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Dislodgement of bacteria from endotracheal tubes after saline instillation and suction catheter insertion

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The University of Arizona, 1992
DISLODGE THE BACTERIA FROM ENDOTRACHEAL TUBES
AFTER SALINE INSTILLATION AND
SUCTION CATHETER INSERTION

by
Debra Ann Hagler

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1992
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APPROVAL BY THESIS DIRECTOR

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[Signature] Gayle A. Traver
Associate Professor of Nursing

Date: July 30, 1992
DEDICATION

I dedicate this thesis to Jamie, Matthew, and Andrew, in grateful recognition of their love and support.
ACKNOWLEDGEMENTS

Gayle Traver, my thesis chairperson, thanks for assisting me through this painful process. I most appreciated your ability to hope with both feet still firmly on the ground.

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Nursing staff of the intensive care units at UMC, thank you for calling me regarding extubation and facilitating my specimen collections.

My co-workers, thank you for all the schedule flexibility you tolerated and the emotional support you provided.
# TABLE OF CONTENTS

List of tables.................................................................7  
Abstract..............................................................................8  
Chapter 1: Introduction.........................................................9  
Statement of the problem......................................................12  
Purpose of the study.........................................................14  
Research question..........................................................14  
Conceptual framework......................................................14  
Summary.................................................................18  
Chapter 2: Review of the Literature......................................19  
Normal saline instillation...................................................19  
Bacterial adhesion...........................................................24  
Magnitude of bacterial exposure.......................................26  
Summary.................................................................30  
Chapter 3: Methodology.......................................................31  
Research design...........................................................31  
Setting.................................................................31  
Protection of human subjects.............................................32  
Data collection............................................................33  
Data analysis............................................................35  
Limitations............................................................35  
Chapter 4: Analysis of data.................................................37  
Characteristics of the sample.............................................37  
Results..............................................................40  
Summary............................................................42  
Chapter 5: Discussion.......................................................46
LIST OF TABLES

Table 1: Discussion of normal saline instillation prior to endotracheal tube suction found in some critical care or respiratory textbooks........13

Table 2: Characteristics of the subjects—Diagnosis, length of time intubated, and size and route of endotracheal tube.................................38

Table 3: Bacterial colony counts by subject, treatment, and treatment order.................................41

Table 4: Paired t-test of mean difference (catheter insertion minus saline instillation) for bacterial colonies dislodged from endotracheal tubes........43

Table 5: Bacterial colony counts after catheter insertion and after combined treatments (catheter and 5 ml saline instillation)...............................45
ABSTRACT

Bacterial glycocalyx formations on the inner lumens of endotracheal tubes may be dislodged into the lower airway by suction catheter insertions or saline instillations. Repeated introduction of bacteria into the lower airway may overwhelm host defense mechanisms, leading to nosocomial pneumonia. Ten crossover subjects required intubation for 2 to 39 days. A range of 0 - 62,000 (mean 26,980) viable bacterial colonies per milliliter was dislodged from freshly removed endotracheal tubes by either catheter insertion or saline instillation. There was no significant difference in numbers of viable bacteria dislodged from endotracheal tubes by catheter insertion versus a 5 milliliter saline instillation. The large numbers of coated bacteria dislodged could be an underestimated infectious hazard, particularly as endotracheal suctioning is generally performed multiple times each day for intubated patients. As optional saline instillations have not improved endotracheal suctioning outcomes in previous studies, caregivers should consider deleting saline instillation during endotracheal suctioning.
CHAPTER 1
INTRODUCTION

Nosocomial pneumonia, one of the leading causes of death for all hospitalized patients, frequently complicates the course of those critically ill patients dependent on mechanical ventilation (Ruiz-Santana et al., 1987). The reported incidence of nosocomial pneumonia in mechanically ventilated patients ranges from 18 to 58 percent (Craven et al., 1986; Daschner, Frey, Wolff, Baumann, & Suter, 1982; Du Moulin Paterson, Hedley-Whyte, & Lisbon, 1982; Jimenez et al., 1989; Langer Mosconi, Cigada, Mandelli, & Intensive Care Group of Infection Control, 1989; Rello et al., 1991). Mortality is high in mechanically ventilated critical care patients who develop a nosocomial pneumonia. Jimenez et al. (1989) and Rello et al. (1991) each reported a 38% mortality rate for critically ill patients who developed nosocomial pneumonias while supported by mechanical ventilation. Those mechanically ventilated patients who survive nosocomial pneumonia may experience a mean increase in length of hospital stay of nearly 10 days (Rello et al., 1991) and a three-fold increase in length of critical care stay (Craig & Connelly, 1984).

Effective mechanical ventilation is accomplished through an artificial airway such as an endotracheal tube or tracheostomy. The presence of an endotracheal tube in the
human airway depresses natural mucociliary transport and cough mechanisms (Ackerman, 1985). Removal of secretions from intubated patients is then facilitated by the performance of endotracheal tube suctioning, an invasive procedure with the potential for numerous life-threatening complications. Commonly identified risks of endotracheal tube suctioning include the immediately apparent clinical problems of hypoxemia, bronchospasm, cardiac dysrhythmias, increased intracranial pressure, vomiting with aspiration, and mucosal damage (Traver, Mitchell, & Flodquist-Priestley, 1991). Methods of minimizing these risks were published in early critical care literature and continue to be refined (Demers & Saklad, 1973; Urban & Weitzer, 1969).

A potential complication of endotracheal tube suction that may occur but is less apparent than those previously mentioned is deposition of microorganisms directly into the lower airway (Yanelli & Gurevich, 1988). The effect of lower airway contamination may not be clinically apparent in connection with one specific endotracheal tube suctioning episode, but is manifested hours to days later when patients develop lower airway colonization or clinically detectable nosocomial pneumonia.

Equipment and techniques that minimize introduction of organisms into the lower airway are an essential part of an overall program to reduce the incidence of nosocomial
pneumonia and its accompanying morbidity and mortality (Craven & Steger, 1989). Methods recommended to minimize the incidence of lower airway contamination associated with endotracheal tube suction include the use of sterile gloves, catheter, irrigating solution, and technique, as well as good handwashing before and after each suctioning episode (Traver et al., 1991).

Recently, the possibility of mechanically dislodging clumps of bacteria into the lower airway from colonized endotracheal tube surfaces has been raised (Sottile et al., 1986). The use of sterile catheters and irrigation solutions would not protect the patient against the possibility of organisms being repeatedly seeded into the lower airway from an already colonized endotracheal tube. Currently, the only feasible method for the removal of respiratory secretions from intubated patients is endotracheal suctioning with a suction catheter. The common clinical use of optional normal saline instillations into the endotracheal tube prior to suction catheter insertion may, however, contribute unnecessarily to lower airway contamination.

The practice of normal saline instillation prior to suction catheter insertion has not yet been scrutinized for its effects on either bacterial dislodgement into the lower airway or nosocomial pneumonia rates. Nurses providing
direct patient care need empirical data regarding the actual level of risk created by the practice of normal saline instillation in order to make sound decisions regarding how to best accomplish endotracheal tube suctioning.

STATEMENT OF THE PROBLEM

Critical care and respiratory care textbooks frequently recommend normal saline instillation prior to endotracheal tube suction on either an as-needed or routine basis. The rationale, when identified, is most often to loosen secretions or to stimulate a cough (Table 1). Nurses and respiratory therapists caring for endotracheally intubated patients commonly instill a bolus of normal saline into the endotracheal tube prior to suctioning, despite a lack of evidence for the benefit of normal saline instillation in suctioning efficacy (Ackerman, 1990; Bostick & Wendelgass, 1987; Gray, MacIntyre, & Kronenberger, 1990). The continued use of normal saline instillation, despite a demonstrated lack of efficacy, may contribute to the problems of lower airway colonization and nosocomial pneumonia through repeated dislodgement of organisms from the endotracheal tube surface to the lower airway.
Table 1.
Discussion of normal saline instillation prior to endotracheal tube suction found in some critical care or respiratory care textbooks.

<table>
<thead>
<tr>
<th>Authors/year of pub</th>
<th>Use of NS</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traver, Mitchell &amp; Flodquist-Priestley, 1991</td>
<td>5-10 ml if needed (not routine)</td>
<td>stimulate cough</td>
</tr>
<tr>
<td>Hudak, Gallo, &amp; Benz, 1990</td>
<td>3-5 ml if secretions tenacious</td>
<td>--</td>
</tr>
<tr>
<td>Dossey, Guzzetta, &amp; Kenner, 1990</td>
<td>5-30 ml if needed (not routine)</td>
<td>loosen thick secretions</td>
</tr>
<tr>
<td>Johanson, Dunnea, Hoffmeister, &amp; Wells, 1985</td>
<td>0.5-1.0 ml if secretions thick</td>
<td>--</td>
</tr>
<tr>
<td>Kenner, Guzzetta, &amp; Dossey, 1985</td>
<td>5 ml</td>
<td>liquefy thick secretions</td>
</tr>
<tr>
<td>Burrell &amp; Burrell, 1982</td>
<td>2-5 ml (with physician’s order)</td>
<td>loosen thick secretions and stimulate cough</td>
</tr>
<tr>
<td>Millar, 1980</td>
<td>5-10 ml if secretions tenacious</td>
<td>mobilize secretions and aid in removal</td>
</tr>
</tbody>
</table>
PURPOSE OF THE STUDY

The purpose of this study was to identify the extent to which normal saline instillation prior to endotracheal tube catheter insertion causes dislodgement of organisms out the caudal end of the endotracheal tube. A model using the endotracheal tube immediately after its removal from the human airway was used to simulate potential bacterial dislodgement into the directly inaccessible human lower airway.

RESEARCH QUESTION

Is the bacterial colony count obtained after a 5 cc normal saline instillation through a used endotracheal tube significantly different than the colony count obtained after insertion of a suction catheter through a used endotracheal tube?

CONCEPTUAL FRAMEWORK

The probability of an endotracheally intubated patient experiencing nosocomial pneumonia is related to an interaction of factors specific to the patient and factors specific to the microbial exposure. Individual patient factors related to lower airway colonization and nosocomial pneumonia include failure of nonspecific or specific host defenses and other miscellaneous risk factors. Combined specific and nonspecific host defense mechanisms maintain a
nearly sterile lower airway under normal circumstances, despite heavy microbial colonization of the upper airway above the level of the larynx.

Placement of an endotracheal tube from the upper airway through the larynx into the lower airway renders the laryngeal area ineffective as a mechanical barrier (Kryger, 1990). Nonspecific host defense mechanisms may also be rendered ineffective by other circumstances common to critically ill patients who require endotracheal tube placement. These circumstances include altered hydration, increased mucus production, and impaired ciliary movement, cough, or alveolar macrophage function (Traver et al., 1991).

Specific pulmonary defense mechanisms against microbes may be rendered ineffective by congenital, acquired, or drug-induced immunodeficiency states commonly found in critically ill populations requiring endotracheal tube placement for ventilatory support (Traver et al., 1991). Both nonspecific and specific host defense mechanisms may be impractical or impossible to support adequately during a critical illness. Endotracheal suctioning, even if performed with negative pressures of 100 mm Hg or less, causes tracheobronchial trauma ranging from loss of epithelium to gross ulceration. The presence of intact mucosa is a first
line of defense, the importance of which should not be underestimated (Kuzenski, 1978).

Other individual risk factors for nosocomial pneumonia include both factors that increase aspiration of foreign substances into the lower airway and factors that enhance pathogenic bacterial survival in the stomach and pharynx. Pulmonary aspiration of substances is more common when patients display a decreased level of consciousness, dysphagia, depressed gag reflex, or delayed gastric emptying (Olivares, Segovia, & Revuelta, 1974). Pulmonary aspiration is also more likely when endotracheal tubes or nasogastric tubes are present as conduits for fluids and bacteria (Craven & Steger, 1989).

Neutralization of gastric acid with H₂ blockers or antacids eliminates the protective bactericidal effect normally associated with an acidic pH. The common use of systemic antibiotics may contribute to pharyngeal colonization with resistant bacteria (Niederman, Mantovani, Schoch, Papas, & Fein, 1989). Gastric and pharyngeal colonizations with gram-negative bacteria are strongly correlated with development of nosocomial pneumonia (Craven & Steger, 1989). These individual risk factors may be unavoidable for the critically ill patient.

Specific microbial factors influencing the development of nosocomial pneumonia include transmission mode, inoculum
size, exposure frequency, and bacterial virulence. Bacterial production of glycocalyx, an adhesive polysaccharide outside the bacterial cell wall, aids in bacterial adhesion and growth by protecting bacterial microcolonies from natural and pharmacologic antibacterial agents (Costerton & Irvin, 1981). Polyvinyl chloride, a material commonly used to produce endotracheal tubes, is relatively easily colonized with bacteria which form an adhesive glycocalyx (Sheth, Franson, et al., 1983). The polyvinyl chloride endotracheal tube develops a bacterial glycocalyx layer through contact with coughed secretions or by inoculation from condensate in the ventilator circuit (Cardinal, Snell, Proulx, Morrison, & Jones, 1991). The endotracheal tube then acts as a conduit for bacteria between the upper and the lower airway (Craven, Goularte, & Make, 1984).

Insertion of a suction catheter or normal saline instillation may dislodge clumps of glycocalyx-protected bacteria from the endotracheal tube into the lower airway (Sottile et al., 1986). Intubated patients typically experience endotracheal tube suctioning numerous times in a single day. The risk of combining the use of normal saline instillation with suction catheter insertion during the endotracheal tube suction procedure has not yet been evaluated for risk of bacterial exposure.
The maintenance of lung sterility under most normal conditions is evidence of the host's ability to clear bacteria as they are continuously introduced. In mice receiving a one-time aerosolized inoculum of bacteria into the lower airway, the ability to clear the bacteria was related to the size of the bacterial inoculum. At larger inoculum levels, clearance was ineffective and bacteria multiplied in the airway after even a single exposure (Toews, Gross, & Pierce, 1979). The introduction of large bacterial inocula into the human lower airway by suction catheter insertion and normal saline instillation during multiple suctioning episodes each day may overwhelm the host's ability to clear the organisms, resulting in multiplication of organisms in the lower airway and nosocomial pneumonia.

SUMMARY

Saline instillation has become a routine step of the endotracheal suctioning procedure practiced in some institutions. There is the potential, however, that saline instillation may increase the risk of lower airway bacterial colonization for intubated patients. The present study was a preliminary investigation into the incidence and magnitude of bacterial dislodgement from endotracheal tubes.
CHAPTER 2
REVIEW OF LITERATURE

The review of the literature focused on studies regarding normal saline instillations into endotracheal tubes, bacterial adhesion, and magnitude of bacterial exposure.

NORMAL SALINE INSTILLATION

Critical care textbooks commonly recommend normal saline instillation prior to endotracheal tube suction (Table 1) on either an "as needed" basis or as part of the routine suctioning procedure. Although the volume of normal saline recommended varies from 0.5 ml (Johanson et al., 1985) to 30 ml (Dossey et al., 1991), the most commonly recommended amount is 5 ml. The majority of critical care texts that recommend normal saline instillation on either a routine or an as needed basis provide the rationale that normal saline loosens or liquefies tenacious secretions.

Use of an endotracheal tube as an artificial airway bypasses the normal upper airway mechanisms that warm and humidify inspired air (Traver et al., 1991). The patient then requires some sort of artificial moisture supplement to maintain effective mucociliary clearance. Aerosolized water is effective in rehydrating dried secretions to enhance their removal from the airway and preventing excessive
airway moisture loss (Shapiro, Kacmarek, Cane, Peruzzi, & Hauptman, 1991). Water in bolus form, however, is not miscible with mucus, even when shaken (Demers & Saklad, 1973).

Hanley, Rudd, and Butler (1978) studied the deposition, distribution, and clearance of endotracheal tube normal saline instillations in dogs and humans. Radioactively-labelled normal saline boluses of 5 ml remained in the trachea and mainstem bronchi without reaching the peripheral lung, even after subsequent lung hyperinflations. Suctioning that followed the instillation and hyperinflation recovered a mean normal saline dose of 10.7% in the dogs and 18.7% in the humans of the volume initially instilled. These findings, although in a small sample, suggest both that normal saline instillations do not affect secretions in the lung periphery and that the majority of the saline instilled remains in the lower airway after suctioning.

A second but much less common rationale cited in critical care texts for the use of normal saline instillation prior to endotracheal tube suction is to stimulate a cough. The alert, intubated patients studied by Hanley et al. (1976) did not cough in response to normal saline instillation. Bostick and Wendelgass (1987) reported their study subjects coughing after normal saline instillation. Gray et al. (1990) reported all subjects
coughing both after normal saline instillation and during stimulation with the suction catheter.

The effectiveness of normal saline instillation in production of a cough, however, does not assure that the use of normal saline instillation prior to endotracheal tube suction elicits more effective cough efforts or airway clearance than does the use of endotracheal tube suction alone. Three recent studies (Ackerman & Gugerty, 1990; Bostick & Wendelgass, 1987; Gray et al., 1990) investigated the weight of secretions obtained by endotracheal tube suction with or without normal saline instillation. Statistically significant (p < 0.05) increases in secretion weight after the use of a 5 ml normal saline instillation were reported in all three studies. The increases ranged from 0.39 to 1.3 grams. However, all three studies were confounded by the inability to determine the amount of normal saline present in the suctioned secretions. The normal saline weight alone could account for changes in secretion weight ranging from 0 to over 5 grams.

Fluids in the airways may potentially interfere with oxygen exchange at the alveolar-capillary interface. Arterial oxygen tension (PaO₂) is one measure of the oxygen exchange at that interface. Bostick and Wendelgass (1987) found that after controlling for variance in presuctioning PaO₂ levels, there was no significant difference in the
postsuctioning $\text{PaO}_2$ levels obtained with or without the use of normal saline. The use of normal saline, then, did not interfere with the ability to oxygenate. Neither, however, did the normal saline contribute to any improvement in secretion removal as would be indicated by an increased $\text{PaO}_2$ over baseline.

Multiple physiologic variables were studied by Gray et al. (1990) in relation to endotracheal tube suctioning and 5 ml normal saline instillation. Although there were statistically significant ($p < 0.05$) changes in heart rate, respiratory rate, systolic and diastolic blood pressure, $\text{PaO}_2$, arterial carbon dioxide tension ($\text{PaCO}_2$), and pH when measured pre- and post-suctioning, there were no significant differences between the groups with normal saline instillation and without normal saline instillation. The use of normal saline instillation in this study provided no additional benefit nor caused any additional risk as measured by multiple physiologic variables.

Ackerman and Gugerty (1990) measured oxygen saturation by ear oximetry in relation to endotracheal tube suctioning and normal saline instillation. No significant differences in oxygen saturation occurred during the first 30 seconds of measurement between the groups with or without normal saline instillation prior to endotracheal tube suction. From 45 seconds to 5 minutes post-treatment, the group experiencing
normal saline instillation prior to endotracheal tube suction had significantly lower oxygen saturation levels than did the group experiencing endotracheal tube suction without normal saline use. The authors stated that the inhibition of gas exchange by normal saline irrigation of the airway was a possible explanation for the difference.

An adverse effect of normal saline instillation identified by Wade (1982) is the patient’s sense of suffocation and drowning following the instillation. Fifteen pulmonary patients in a crossover study rated their discomfort as higher during suctioning preceded by normal saline instillation than during suctioning without normal saline, but the difference was not statistically significant (Gray et al., 1990).

Cardinal et al., (1991) have identified an additional potential risk from fluids traveling through the endotracheal tube into the lower airway. Condensation droplets form in the lumens of endotracheal tubes exposed to room temperature when the tubes are connected to heated and humidified mechanical ventilator circuits. As the condensation droplets coalesce and flow caudally through the endotracheal tube, bacteria from the tube continuously inoculate the lower airway, potentially overwhelming host defense mechanisms.
BACTERIAL ADHESION

Bacteria in both natural and pathogenic ecosystems produce glycocalyx, a polysaccharide/protein matrix which enhances bacterial microcolony formation and adhesion to both living and inert surfaces. Under favorable conditions, microcolonies spread and join to form a continuous surface of glycocalyx-bound bacteria. The glycocalyx layer offers the bacterial microcolonies protection from surfactants, antibodies, phagocytes, and antibiotic medications. Individual bacteria released from the surface of the protected glycocalyx later circulate to establish new microcolonies in areas where there are similarly favorable conditions for growth (Savage & Fletcher, 1985).

Sheth, Rose, Franson, Buckmire, and Sohnle (1983) found that after a two minute exposure to a bacterial suspension, polyvinyl chloride intravenous catheter surfaces became colonized with adherent bacteria. Initial 50 ml saline rinses of the catheters produced cultures with > 500 colonies/mm$^3$. Immediate sequential 50 ml saline rinses were performed 8 to 12 times before cultures of the rinse fluid showed a decrease in bacterial colonies to between 0 and 50 colonies/mm$^3$. Even when the eighth to twelfth rinse fluid demonstrated no bacterial growth, bacteria continued to adhere to the catheters as evidenced by scanning electron microscopy and positive rolled catheter cultures on blood
agar plates. Coagulase-negative staphylococci consistently adhered to the polyvinyl chloride catheters in greater numbers than to the Teflon catheters tested.

Scanning electron microscopy has been used to detect the presence of adherent bacteria that may not be demonstrated by traditional culture techniques. The surfaces of 25 polyvinyl chloride endotracheal tubes were studied after removal from critical care patients. The tubes had been in patients for a range of 24 hours to 46 days. In 84% of the cases, the surfaces studied were completely covered with bacteria enclosed in a protective adhesive layer. In the remaining 16% of cases, the surfaces studied were at least partially covered. Clumps of glycocalyx-covered bacteria protruded from the surface matrix into the lumens of the endotracheal tubes in some cases as well. The authors proposed that mechanical dislodgement of these protruding bacterial clumps with their protective glycocalyx layer may be a form of bacterial inoculation that is particularly effective in causing and maintaining nosocomial pneumonia (Sottile et al., 1986).

Cash et al. (1979) developed a research model to extend the transient pulmonary infections usually induced by bacterial aerosol or bolus inoculation into more chronic infections similar to human nosocomial pneumonias. Viable *Pseudomonas aeruginosa* were coated with a protective agar
layer, then delivered into rat tracheas at a dose of $10^4$ organisms. A single inoculation led to an increase within three days in viable bacteria recovered from the rat lungs to the $10^6$ level; this level persisted throughout the 35 day study. Similar inocula of bacteria, when delivered experimentally in saline, were cleared in less than a week. Sottile et al. (1986) compared the natural glycocalyx protection of bacteria to the protection provided by the agar in the Cash model, suggesting that clumps of protected bacteria more efficiently and persistently caused infection.

**MAGNITUDE OF BACTERIAL EXPOSURE**

Even when bacteria have survived or bypassed upper airway defenses to reach the lower airway, host defenses still include mechanical removal and/or bacterial killing. Large numbers of bacteria or repeated exposures may, however, overwhelm either or both of these defenses.

Green and Kass (1964) aerosolized *Staphylococcus aureus* or *Proteus mirabilis* into the environments of mice over a 30 minute period during which approximately $4 \times 10^4$ viable organisms reached the lungs. Their use of radioactive tracers indicated that phagocytic ingestion and killing of the bacteria preceded mechanical removal of these bacterial types. Clearance rates for viable bacteria were determined by use of culture techniques. Viable staphylococci were
decreased by 81% within two hours of exposure and by 91% within four hours. Laurenzi et al. (1964) demonstrated a similar rate of clearance for *S. aureus* in mice after aerosol exposure. Initial colony counts of $5 \times 10^4$ declined by 95% within six hours after exposure.

Jackson et al. (1967) used aerosol exposure techniques similar to Green and Kass (1964) to examine the clearance of several different gram-negative organisms by mice, including *Pseudomonas* species, *E. coli* and *P. mirabilis*. Inoculation sizes ranged from $1-42 \times 10^8$. Clearance rates of the bacteria were similar to one another except for the two *Pseudomonas* species, in which increases over the initial inoculation size were seen one hour after exposure. The pulmonary clearance of the *Pseudomonas* by two hours after inoculation proceeded in a pattern similar to that of the other bacteria. The increased difficulty of clearing *Pseudomonas* from murine lungs was attributed to a firmly bound slime layer property of the *Pseudomonas* cell. Glycocalyx had not yet been discussed in the literature.

Inoculum size as a major determining factor in clearance of aerosolized bacteria was first demonstrated by Toews, Gross, and Pierce (1979). *Staphylococcus aureus* were 84% cleared within four hours after deposition of $4 \times 10^6$ organisms, but only 75% cleared within four hours after deposition of $1.5 \times 10^7$ organisms. *Pseudomonas aeruginosa*
were completely cleared within four hours after deposition of $8 \times 10^4$ organisms. Deposition of a larger, $6 \times 10^5$, *P. aeruginosa* inoculum resulted in multiplication of the bacteria that exceeded killing up to 191% of the inoculum size within two hours after deposition and 227% of the inoculum size within four hours. *Klebsiella pneumoniae* clearance patterns were very different from those of the other two bacterial types used in the study. Clearance of *K. pneumoniae* was 65% complete four hours after the larger inoculum of $1.3 \times 10^6$, but only 38% complete within four hours after the smaller inoculum of $1.6 \times 10^5$ organisms. Mechanisms of clearance were identified for each of the three bacterial strains. The mechanism for each strain differed in levels of dependence on granulocytes versus alveolar macrophages. Granulocyte responses after inoculation with *K. pneumoniae* directly and positively related to the size of the bacterial inoculum.

The pulmonary immune response has a great reserve capability beyond that usually required to maintain lung sterility. Test systems have been developed to stress immune reserve capability and demonstrate bacterial clearance in response to varying levels of bacterial inoculation. Clawson and Repine (1976) challenged neutrophils in vitro with increasing quantities of *Staphylococcus aureus*. At levels of 100 *S. aureus* per
neutrophil, neutrophils killed 48 of the bacteria. The neutrophils continued to ingest \textit{S. aureus} presented at higher ratios, but were unable to kill the bacteria.

Onofrio et al. (1983) developed a bolus bacterial inoculation method to deliver more precise inocular sizes directly into the intrathoracic tracheas of mice. At inocular sizes of $10^5$, \textit{S. aureus} were 86% cleared within four hours, 95% cleared within 8 hours, and 98% cleared within 12 hours. At inocular sizes of $6.7 \times 10^6$, \textit{S. aureus} were 52% cleared at four hours, 93% cleared at 8 hours, and 97% cleared at 12 hours. Clearance of bacteria after an inoculum size of $3 \times 10^7$ was significantly different than clearance for the smaller inocula. At this largest inocular size, only 35% of the bacteria were cleared at four hours, and 38% at eight hours. Bacterial multiplication exceeded killing at 12 hours, so that the bacterial count was 126% of the initial inoculation. At the $10^7$ inoculation level, 70% of the bacteria were still viably present after 24 hours. In mice, an inocular size of $10^8 \textit{S. aureus}$ was associated with an 80% mortality rate within 12 hours of tracheal inoculation.

In cases of impaired host defenses, infection and mortality may occur with smaller individual inoculations. Green and Kass (1964) studied pulmonary clearance of \textit{S. aureus} in mice exposed to a variety of situations. Ethanol
intoxication depressed bacterial clearance on a dose-related basis. Hypoxia also depressed bacterial clearance, particularly when the hypoxic condition was maintained for 48 hours prior to inoculation with bacteria. Acute high dose corticosteroids mildly depressed bacterial clearance. Acute starvation depressed clearance of *S. aureus* relative to the percentage of body weight lost. Ineffective bacterial clearance from any cause, including those in the study, may increase susceptibility in infection.

**SUMMARY**

A review of the literature did not reveal any studies specifically investigating the dislodgement of bacteria from endotracheal tubes during suctioning procedures. The review supports that the efficacy of saline irrigation is questionable, that bacteria adhere to endotracheal tubes, and that bacterial inoculation of the lower airway is related to development of pulmonary infection.
CHAPTER 3

METHODOLOGY

In this chapter, a discussion of research design, population and sample characteristics, data collection, data analysis, and limitations is presented.

RESEARCH DESIGN

A descriptive design was used to identify the influences of normal saline instillation and suction catheter insertion on bacterial dislodgement from endotracheal tubes. Each endotracheal tube, recovered after its removal from a subject, was both irrigated with normal saline and cannulated with a suction catheter in a predetermined random order.

SETTING

The population from which the convenience sample was drawn consisted of adult patients in the cardiac or the medical/surgical/trauma critical care unit of a Southwestern university hospital. Each potential subject required endotracheal intubation with or without mechanical ventilatory support and met the following criteria:

1. was at least 16 years old.
2. had an endotracheal tube in place for at least 48 hours.
3. had a physician’s order for removal of the endotracheal tube.
4. consented to participate in the study or had a family member guardian who consented to the participation.
5. had not been included in the study during a previous intubation period.

Potential subjects were identified by daily rounds or telephone communications between the investigator and the critical care nursing staff. Patients meeting the criteria for inclusion were contacted regarding their willingness to participate. The potential subjects were contacted either prior to removal of the endotracheal tube or just after removal but prior to the usual disposal of the tube.

PROTECTION OF HUMAN SUBJECTS

Potential subjects received an explanation of the study purpose and methods as well as assurance that a decision not to participate in the study would not affect their future health care. They were informed of the absence of known risks or costs as a result of participation. Any questions posed by the patient and/or legal guardian were answered. If the potential subject expressed willingness to participate, consent was obtained and documented on the Human Subjects Consent Form (Appendix A). The research
proposal was approved by the University of Arizona Human Subjects Office and the University Medical Center Department of Nursing (Appendix B).

DATA COLLECTION

After a physician's order for extubation was received by the critical care nursing staff, the extubation process proceeded at the usual rate by the nursing or respiratory therapy staff. If the investigator had not yet arrived when the patient and staff were ready for extubation, extubation was not delayed, but the removed endotracheal tube was placed by the nursing staff into a clean plastic bag on a horizontal surface and kept at room temperature. If the investigator was unable to collect the endotracheal tube specimens within 60 minutes after extubation, the endotracheal tube was not used for the study.

Initial treatment sequences were randomized for each subject by use of a table of random numbers, then the endotracheal tube was subjected to the opposite treatment as well. Treatment A consisted of insertion of a 14 French suction catheter through the universal adapter and cephalocaudal length of the removed, vertical endotracheal tube until a 5 cm length of catheter protruded from the caudal end. The protruding caudal 5 cm of the suction catheter was cut off with sterile scissors, dropping into a
sputum specimen cup. The remainder of the suction catheter was then removed through the universal adapter end of the endotracheal tube and discarded.

Treatment B consisted of instilling 5 cc of prepackaged sterile normal saline without additives from a freshly opened unidose vial through the universal adapter and cephalocaudal length of the removed, vertical endotracheal tube. The fluid was collected from the caudal end of the endotracheal tube into a sputum specimen cup during the instillation.

Collected specimens were transported by the investigator to the hospital microbiology laboratory within 30 minutes after specimen collection and within 90 minutes after extubation. Certified laboratory technicians processed catheter specimens by sonification in normal saline prior to plating. Normal saline instillation specimens were not diluted further prior to plating. In either case, specimen fluid was transferred to a blood agar-MacConkey biplate, used for quantification of colony counts between $10^3$ and $10^5$, then streaked using a flamed calibrated platinum loop. Low range colony counts were identified by simultaneous preparation of a 1/40 plate inoculated by drop from a Pasteur pipette. Bacterial colony counts were taken after 48 hours of plate incubation at 35°C. Counts were reported as colonies per ml for each identified organism.
The medical records of subjects were reviewed for data regarding diagnosis, use of antibiotics, sputum cultures, and length of intubation with the endotracheal tube from which specimens were collected. Information was transcribed onto code-numbered data sheets (Appendix C).

DATA ANALYSIS

Descriptive statistics were used to present the demographic data. Colony count figures underwent logarithmic transformation prior to analysis. Logarithmic transformation is used when data include an extensive range of positive whole numbers. Each colony count value of 0 colonies per ml was treated as a count of 1 colony per ml since a value of 0 cannot be directly transformed (Steel & Torrie, 1980). Analysis of variance was used to compare colony counts of dislodged bacteria after catheter insertion with colony counts of dislodged bacteria after normal saline instillation.

LIMITATIONS

Limitations to this study have been recognized. The small sample size, related to the expense of processing cultures, may limit the generalizability of findings. The inability of the investigator to respond to an extubation
within 60 minutes on one occasion resulted in the loss of a potential subject.
In this chapter the characteristics of the sample, presentation of data, and statistical analysis are included. Data analysis was accomplished using the SAS program (SAS Institute, 1985).

CHARACTERISTICS OF THE SAMPLE

The convenience sample consisted of 10 inpatient subjects from a Southwestern university hospital. Eight of the subjects were recruited from the medical-surgical intensive care unit. The remaining two subjects were recruited from the cardiac intensive care unit. Four of the subjects were admitted with a diagnosis of closed head injury. Two of the subjects were admitted with a diagnosis of gastrointestinal bleeding. The remaining subjects were admitted with one of the following diagnoses: tricyclic overdose, bacterial meningitis, exacerbation of chronic obstructive pulmonary disease, or congestive heart failure. Information regarding diagnosis, duration of endotracheal intubation, endotracheal tube size, and route of intubation is presented in Table 2.

All of those potential subjects who were invited to participate in the study agreed to do so. Two additional family members agreed to participate, but those patients expired prior to extubation.
Table 2.

Characteristics of the subjects - Diagnosis, length of time intubated, and size and route of endotracheal tube.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Intubation (days)</th>
<th>Tube Size/Route (internal diameter - mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed head injury</td>
<td>14</td>
<td>7.5 Nasal</td>
</tr>
<tr>
<td>Tricyclic Overdose</td>
<td>39</td>
<td>7.5 Oral</td>
</tr>
<tr>
<td>Gastrointestinal bleed</td>
<td>20</td>
<td>8.0 Oral</td>
</tr>
<tr>
<td>Gastrointestinal bleed</td>
<td>6</td>
<td>7.0 Oral</td>
</tr>
<tr>
<td>Bacterial meningitis</td>
<td>7</td>
<td>8.0 Oral</td>
</tr>
<tr>
<td>COPD exacerbation</td>
<td>4</td>
<td>8.0 Oral</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>2</td>
<td>7.5 Oral</td>
</tr>
<tr>
<td>Closed head injury</td>
<td>3</td>
<td>8.0 Oral</td>
</tr>
<tr>
<td>Closed head injury</td>
<td>13</td>
<td>8.0 Oral</td>
</tr>
<tr>
<td>Closed head injury</td>
<td>11</td>
<td>8.0 Oral</td>
</tr>
</tbody>
</table>
The length of time subjects were intubated with the tubes used for this study ranged from 2 to 39 days, with a mean duration of 12 days and a median duration of 9 days. All of the subjects required mechanical ventilatory support for some portion of the time that the endotracheal tube was in place. Two of the subjects were expected to require long-term ventilatory support. Their endotracheal tubes were obtained for study at the time of airway change to tracheostomy.

Nine of the subjects were intubated orotracheally. The remaining subject was intubated nasotracheally. Endotracheal tube sizes ranged from 7.0 to 8.0 mm internal diameter.

Nine of the subjects had sputum culture reports positive for bacteria other than normal flora at some time prior to extubation. The remaining subject did not have sputum cultures ordered during his stay. Antibiotic therapy was received by each subject at some time between admission and extubation. Seven of the subjects received multiple antibiotics during hospitalization prior to extubation, while three of the subjects received a single antibiotic course. All but two of the subjects had received intravenous antibiotics within 24 hours prior to extubation.
RESULTS

The bacterial colony counts after suction catheter insertion and after normal saline instillation for each subject are presented in Table 3, along with presumed counts for a 5 ml dose of saline. Six of the subjects had a greater count of viable bacteria dislodged from the endotracheal tube after a single normal saline instillation than after a single suction catheter insertion. Three subjects had a greater number of viable bacteria dislodged from the endotracheal tube after a single suction catheter insertion than after a single normal saline instillation. A subject intubation for 7 days had no viable bacteria dislodged by either suction catheter insertion or normal saline instillation.

Counts of viable bacteria dislodged from the endotracheal tube after a single suction catheter insertion ranged from a reported <40 per ml, the minimum quantification by this technique, to 60,000 per ml, with a mean count of 10,452 per ml. Counts of viable bacteria dislodged from the endotracheal tube after a single 5 ml normal saline instillation ranged from <40 per ml to 62,000 per ml with a mean count of 15,928 per ml. In six cases, the bacterial colony count dislodged was greater from the second procedure performed on the subject's endotracheal
Table 3.

Bacterial colony counts by subject, treatment, and treatment order.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Catheter Insertion (A)</th>
<th>Saline$^a$ Instillation (B)</th>
<th>Saline$^a$ Instillation Total Colony Count (5ml Volume)</th>
<th>Initial treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>120</td>
<td>3,480</td>
<td>17,400</td>
<td>A</td>
</tr>
<tr>
<td>02</td>
<td>25,000</td>
<td>62,000</td>
<td>310,000</td>
<td>B</td>
</tr>
<tr>
<td>03</td>
<td>60,000</td>
<td>40,000</td>
<td>200,000</td>
<td>B</td>
</tr>
<tr>
<td>04</td>
<td>240</td>
<td>680</td>
<td>3,640</td>
<td>A</td>
</tr>
<tr>
<td>05</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>A</td>
</tr>
<tr>
<td>06</td>
<td>5,200</td>
<td>29,000</td>
<td>145,000</td>
<td>A</td>
</tr>
<tr>
<td>07</td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>A</td>
</tr>
<tr>
<td>08</td>
<td>13,000</td>
<td>8,000</td>
<td>40,000</td>
<td>B</td>
</tr>
<tr>
<td>09</td>
<td>880</td>
<td>16,000</td>
<td>80,000</td>
<td>A</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>120</td>
<td>600</td>
<td>B</td>
</tr>
</tbody>
</table>

$^a$/Colony counts per ml.
tube. Only three subjects had greater counts of dislodged bacteria from the initial procedure performed.

The colony counts obtained by either catheter insertion or saline irrigation were bimodally distributed. Prior to statistical analysis, logarithmic transformation was used to produce a more normal curve (Steel & Torrie, 1980). There was no significant difference (p > 0.05) between the bacterial colony counts obtained after a 5 ml normal saline instillation through a used endotracheal tube and the bacterial colony count obtained after a suction catheter insertion through a used endotracheal tube, using logarithmically transformed data. Neither was there a significant difference between counts of viable bacteria dislodged from endotracheal tubes by saline instillation versus suction catheter insertion when subjects were grouped by treatment order (Table 4).

The relationship between length of time subjects remained intubated and total counts dislodged by the combination of treatments was determined by linear regression. The level of correlation between these variables was r=0.

SUMMARY

There was no statistically significant difference between the bacterial colony count obtained after a 5 ml normal saline instillation through a used endotracheal tube
Table 4.

Paired t-test of mean difference (catheter insertion minus saline instillation) for bacterial colonies dislodged from endotracheal tubes.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>mean (±SD) difference</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>-0.41 (1.10)</td>
<td>0.27</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>-0.08 (0.69)</td>
<td>0.10</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>-0.15 (1.31)</td>
<td>0.79</td>
</tr>
</tbody>
</table>

a/Group 1 = all subjects, group 2 = subjects who received suction catheter insertion as first procedure, and group 3 = subjects who received saline instillation as first procedure.
and the colony count obtained after insertion of a suction catheter through a used endotracheal tube. Both saline instillation and catheter insertion, however, dislodge large numbers of viable organisms. The combination of both saline instillation and catheter insertion, in either order, produces greater total bacterial dislodgement than does catheter insertion alone (Table 5).
Table 5.

Bacterial colony counts after catheter insertion and after combined treatments (catheter and 5 ml saline instillation).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Catheter Insertion</th>
<th>Combined catheter insertion and 5 ml saline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total colony count</td>
<td>Total colony count</td>
</tr>
<tr>
<td>1</td>
<td>120</td>
<td>17,520</td>
</tr>
<tr>
<td>2</td>
<td>25,000</td>
<td>335,000</td>
</tr>
<tr>
<td>3</td>
<td>60,000</td>
<td>260,000</td>
</tr>
<tr>
<td>4</td>
<td>240</td>
<td>3,640</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>5,200</td>
<td>150,200</td>
</tr>
<tr>
<td>7</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>8</td>
<td>13,000</td>
<td>53,000</td>
</tr>
<tr>
<td>9</td>
<td>880</td>
<td>80,880</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>600</td>
</tr>
</tbody>
</table>
Chapter 5
DISCUSSION AND CONCLUSIONS

Included in this chapter are interpretation of data as related to the literature and conceptual framework, implications for patient care, and recommendations for future research.

INTERPRETATION OF DATA

The results of this study demonstrate that sterile suction catheter insertion into endotracheal tubes dislodges large numbers of viable bacteria from the tube. In vivo, this dislodged bacteria contacts the lower airway. Catheter insertion or saline instillation are not equivalent alternatives for airway patency maintenance. The addition of a saline instillation step prior to or following suction catheter insertion dislodges more viable bacteria than catheter insertion alone.

Although there was no statistically significant difference ($p < 0.05$) in number of viable bacterial colonies dislodged by catheter insertion through the endotracheal tube versus saline irrigation through the endotracheal tube, there are important clinical differences. The bacterial colony counts in this study were reported in colonies per ml of fluid. Since a 5 ml dose of saline was used for each irrigation, the total colonies dislodged from the
endotracheal tubes were approximately five times the reported count. The majority of saline used for irrigation of endotracheal tubes in vivo is not recovered (Hanley et al., 1978), so saline and bacteria are introduced into the lower airway together. Thus, if a mean count of 15,928 bacterial colonies per ml of saline is instilled and less that 20% of the total fluid instilled is suctioned out of the airway, counts greater than a mean of 63,000 viable bacteria remain in the airway after a single 5 ml saline instillation. This is a $10^4$ mean level of inoculation. Levels of inoculation in this study ranged up to 248,000 viable colonies for one subject after a single 5 ml saline instillation, well into the $10^5$ level of inoculation that was sufficient to overwhelm defense mechanisms in the rats studied by Cash et al. (1979) or the mice exposed to P. aeruginosa by Toews et al. (1979).

Suction catheters used in the study were cultured after insertion through the endotracheal tube. In clinical practice, these catheters are removed from the endotracheal tube after use and discarded. An unknown quantity of bacteria dislodged from the endotracheal tube but adhering to the suction catheter would then be discarded as well. Thus, the model used in this study may underestimate actual clinical bacterial counts after saline irrigation and
overestimate the actual clinical bacterial counts after catheter insertion.

The two subjects intubated the longest times also had the largest total numbers of bacteria dislodged. This finding is similar to that of Sottile et al. (1986). However, the correlation for all subjects between length of time intubated and total numbers of bacteria dislodged from the endotracheal tube was .00. The same two subjects intubated longest were the only subjects who did not receive intravenous antibiotics within 24 hours prior to extubation.

IMPLICATIONS FOR NURSING

Numerous potential hazards of endotracheal suctioning have been documented previously. The risk of dislodging viable bacteria into the lower airway from the lumen of the endotracheal tube must also be weighed against the potential benefits of endotracheal suction to the individual patient.

In some critical care units, patients are still routinely suctioned at preset intervals. For patients who do not actually require suctioning at those times, the risk of bacterial inoculation outweighs the benefit. This risk is multiplied during the numerous times each day suctioning is performed during the length of time the patient is intubated. Routine saline instillations during a suctioning episode have not been effective in improving immediate suctioning outcomes in previous studies. The risk of lower
airway contamination identified in this study in addition to the lack of benefit of saline instillation demonstrated in previous studies leads to the recommendation that saline instillation be omitted as a routine procedure for airway maintenance.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future studies might address other aspects of saline and catheter bacterial dislodgement. In clinical practice, the same suction catheter is typically passed through the endotracheal tube more than once, continuing until secretions are completely cleared. A study might identify how successive catheter insertions or saline instillations affect bacterial dislodgement during a suctioning episode. The significance of bacterial dislodgement by saline instillation might be evaluated in a study designed to compare outcomes in groups of patients who receive saline prior to catheter insertion with those who do not receive saline instillation at all.

Maintenance of tracheostomy tubes differs from that of endotracheal tubes. The inner lumen of the tracheostomy tubes inner cannula is typically cleaned with friction and diluted hydrogen peroxide several times a day for hospitalized mechanically ventilated patients. Does this cleaning procedure prevent bacterial glycocalyx formation
and eliminate the risks identified for patients with endotracheal tubes?

SUMMARY/CONCLUSIONS

The findings discussed here lead to the conclusion that, for patients who are endotracheally intubated longer than 48 hours, saline instillation poses an infectious risk greater than that posed by suction catheter insertion alone. Further study is necessary to determine whether or not that risk is borne out in actual negative patient outcomes.
APPENDIX A: SUBJECT’S CONSENT FORM

Subject’s Consent

Effects of Endotracheal Tube Irrigation

I AM BEING ASKED TO READ THE FOLLOWING MATERIAL TO ENSURE THAT I AM INFORMED OF THE NATURE OF THIS RESEARCH STUDY AND OF HOW I WILL PARTICIPATE IN IT, IF I CONSENT TO DO SO. SIGNING THIS FORM WILL INDICATE THAT I HAVE BEEN SO INFORMED AND THAT I GIVE MY CONSENT. FEDERAL REGULATIONS REQUIRE WRITTEN INFORMED CONSENT PRIOR TO PARTICIPATION IN THIS STUDY SO THAT I KNOW THE NATURE AND THE RISKS OF MY PARTICIPATION AND CAN DECIDE TO PARTICIPATE OR NOT PARTICIPATE IN A FREE AND INFORMED MANNER.

Purpose

I am/my family member is being invited to voluntarily participate in the above-titled research project. The purpose of this project is to compare different techniques used by nurses to remove mucus from breathing tubes.

Selection Criteria

I am/my family member is being invited to participate because I/my family member no longer requires the help of a breathing tube and will have it removed soon. Approximately 20 subjects will be enrolled in this study.

Procedure

If I agree to participate, I will be asked to allow the researcher to collect the mucus inside my breathing tube after the breathing tube is removed from my throat. Information such as how long I used the breathing tube, my diagnosis, whether or not I received medication to treat infections, and whether or not a lung infection was present before breathing tube was removed will be obtained from a review of my medical records.

Risks

My participation in this study poses no known risks to me. If I choose not to participate, my decision will not affect my future care in any way.
Benefits

My participation in this study provides no benefits to me other than that the information will be used to improve the care of patients requiring breathing tubes in the future.

Confidentiality

All information will be kept confidential by the principal investigator, Debra Hagler, RN. A code number will be used instead of my name on the data sheets, which will be kept in a locked file cabinet. If information from this study is used in a later study, the same confidentiality procedures will be maintained.

Participation Costs

There are no costs to me as a participant in this study.
I can obtain further information from Debra Hagler, RN at 888-5075. If I have questions concerning my rights as a research subject, I may call the Human Subjects Committee Office at 626-6721.
AUTHORIZATION

"IN GIVING MY CONSENT BY SIGNING THIS FORM, I AGREE THAT THE METHODS, INCONVENIENCES, RISK AND BENEFITS HAVE BEEN EXPLAINED TO ME AND MY QUESTIONS HAVE BEEN ANSWERED. I UNDERSTAND THAT I MAY ASK QUESTIONS AT ANY TIME AND THAT I AM FREE TO WITHDRAW FROM THE PROJECT AT ANY TIME WITHOUT CAUSING BAD FEELINGS OR AFFECTING MY MEDICAL CARE. MY PARTICIPATION IN THIS PROJECT MAY BE ENDED BY THE INVESTIGATOR OR BY THE SPONSOR FOR REASONS THAT WOULD BE EXPLAINED. NEW INFORMATION DEVELOPED DURING THE COURSE OF THIS STUDY WHICH MAY AFFECT MY WILLINGNESS TO CONTINUE IN THIS RESEARCH PROJECT WILL BE GIVEN TO ME AS IT BECOMES AVAILABLE. I UNDERSTAND THAT THIS CONSENT FORM WILL BE FILED IN AN AREA DESIGNATED BY THE HUMAN SUBJECTS COMMITTEE WITH ACCESS RESTRICTED TO THE PRINCIPLE INVESTIGATOR, DEBRA HAGLER, RN, OR AUTHORIZED REPRESENTATIVE OF THE NURSING DEPARTMENT. I UNDERSTAND THAT I DO NOT GIVE UP ANY OF MY LEGAL RIGHTS BY SIGNING THIS FORM. A COPY OF THIS SIGNED CONSENT FORM WILL BE GIVEN TO ME."

Subject’s Signature Date

Family Member/Legal Guardian Date
(if necessary)

Witness Date

INVESTIGATORS AFFIDAVIT

This consent form has carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge the person who is signing this consent form understands clearly the nature, demands, benefits, and risks involved in his/her participation and his/her signature is legally valid. A medical problem or language or educational barriers has not precluded this understanding.

Signature of Investigator Date
December 12, 1991

Debra Hagler, RN, BSN
College of Nursing
Arizona Health Sciences Center

RE: EFFECTS OF ENDOTRACHEAL TUBE IRRIGATION

Dear Ms. Hagler:

We received documents concerning your above cited project. Regulations published by the U.S. Department of Health and Human Services [45 CFR Part 46.101(b)(5)] exempt this type of research from review by our Committee.

Please be advised that approval for this project and the requirement of a subject's consent form is to be determined by your department.

Thank you for informing us of your work. If you have any questions concerning the above, please contact this office.

Sincerely yours,

William F. Denny, M.D.
Chairman,
Human Subjects Committee

cc: Departmental/College Review Committee
MEMORANDUM

TO: Debra Hagler, R.N., B.S.N.
FROM: Leanna Crosby, D.N.Sc., R.N., Director of Intramural Research
DATE: December 16, 1991

SUBJECT: Human Subjects Review "Effects of Endotracheal Tube Irrigation"

Your research project has been reviewed and approved by William Denny, M.D., Chairman of the University of Arizona Human Subjects Committee, and deemed to be exempt from review by their full committee. You will be receiving a confirmation letter from Dr. Denny. In addition, your project has been reviewed and approved by the College of Nursing Human Subjects Review Committee. At the completion of your research, please bring your signed consent forms to the Office of Nursing Research.

We wish you a valuable and stimulating experience with your research.

LC/ga
Debra Hagler  
1204 W. Schafer Drive  
Tucson, Arizona 85705

Dear Mr. Hagler:

It is a pleasure to approve the request to conduct the study, "Effects of Endotracheal Tube Irrigation" at the University Medical Center Adult Health Services. Theresa Grzyb-Wysocki, Director, Adult Health Services will serve as your contact person.

Please let me know if you have any questions. We look forward to having you share your results with the nursing staff and administration.

Sincerely,

[Signature]

Lauri McCanless, MS, RNC, CNS  
Nursing  
University Medical Center

LMcC/e
APPENDIX C. DATA COLLECTION FORM.

Subject ID # _____________
Date/time of extubation _____________
Date/time of specimen collection A _____________ (catheter)
Date/time of specimen collection B _____________ (NSI)
Date/time of specimen receipt in lab _____________
Colony count A: _________
Colony count B: _________
ET size _________
                  Type _________

Diagnosis admitting _______________________
Diagnosis current _______________________
Date/time of intubation ____________________
Results of previous sputum cultures:

Antibiotic therapy:
References


