with three per cent hexachlorophene) were used as the detergents in this study and their effects compared.

**Statement of Hypothesis**

The stroke handwashing technic using either phlisdem or phlischex is a more effective method of removing the transient organism, *E. coli*, than are ordinary handwashing methods.

\(^{22}\text{Walter, op. cit., p. 180}\)

\(^{25}\text{Price, "The Bacteriology of the Normal Skin...", The Journal of Infectious Diseases, 65:307, November-December 1935.}\)
CHAPTER III
METHODOLOGY

Selection and Description of the Sample

The fifteen nursing students participating in this study were basic nursing students who had completed the study of microbiology, and their experience on the ward was limited to two to six hours per week for a period of seven months. Twelve of the subjects were right-handed and three were left-handed.

The six graduate nurses who volunteered to help in this study were undergraduate students in the graduate nurse division at Boston University School of Nursing. They had an average of 3.5 years of experience. All of these participants were right-handed.

Tools and Procedure Used to Collect Data

*E. coli* was used as the experimental organism. The original culture was obtained from the Bacteriology Laboratory of the Biology Department at Boston University.

1. All cultures used were a twenty-four hour culture of *E. coli* in 8 ml. of nutrient broth.

2. Five sterile 1/2" x 1 1/2" gauze sponges were sterilized in a Petri dish and the culture of *E. coli* was poured over the sponges.

3. Sterile Petri dishes with two 3/4" gauze strips, one 3/4" long and the other 1/2" were placed at right angles in the bottom of the Petri dish. The longer strip is placed under the other strip and extends up the side of the Petri dish to
make tabs.

4. pHisoderm, a soapless detergent, was used in Parts I and III. pHisoderm is a detergent cream which is characterized as having active emulsifying sudsing and dispersing properties. The surface activity is forty per cent greater than that of ordinary soap. 

5. pHisohex, (pHisoderm with three per cent hexachlorophene added) was used in Parts II and IV.

6. Sterile EMB agar was poured into the Petri dishes over the gauze strips and used to culture the hands.

7. The method of handculture which was used in this study is described by Sommermeyer. For all cultures, the bottom of the Petri dish was inverted over the part of the hand to be cultured and the investigator pulled on the tab with flamed forceps until the entire agar surface fell on the hands. The circle of agar was immediately returned to the Petri dish. Only the palmar surface of the hands and fingers were cultured on EMB agar. The palm and thumb were cultured as the lower half and called L. The four fingers were cultured together and called U. Both hands were cultured so the markings on the Petri dish read UL, upper left; LL, lower left; UR, upper right; LR, lower right. The under surface of the bottom of the Petri

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2Sommervier, Lucille, Laboratory Manual and Workbook in Microbiology (For Students of Nursing), pp. 85-89.
dish was marked to designate the thumb side of the plate. This facilitated in plotting the colonies on outlines of the hands.

6. The stroke handwashing technique used in this study was done under the supervision of the investigator, and the directions for this handwashing procedure were given as follows:

1. Wet the hands with warm water.
2. Pour several ml. of liquid detergent on the hands.
3. Beginning at the thumb side apply friction on the dorsal side of the hand with the opposite hand by moving forward to the thumb. Grasp the thumb, rotating it, and return to the dorsal side of the hand with open hand applying friction. This constitutes Stroke 1.
4. Stroke 2: Beginning at the wrist, cover the dorsal side of the hand with friction from the opposite hand, move toward the first finger, grasp it with a rotating motion, and return to the dorsal part of the hand.
5. Strokes 3-5 do the dorsal side of the hand and fingers two through four.
6. Strokes 6-10 move to the palmar surface of the hand, and beginning at the thumb side, use the technique as described in strokes 1-5.
7. Strokes 10-20 do the opposite hand in the same manner.
8. Rinse the hands well under running water and dry with paper towels. Unsterile paper towels were used because sterile paper towels are not used in the clinical situation. This can be considered a variable factor.
Procurement of Data

The collection of data was divided into four parts. Each part consisted of Control A, Control B, and Test C. Controls A and B as described under Part I were carried out in the same manner in Parts II, III, and IV.

Part I: Ordinary handwashing methods with phisoderm

Control A: Unwashed hands were cultured on EMB agar.

Control B: The palmar surface of the hands and fingers were contaminated by handling a 1\(\frac{1}{2}\)" x 1\(\frac{1}{2}\)" sponge contaminated with *E. coli* and allowed to air dry. Hands were cultured on EMB agar.

Test C: The subject washed her hands using phisoderm and her own technic and dried the hands on paper towels. The hands were cultured on EMB agar.

Part II: Ordinary handwashing methods with phisohex

Test C: The subject washed her hands using phisohex and her own technic and dried the hands on paper towels. The hands were cultured on EMB agar.

Part III: Stroke handwashing technic with phisoderm

Test C: The subject washed her hands using phisoderm and the stroke handwashing technic and dried the hands on paper towels. The hands were cultured on EMB agar.

Part IV: Stroke handwashing technic with phisohex

Test C: The subject washed her hands using the stroke handwashing technic and phisohex and dried the
hands on paper towels. The hands were cultured on EMB agar.

All plates were incubated at 37°C right side up for forty-eight hours. This was done to prevent the loosened agar from falling into the top of the Petri dish. Colonies showing the characteristic metallic sheen of *E. coli* growth on EMB agar were considered positive and counted. Profuse growth which was too numerable to count was recorded as "TNTC". All other plates were considered negative. The usual confirmation of positive plates was not done because the experimental organism was known.
CHAPTER IV
FINDINGS

Presentation of Data

The plates which were negative for *E. coli* are designated by the symbol (−) in the tables. Plates with positive *E. coli* growth were counted and the number in the tables pertains to the number of colonies counted. Plates with colonies which were too numerous to count were designated as "TNTJ".

In each part of the study the following letters are used to designate parts of the hand.

UL  Upper Left hand
LL  Lower Left hand
UR  Upper Right hand
LR  Lower Right hand

All outlines of the hands which showed growth are presented after the tables to which they pertain. The colonies are plotted in the position in which they occurred.

The results of this study are presented in the following tables.
### TABLE I

ORDINARY HANDWASHING WITH PHISODERM BY NURSING STUDENTS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dexterity</th>
<th>Control A*</th>
<th>Control B†</th>
<th>Test C‡</th>
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<tr>
<td></td>
<td></td>
<td>UL  LL  UR  LR</td>
<td>UL  LL  UR  LR</td>
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</tr>
<tr>
<td>1</td>
<td>right</td>
<td>-     -    -    -</td>
<td>TNTC  TNTC  TNTC  TNTC</td>
<td>-     -    -    -</td>
</tr>
<tr>
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<td>left</td>
<td>-     -    -    -</td>
<td>TNTC  TNTC  TNTC  TNTC</td>
<td>-     -    -    -</td>
</tr>
<tr>
<td>4</td>
<td>right</td>
<td>-     -    -    -</td>
<td>TNTC  TNTC  TNTC  TNTC</td>
<td>-     -    -    -</td>
</tr>
<tr>
<td>5</td>
<td>right</td>
<td>-     -    -    -</td>
<td>TNTC  TNTC  TNTC  TNTC</td>
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</table>

* Control A refers to that part of the study in which the unwashed hands were cultured.

† Control B refers to that part of the study in which the hands were cultured after contamination with *E. coli*.

‡ Test C refers to that part of the study after the hands were washed using ordinary handwashing methods or the stroke handwashing technic.
FIGURE 1

PLOTTED COLONIES OF SUBJECT 1, PART I, TEST 0

LEFT HAND
FIGURE II

PLOTTED COLONIES OF SUBJECT 10, PART I, TEST 0

LEFT HAND
FIGURE III

PLOTTED COLONIES OF SUBJECT 13, PART I, TEST 10

LEFT HAND
### TABLE II
ORDINARY HANDWASHING WITH PHISODERM BY GRADUATE NURSES

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dexterity</th>
<th>Control A*</th>
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* Control A refers to that part of the study in which the unwashed hands were cultured.

† Control B refers to that part of the study in which the hands were cultured after contamination with *E. coli*.

‡ Test C refers to that part of the study after the hands were washed using ordinary handwashing methods or the stroke handwashing technic.
### TABLE III

**ORDINARY HANDWASHING WITH PHISOHEX BY NURSING STUDENTS**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dexterity</th>
<th>Control A*</th>
<th>Control B*</th>
<th>Test C*</th>
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</tr>
</tbody>
</table>

* Control A refers to that part of the study in which the unwashed hands were cultured.

† Control B refers to that part of the study in which the hands were cultured after contamination with *E. coli*.

‡ Test C refers to that part of the study after the hands were washed using ordinary handwashing methods or the stroke handwashing technic.
FIGURE V

PLOTTED COLONIES OF SUBJECT 2, PART II, TEST C

LEFT HAND
FIGURE VI

PLOTTED COLONIES OF SUBJECT 8, PART XI, TEST C

LEFT HAND
FIGURE VII
PLOTTED COLONIES OF SUBJECT 9, PART II, TEST 9

RIGHT HAND
FIGURE VIII

PLOTTED COLONIES OF SUBJECT 10, PART II, TEST C

LEFT HAND
FIGURE IX

PLOTTED COLONIES OF SUBJECT 102, PART II, TEST C

RIGHT HAND
FIGURE X

PLOTTED COLONIES OF SUBJECT 13, PART II, TEST C

LEFT HAND
TABLE IV
STROKE HANDWASHING WITH PHISODERM BY NURSING STUDENTS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dexterity</th>
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<th>Test C#</th>
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</table>

One set of plates, #13, was discarded because of an error in bacteriological technique. A plate contaminated with *E. coli* was used to culture the washed hand.

* Control A refers to that part of the study in which the unwashed hands were cultured.

† Control B refers to that part of the study in which the hands were cultured after contamination with *E. coli*.

‡ Test C refers to that part of the study after the hands were washed using ordinary handwashing methods or the stroke handwashing technique.
### TABLE V

**RESULTS OF STROKE HANDWASHING WITH PHISOCHEX BY NURSING STUDENTS**

<table>
<thead>
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</table>

* Control A refers to that part of the study in which the unwashed hands were cultured.

† Control B refers to that part of the study in which the hands were cultured after contamination with *E. coli*.

‡ Test C refers to that part of the study after the hands were washed using ordinary handwashing methods or the stroke handwashing technique.
FIGURE XI

PLOTTED COLONIES OF SUBJECT 1, PART IV, TEST C

LEFT HAND
FIGURE XXI
PLOTTED COLONIES OF SUBJECT 7, PART IV, TEST Q

RIGHT HAND
FIGURE XIII

PLOTTED COLONIES OF SUBJECT 7, PART IV, TEST C

LEFT HAND
Discussion of the Data

In this study, all hands prior to contamination with E. coli were negative for E. coli. This control was carried out to ascertain that the E. coli on the hands in Control B was from the contaminating sponge and not part of the normal flora or from other extraneous sources.

According to Topley and Wilson, among the organisms found on the skin, there will be occasional coliforms. The small sample in this study may account for the all-negative plates in Control A. If the sample were larger than fifteen, some of the subjects may have exhibited E. coli as part of the normal flora.

Another reason for the lack of positive E. coli plates may be attributed to the technic of placing the SMD agar on the hands. No attempt was made to recover organisms from between the fingers, under the nails, or any surface other than the palmar surface. It is possible that E. coli beneath the immediate surface of the skin may not have been recovered with the technic used in this study.

In Control B, the hands were cultured to determine the amount of contamination of E. coli. For all parts except five cases in Part III, the results were too numerable to count. However, the five cases showed inconsistent growth. Seven plates were negative, eleven plates showed growth which was counted, and two plates were too numerable to count. It was thought at first to be due to the use of hexachlorophene

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soap by the subjects, but, after inquiry, only one subject out of five was found to use a soap with hexachlorophene. Because five gauze sponges were in one Petri dish and covered with 8 ml. of a twenty-four hour culture of *E. coli* in nutrient broth, it was then felt that perhaps the culture was the cause of the inconsistency. A review of the technic revealed that one tube of nutrient broth had been inoculated with *E. coli* from an older slant and not the one which had been used for the other two cultures. Nutrient broth was inoculated from this slant again, and the broth, after twenty-four hours, remained fairly clear, indicating that little or no growth had occurred. The original culture from which this nutrient broth had been inoculated did not produce as heavy a growth on subculture as the other slants did.

Table II gives the results of the six graduate nurses who offered their assistance when it was felt that the students were not being realistic in their handwashing procedure. All these nurses felt that they had washed their hands for this study in a manner similar to the method they would have used in a nursery situation between diaper changes.

The results of this study were compared with the data from a study by Sommermeyer which was carried out in the nursery. The latter study showed that sixteen of the twenty-eight nursery personnel whose hands were cultured after ordinary handwashing methods and between diaper changes had positive plates for *E. coli*. This may be attributed to the presence of organic matter which is more difficult to remove. The lack of organic matter in the pure culture of *E. coli* made it more easily removable in the laboratory situation and possibly this
could not be duplicated in the actual situation.

In observing the subjects in this study, it was felt that the subjects washed their hands in an unreal manner in comparison to handwashing which can be observed in a hospital ward.

The instructions in the handwashing included using several ml. of detergent. A dispenser was not available, and because the detergent is a cream, it is difficult to measure accurately. Approximate equal amounts were poured into large, sterile test tubes prior to the experiment. The unequal amounts of the detergent which were delivered to the hands from the test tube may have presented a difference in the amount of water used to wet the hands and wash off the resulting suds. This probably varied the dilution of the detergent.

In spite of the few positive plates in the recorded results, these are not statistically significant. The data presented in this study show that phisoderm was equally as effective as phisochex in removing *E. coli* as the transient organism from the hands. The data also revealed that ordinary handwashing methods used by the subjects was as effective as the stroke handwashing.

The left-handed subjects in this study showed negative plates after all handwashing. Therefore, no conclusions can be made.

The twelve right-handed subjects showed twelve positive left hand cultures as compared with only three positive right hand cultures.

The outlines of the hands reveal a total of eighteen colonies on the palm of the hands. The second finger showed three colonies and fingers one, three, and four each had one colony. No colonies grew in the thumb area. In this study, the week area in handwashing appears to be the palm of the hand.
CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

An evaluation of the effectiveness of a stroke handwashing technique using either phisohex or phisoderm for the removal of *E. coli* as compared with ordinary handwashing techniques was done.

The stroke handwashing technique is based on a numerical count (1-20) using a detergent with friction and a rotating motion. Ordinary handwashing was the procedure used by nurses to wash their hands.

Fifteen nursing students were the subjects in this study. Their experience on the wards was limited to two to six hours per week over a period of seven months.

*E. coli* was used as the transient organism. All hands were cultured with EMB agar before and after contamination with *E. coli* and after handwashing procedures. The study was divided into four parts. In Parts I and II, ordinary handwashing methods using phisoderm and phisohex were studied. In parts III and IV, the stroke handwashing technique using phisoderm and phisohex were studied. Colonies were plotted on outlines of the hands to determine the weak area in handwashing.

The results of this study reveal that the stroke handwashing technique was as effective as ordinary handwashing methods. phisoderm and phisohex were compared and phisoderm was found to be equally as effective as phisohex in removing *E. coli* as the transient organism from the hands.

A review of the hand outlines revealed more organisms on the
palm of the hands than on the fingers. A total of eighteen colonies were counted on the palms as compared with three colonies on the second finger, and one colony each on the remaining fingers. The weak area in handwashing in this study was the palm of the hand. The sample in this study is too small to generalize on weak areas in handwashing.

**Conclusions**

This study which was carried out in the laboratory and is by no means conclusive, has brought out the following facts:

1. The results of this study do not lend support to the theory that the stroke handwashing technic using a detergent and friction in removing the transient organism, *E. coli*, is more effective than ordinary handwashing methods which vary with the individual.

2. The use of phisoHex, a phisoderm preparation with 3 per cent hexachlorophene, does not aid in reducing the gram-negative organism, *E. coli*, from the hands.

3. No conclusions can be drawn from observations made on left-handed subjects because, in all cases, the plates were negative for *E. coli* following handwashing using both the stroke handwashing technic and ordinary methods.

4. The weak area of handwashing in this study was the palm of the hand.

**Recommendations**

This study has been an interesting undertaking, but the writer
realizes the limitations of such a procedure in the laboratory.

A similar study should be undertaken in the newborn nursery. Cultures taken before and after handwashing would be similar to the Controls A and B and Test C of this study. A study of the stroke handwashing technique in the clinical area with a larger sampling would help evaluate this method under the pressure conditions which were lacking in the laboratory.

It is also suggested that a comparison of pHisoHex and pHisoDerm be done in vitro in the form of a phenol coefficient test.

Further study of both left-handed and right-handed people is suggested to determine whether in a larger sampling and in the actual clinical situation there is a difference in the amount of organisms left on the opposite hand.
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- Personal Communication

Topley, W.V.O. and Wilson, G.S., The Principles of Bacteriology and Immunity, Baltimore: Wm. Wood and Co., 1936


