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Clinical indicators of transpyloric feeding tube placement in critically ill children.

Mary Frances Drake Pate
University of Alabama at Birmingham

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CLINICAL INDICATORS OF TRANSPYLORIC FEEDING TUBE PLACEMENT IN CRITICALLY ILL CHILDREN

by

MARY FRANCES DRAKE PATE

A DISSERTATION

Submitted to the graduate faculty of The University of Alabama at Birmingham, in partial fulfillment of the requirements for the degree of Doctor of Science in Nursing

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ABSTRACT OF DISSERTATION
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Children admitted to intensive care units may receive transpyloric (TP) tube feedings as a part of care. Traditionally, placement of these tubes is verified by confirmatory radiograph. This study was conducted to determine if clinical indicators were predictors of TP tube placement, thereby possibly decreasing or eliminating the need for confirmatory radiographs. If confirmatory radiographs were decreased or eliminated, cost savings to the patient and hospital could be realized. A reduction in the number of confirmatory radiographs would also decrease the radiation exposure obtained by patient, family, and staff. Data were collected in critical care units in the study hospital and were based on 54 cases. Each TP tube was assessed for the four clinical indicators (predictor variables) of pH, vacuum effect, aspirate color, and ausculatory findings. The clinical indicators were then compared to radiographic results (dependent variable). Findings revealed that clinical indicators can predict TP placement, but do so most accurately when used in combination with each other.

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CHAPTER 1

INTRODUCTION

Children have higher metabolic rates than adults, and even inactive children require baseline maintenance caloric intake for growth. Critically ill children, especially those experiencing burns or trauma, have significantly increased caloric requirements (Hazenski, 1992). Malnutrition develops within 48 hr after intensive care unit (ICU) admission in up to 20% of critically ill children (Brilli, Carver, Krafte-Jacobs, Moore, & Persinger, 1996). If inadequate oral intake is not expected, children admitted to ICUs should receive nutritional support within 36 hr of admission (Kuhn, 1990). Enteral tube feedings are the preferred method of nutrition in critically ill children who have functional gastrointestinal systems (Brilli et al.). Enteral feedings enhance gut healing, reduce bacterial translocation, are associated with reduced rates of sepsis, and are provided at less cost than parental nutrition (Zalaga, 1991). Gastric and transpyloric (TP) routes may be used to provide enteral feeds; however, when a child has gastroparesis or risks aspiration due to gastroesophogeal reflux, enteral tubes are placed transpylorically instead of gastrically to decrease aspiration risks (Edes, 1991). Furthermore,

gastric motility recovers more slowly than intestinal motility (Livingston & Passaro, 1990), making this another reason for instituting transpyloric feedings rather than gastric feedings.

Transpyloric tubes are usually made of polyvinylchloride or silicone and may be placed oro- or naso-gastrically. Since the materials used to make the tubes are pliable, stylets may be utilized to stiffen the tube to aid in tube insertion. However, use of a stylet may increase the risk of pneumothorax (Verger, 1996). When the physician orders a TP tube, it may be placed under fluoroscopy, or placed by the nurse at the bedside. The correct size of feeding tube is then selected for placement based on the child's age and size. Transpyloric tubes are placed into a patent nari and advanced to the stomach while the child is positioned on the right side with the head slightly flexed and elevated (Mohler, Ugo, & Wilson, 1992). Confirmation of gastric placement is then performed by auscultation while insufflating the tube with air. Next, air is injected through the TP tube with a 60-cc syringe while an attempt is made to advance the tube past the pyloric sphincter into the duodenum or jejunum. Air insufflation during advancement facilitates movement of the tube through the pylorus. The bedside nurse then assesses tube placement by utilization of the clinical indicators of vacuum effect, ausculatory findings, aspirate color, and pH values (predictor variables). Routinely, feedings are not

started until there is radiographic confirmation (dependent variable) of intestinal placement.

Routine procedures such as the confirmatory radiograph for TP tube placement need to be assessed for usefulness. Groups such as the National Association of Children's Hospitals and Related Institutions (NACHRI) use practices such as this to evaluate cost effectiveness and patient outcomes. Otherwise, interventions by health care providers may be based on tradition, routine, or habit rather than on research.

Purpose

The purpose of this study was to ascertain whether clinical indicators were predictors of TP tube placement in critically ill children.

Guiding Framework

This study was guided by a joint position statement prepared by the 8,000-member Society of Critical Care Medicine and the 78,000-member American Association of Critical-Care Nurses. The position statement titled "Essential Provisions for Critical Care in Health System Reform" (American Association of Critical Care Nurses and Society of Critical Care Medicine ([ACCN & SCCM], 1994) provided a framework in which critical care health providers may practice.

Individuals of all ages may suffer from critical illness or injury. Four to six million individuals per year

become critically ill or injured in the United States. Despite the best prevention efforts, 80% of all U.S. inhabitants will need critical care during their lifetime--as a patient, family member, or close friend of a patient. Additionally, patients receiving critical care account for almost 30% of hospital costs, yet they occupy only 7% to 10% of all inpatient hospital beds. The cost of care provided to a critically ill or injured patient can exceed three to four times the cost of care rendered to a patient occupying a routine hospital location and is eight times more costly if that person receives breathing assistance from a ventilator (AACN & SCCM, 1994).

A reformed health system emphasizes quality improvement. High-quality care maximizes the likelihood of desired outcomes for the individual and society and is consistent with emerging knowledge. The AACN and SCCM (1994) support the control of health care costs. However, cost control measures must not diminish the quality of patient care. One cost control measure supported by the position paper is the elimination of care that has been shown to be unnecessary and of no benefit to the patient (AACN & SCCM). A confirmatory radiograph after TP tube placement may be one of the unnecessary procedures that the position paper addresses. If confirmatory radiographs for TP tube placement can be decreased or eliminated, then the patient and staff would not be exposed to radiation and the patient and hospital could realize cost savings.

The AACN and SCCM (1994) contend that increased funding for research will enable health care providers to improve patient survival, speed recovery, minimize disability, and relieve pain and suffering. Academic health centers and teaching hospitals have an opportunity to play a vital role in improving patient outcomes. This improvement could occur through the training of health care providers and the development of innovative strategies for care and research that is patient outcome focused. Therefore, research related to practices that are done out of tradition, routine, or habit should be a top priority for these institutions.

As mentioned earlier, groups such as NACHRI (1996) propose to enhance or maintain the quality of patient care through the identification, implementation, and evaluation of cost effective care practices that promote optimal patient and family outcomes. In the rapidly changing environment of pediatric health care, fee-for-service centers are quickly becoming capitated expense centers. Thus, the barriers of tradition, routine, and habit must be broken down so that clinical resources can be managed more effectively. This goal can be met only when patient care practices are research based. This is a goal congruent with the AACN and SCCM's (1994) joint position paper.

Problem Statement

Do clinical indicators predict TP tube placement in critically ill children?

Research Questions

For the purpose of this study, the following research questions were explored:

1. Is pH a predictor of TP tube placement?
2. Is vacuum effect a predictor of TP tube placement?
3. Are ausculatory findings a predictor or TP tube placement?
4. Is aspirate color a predictor of TP tube placement?
5. Is there a predictive relationship between pH, vacuum effect, ausculatory findings, aspirate color, and TP tube placement by confirmatory radiograph?

Assumptions

For the purpose of this study, the following assumptions were presented.

1. The pH of intestinal fluid can be measured.
2. Nurses follow hospital policy and procedure for TP tube placement.
3. Subjects possess functioning gastrointestinal systems.

Limitations

For the purpose of this study, the following limitations were considered.

1. The sample was limited to children in critical care units in one hospital.

2. The sample was limited to children between newborn and 18 years of age.

The selection of this age group was based on admission criteria for the critical care units of the study hospital. TP tubes are used in patients throughout the life span. In infancy, the stomach is pear-shaped and in a transverse position. Infants also have rapid transit times and small stomach capacity. This contributes to the high frequency of feeding and stooling. By the age of 7 years, the shape, position, and transit time approximates that of the adult stomach (Verger, 1996). Therefore, there was no expected effect related to patient age because transit time was not the variable under study.

Definitions of Terms

The following terms were defined for the purpose of this study.

pH--the concentration of hydrogen ions as measured by litmus paper in 0.5 increments.

Intestinal fluid--the bright translucent yellow/green fluid from the intestine which drains by gravity into a receptacle or is aspirated from a TP tube.

Transpyloric (TP) tube--a 5 french to 8 french polyvinyl chloride, silastic, weighted or nonweighted feeding tube that is placed distal to the stomach.

Critically ill child--a child that is admitted to either the pediatric, neonatal, or burn intensive care or the intermediate care unit in the study hospital.

Vacuum effect (snap test)--the effect obtained when a 60-cc syringe is attached to the end of a TP tube and all the air is evacuated and then the syringe plunger is pulled back and allowed to passively "snap back" into the hub of the syringe.

Significance

Nutritional therapy is an important intervention for the critically ill child. Children have larger body surface areas in relation to weight, less subcutaneous tissue, and higher basal metabolic rates than that of adults (Ferraro-McDuffie, Huddleston, & Wolff-Small, 1993). These characteristics make the critically ill child more susceptible to malnutrition. Disease process, such as cancer, and injuries, such as burns and trauma, may also increase a child's nutritional needs. Malnutrition increases morbidity, length of stay, resource use, and mortality (Berry et al., 1994). Therefore, some form of nutrition should be instituted as quickly as possible following admission. Enteral feedings can be provided in less time, less expensively, and with fewer side effects than parenteral feeds, possibly decreasing length of stay and cost for the patient.

Clinical indicators are routinely used by the bedside nurse to predict TP tube position; however, radiographs are still ordered by the physician to confirm proper placement. This practice is contrary to the joint position paper by the AACN and SSCM (1994) and the goals of NACHRI (1996).

Both of these groups advocate the elimination of unnecessary procedures. The practice of ordering confirmatory radiographs could possibly be decreased or eliminated if clinical indicators were found to be a reliable predictor of TP tube placement. If confirmatory radiographs were decreased or eliminated, cost savings to the patient and hospital could be realized (Abrahms, 1979). This would be especially true for patients who have repeated TP tube placements. In addition, radiation exposure to the patient and critical care staff would be decreased if confirmatory x-rays were decreased or eliminated (Miracle & Wigginton, 1990). Critically ill children may receive numerous radiographs for reasons such as endotracheal tube placement, vascular line placement, and evaluation of interventions. This practice exposes the patient to a cumulative radiation dose, which at levels outside of the recommended acceptable radiation dose levels could cause detrimental health effects (Bowen, Lynch, & Malone, 1994; Dellagrammaticas & Robinson, 1983; Isdale & Werner, 1986). If the TP tube must be reinserted due to dislodgment or being pulled out, TP tube reinsertion would call for another radiograph, thereby exposing the child to more radiation.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The study's purpose was to ascertain whether clinical indicators predict TP tube placement in critically ill children. Various research related to the clinical indicators and TP tubes is presented.

Research Related to pH Sensing Feeding Tubes

In a study by Botoman, Kirtland, and Moss (1994), placement of standard feeding tubes versus pH-sensor feeding tubes in 39 adult patients was evaluated. Twenty patients received the pH-sensor tubes, and 19 received the standard TP tubes. The investigators evaluated speed and accuracy of placement, displacement detection, and costs for the two groups. At 48 hr, 93% of the pH-sensor feeding tubes reached the duodenum, in contrast with 67% of the standard feeding tubes. In patients with decreased amounts of gastric acid, the pH-sensing feature was useless. Thus, confirmatory radiographs were needed. In two thirds of the patients, when the pH changed from alkaline (esophagus) to acid (stomach) to alkaline (duodenum), there was 100% specificity for duodenal placement compared with the confirmatory radiograph. The writers stated that they felt "sufficiently comfortable" in advocating that x-rays not be

obtained when this pattern was encountered. A cost saving of $85 per subject was also calculated. Since approximately 7 million feeding tubes are placed annually in the United States alone, a savings of up to $595 million could be realized if this technology were used more widely. However, if each subject had received one confirmatory radiograph, the savings would have been only $17.25 per subject due to the cost of the pH-sensing feeding tube.

In a 1994 study by Berry et al., the investigators sought to determine if anti-ulcer regimens would affect pH sensor tube placement in the adult population. Twenty-five intensive care patients received the pH-sensing TP tubes. Many of the patients were intubated and on mechanical ventilation. All patients were receiving anti-ulcer medications in the following configurations: ranitidine at varying times and dosages, famotidine plus antacids, and sucralfate. Study findings revealed that anti-ulcer therapies did not preclude pH-sensing TP tube placement. Successful intestinal placement occurred in 91% of the attempts. Observed pH values did not differ between successful and unsuccessful placement.

Brilli et al. (1996) looked at critically ill children younger than 4 years of age to evaluate the insertion techniques of standard and pH-sensor transpyloric feeding tubes. There were 34 children in the standard feeding tube group and 34 children in the pH-sensor group. Identical TP feeding tubes were used in both groups, with a pH-sensor being added in the pH-sensor group. Ninety-seven percent of

patients in the pH sensor group had successful placement after the first attempt, compared with 53% of the patients in the standard feeding tube group. All patients in the pH-sensor group had successful placement after the second attempt, compared with 78% of patients in the standard feeding tube group. A pH of greater than 5.6 accurately predicted TP placement 97% of the time in the pH-sensor group. Hospital costs were $114 per patient in the pH sensor group and $135 per patient in the standard feeding tube group.

Research Related to Clinical Indicators

Determination of gastric pH is most commonly done using pH-sensitive test paper (Gedeit, Havens, Weigle, & Werlin, 1993). The use of this method of determining gastric pH was first described by Einhorn in 1910 (Cioffi et al., 1993). However, several studies (Ahern, Neill, & Rice, 1993; Baghie, Fromm, Levine, Mojtahedzdeh, & Opekun, 1994; Dobkin, Roher, & Valcour 1990; Durham & Weigelt, 1989; Eisenberg, Cort, & Zuckerman, 1990) have shown that values from pH-meters were more reliable than pH paper due to the subjectivity of the readers' interpretation of the visual color.

Eisenberg et al. (1989) sought to determine whether pH aspirates could differentiate between gastric and intestinal secretions. The sample consisted of 181 adult subjects, 94 with nasogastric tubes and 87 with nasointestinal tubes. Patients receiving antacids orally or

by tube within 4 hr were excluded from testing for fear of interference with pH values. Aspirate pH values were recorded within 5 min of a confirmatory x-ray, and comparisons were made. Eighty-one percent of the aspirates from the nasogastric tubes had pH values ranging from 1 to 4, while 88% of the aspirates from nasointestinal tubes had a pH of 6 or greater. Only one aspirate from a tube inadvertently placed in the lung was tested and had an alkaline pH. Clark, Metheny, Reed, and Worseck (1993), in a replication of the above study, found that gastric pH values were significantly higher in subjects receiving acid inhibitors than in those not receiving these agents; however, the use of acid inhibitors had no significant effect on intestinal pH readings.

Foulks, Hanlon, Waits, and Welch (1994) evaluated the validity of four indicators to predict successful duodenal feeding tube placement in 106 adult patients. The four indicators under study were auscultation, vacuum effect, pH, and color of prepyloric and postpyloric aspirate. Eighty-three percent of the feeding tubes inserted blindly at the bedside were successfully placed into the duodenum, using the four indicators. Auscultation and vacuum effect, alone or in combination, were not conclusive for duodenal placement; therefore, a confirmatory radiograph was recommended by the authors for these indicators. Color and pH changes were found to be valid indicators of duodenal placement, with positive predictive values of 100%. The researchers indicated that more studies need to be done

before confirmatory radiographs are deleted. This recommendation was made because 40% of the TP tubes that were positively placed and 36% of the TP tubes that showed a positive color change were noted to be in the proximal duodenum upon radiographic examination.

Auscultation while insufflating air through gastric or intestinal tubes has traditionally been used by nurses as a determination of placement (Barry-Walker et al., 1994). Migration of feeding tubes into the intestine has also been determined by auscultation related to changes in pitch and location of sounds during insufflation (Mohler et al., 1992; Thurlow, 1986; Zalaga, 1991). Eisenberg, Metheny, and Spies (1988) found that during air insufflation into feeding tubes, sounds were auscultated over the epigastrium when tubes were not in the stomach. Air was also auscultated at the epigastrium when the feeding tube was in the esophagus, duodenum, and jejunum. Several studies (Baxter, Dobranowski, Fitzgerald, & Woods, 1992; Dettenmeier, Hampton, Metheny, Wiersema, & Williams, 1990; Ravish & Roubenhoff, 1989) have also shown that sounds or air insufflation may be noted over the epigastrium when the feeding tube has been inadvertently placed in the lung.

Assessment of feeding tube aspirate color is one method used to determine TP tube placement (Barry-Walker et al., 1994); however, it is sometimes difficult to obtain an aspirate because small-bore feeding tubes are flexible and the tubes tend to collapse when suction is applied, making aspiration difficult (Eisenberg et al., 1988). Clark et al.

(1993) and Clark, McSweeny, Metheny, Reed, Wehrle, and Wiersema (1993) identified several techniques which increased the likelihood of obtaining an aspirate. These techniques were insufflating small bursts of air through the tube before aspirating, the use of a 10-mL syringe to aspirate fluid, waiting 15 to 30 min before trying again, repositioning the patient from side to side, or moving the head of the bed up and down.

Clark, McSweeny et al. (1993) found that fluid aspirate color changed as the feeding tube moved through the gastrointestinal tract. Gastric aspirates were found to be cloudy, green, off-white, brown, or colorless. Other studies (Baxter et al., 1992; Dettenmeier et al., 1990; Lenchner, Promisloff, & Wendell, 1991) revealed that in some cases, respiratory aspirate resembled gastric aspirates. Intestinal aspirated were shown (Clark, McSweeny et al., 1993) to be clear and yellow to gold in color.

Vacuum effect as an indicator of TP tube placement has not been previously described in the research literature related to children. The term vacuum effect was found in only one research article (Foulks et al., 1994) and was related to the adult population.

Summary

Several research studies reported the use of the four clinical indicators in this study as useful in the assessment of TP tube placement; however, the majority of the research available was related to pH testing of

gastrointestinal aspirate and TP tube placement. There was minimal research available regarding the clinical indicators of aspirate color, vacuum effect, and ausculatory findings. Additionally, the majority of the studies found during the literature review were carried out in the adult population.

CHAPTER 3

METHODOLOGY

The purpose of this study was to ascertain whether clinical indicators were predictors of transpyloric feeding tube placement in critically ill children.

Design

This study employed a descriptive comparative design. This type of design was selected because clinical indicator data from tubes that were in transpyloric placement were compared with clinical indicator data from tubes that were not in transpyloric placement.

Population and Sample

The target population in this study was critically ill children admitted to four units in the study hospital. Critically ill children with TP feeding tubes composed the convenience sample. Suitable subjects were sought by the investigator during daily bedside rounds in the four units. The four units were a pediatric intensive care unit, a special care unit, a neonatal intensive care unit, and a burn center. For the purpose of attaining statistical power of .80 (alpha = .05) a minimum of 54 subjects were required and obtained.

Protection of Human Subjects

Prior to implementation of the study, an application for approval of human use was submitted for review by the Institutional Review Board (IRB) of The University of Alabama at Birmingham and the study hospital's research review board. Approval was obtained from both parties (Appendices A & B). No patient identifying information was required and the need to view the chart was not necessary when the data collection tool was fully completed by the RN. When the chart was reviewed, it was only seen once. Information derived from this study was reported as group data.

Instrumentation

One instrument was developed by the investigator for data collection. The instrument was constructed for the purposes of categorizing the subjects according to age, sex, diagnosis, medications, transpyloric feeding tube type, clinical indicators, and radiographic findings. Information related to age, gender, and diagnosis was collected for the purposes of categorization only. There were no effects expected regarding the clinical indicators due to age, gender, or diagnosis. Information related to gender was collected so that the investigator could also assess for any potential gender biasing. Information related to clinical indicators and radiographic findings were obtained for descriptive and discriminant function analyses.

Procedure

Approval from the study hospital's research review board and The University of Alabama at Birmingham's IRB was sought and obtained by the investigator. After these approvals were obtained, the registered nurses (RNs) from the four critical care areas were educated by the investigator concerning data collection instrument completion. After obtaining informed consent (Appendix C), transpyloric tubes were placed by the staff RN according to hospital policy and procedure upon physician order. When intestinal fluid appeared in the drainage receptacle, the pH of the fluid was checked by the RN and documented on the data collection tool (Appendix D). If fluid did not appear within 1 hr after insertion, fluid was aspirated from the transpyloric tube according to the hospitals policy and procedure using a 60-cc syringe. Once aspirate was obtained, a radiograph was called for by the patient's nurse. The remaining clinical indicators (ausculatory findings, aspirate color, and vacuum effect) were then assessed and documented on the data collection tool. This assessment occurred within 5 min of the confirmatory radiograph, with no knowledge of radiograph results. When radiographic results were obtained, these were also documented on the data collection tool by the patient's nurse. After completion of all data collection by the bedside nurse, the tool was left at the bedside for retrieval by the investigator during daily bedside rounds.

Analysis of Data

Analysis of data was performed by the Statistical Package for Social Sciences (SPSS) graduate student computer program. The study was composed of four predictor variables (pH, ausculatory findings, vacuum effect, aspirate color) and one dependent variable (TP placement by radiograph as "in" or "out"). Demographic findings were presented by simple descriptive analysis to describe the sample. Additional analyses were employed using discriminant function analysis. Use of discriminant function analysis allowed the investigator to predict group membership of TP tubes that were in transpyloric placement upon radiography versus those that were not; determine whether there were differences between groups ("in" and "out" tubes) and the magnitude of any differences; and determine which variables were most predictive of TP tubes which were in transpyloric placement and which were not.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

The purpose of this study was to ascertain whether clinical indicators were predictors of TP tube placement in critically ill children. Data analyses were performed on information obtained from 54 tube placements. This chapter consists of the findings from the analysis of data through the SPSS computer program for graduate students. The findings are presented in two sections: descriptive information about the sample and variables under study, and analysis of data which addressed the research questions.

Findings

There were 62 cases processed for this analysis. Eight cases were excluded due to missing values. Therefore, the analysis is based on 54 cases. All cases were obtained from three of the four critical care units in the study hospital. In one unit, the burn center, all TP tubes were placed under fluoroscopy during the study due to physician preference. Therefore, no cases from that area were used in this analysis.

Sample

There were 29 (53.7%) female and 25 (46.3%) male participants in the study. Table 1 displays the age groupings of the study participants as defined by the American Academy of Pediatrics. The largest age grouping was the neonatal group, followed by infants, children in early childhood, children in middle childhood, and adolescents. As stated previously, this information was obtained for the purposes of categorization only.

Table 1

Frequencies and Percentages of the Participant Age Groupings

Age	Frequency	Percent	Cumulative %
Neonate	26	48.10	48.10
Infant	17	31.40	79.50
Early childhood	1	1.85	81.35
Middle childhood	5	9.20	90.55
Adolescent	5	9.20	100.00
Total	54	100.00	

Table 2 contains demographic data which displays the diagnoses of the study participants. Critically ill children with respiratory diagnoses comprised half of the study grouping having TP feeding tubes placed. As stated previously, the major criteria for having a TP tube placed

was a functioning gastrointestinal tract. Staff nurses reported that children with diagnoses such as pyloric stenosis or other congenital gastrointestinal problems required more time to obtain correct placement. Otherwise, no other effects related to diagnosis were noted by nursing staff.

Table 2

Frequencies and Percentages of Participant Diagnoses

Diagnosis	Frequency	%	Valid %	Cumulative %
Respiratory	27	50.00	50.90	50.90
Gastrointestinal	12	22.20	22.64	73.54
Neurologic	7	12.96	13.20	86.74
Cardiovascular	2	3.70	3.77	90.51
Ingestions	2	3.70	3.77	100.00
Renal	1	1.85	1.88	92.36
Traumatic	1	1.85	1.88	94.27
Immunologic	1	1.85	1.88	96.15
--	1	1.85	missing	
Total	54	100.00		

Is pH a Predictor of TP Tube Placement?

Table 3 shows gastrointestinal pH values, which range from 4.5 to 7.5. All tubes in the transpyloric position had pH values ranging from 6.0 to 7.5. Tubes not in

transpyloric position had pH values of 4.5 to 5.0 except for one tube which was in the esophagus and had a pH of 7.5

Table 3

Frequencies and Percentages of pH From Gastrointestinal Fluid

pH Value	Frequency	%	Cumulative %
4.50	19	35.2	35.2
5.00	4	7.4	42.6
6.00	2	3.7	46.3
6.50	9	16.7	63.0
7.00	9	16.7	79.6
7.50	11	20.4	100.0
Total	54	100.0	

Is Vacuum Effect a Predictor of TP Tube Placement?

Table 4 contains frequency data related to the clinical indicator, vacuum effect. As shown, a vacuum effect was demonstrated in 50% of the tubes. All tubes with vacuum effects were in transpyloric placement. A vacuum effect was absent in 46.3% of the tubes. Each of the tubes without a vacuum effect was not in transpyloric placement. Nursing staff were unsure of the findings regarding vacuum effect 3.7% of the time.

Table 4

Frequencies and Percentages of Vacuum Effect Findings

Vacuum effect	Frequency	%	Cumulative %
Present	28	50.0	50.0
Absent	24	46.3	96.3
Unsure	2	3.7	100.0
Total	54	100.0	

Are Ausculatory Findings a Predictor of TP Tube Placement?

Table 5 is a display of staff members' ausculatory findings. All tubes not in transpyloric position by radiograph (24 tubes) were noted to be heard at their loudest in the center of the abdomen near the epigastrium. Tubes in transpyloric position by radiograph were noted to be heard at their loudest on the right side of the lower abdomen (21 tubes). Of the remaining nine tubes in transpyloric position, staff ausculated sounds of equal intensity regardless of stethoscope position on the abdomen in three instances. In six cases, staff were unsure where they heard sounds more intensely. No tubes in this study were noted to be at their loudest on the left side.

Table 5

Frequencies and Percentages of Ausculatory Findings

Ausculatory findings	Frequency	%	Cumulative %
Right	21	38.9	38.9
Equal	3	5.9	44.4
Unsure	6	11.1	55.6
Center	24	44.4	100.0
Total	54	100.0	

Is Aspirate Color a Predictor of TP Tube Placement?

Table 6 is a presentation of aspirate color frequency. Tubes in transpyloric position (30 tubes) were noted to have either translucent green (2 samples) or translucent yellow (26 samples) aspirate color. Of the remaining two tubes in transpyloric position by radiograph, one had bright orange aspirate and the second tube yielded creamy white fluid. Feeding tubes not in transpyloric position by radiograph (24 tubes) had aspirate described as cloudy white (11 tubes) or cloudy green (13 tubes).

Is There a Predictive Relationship Between Predictor Variables and the Independent Variable?

Discriminant function analysis was performed with the four clinical indicators (predictor variables) considered simultaneously in the equation. The canonical correlation

Table 6

Frequencies and Percentages of Aspirate Color

Aspirate Color	Frequency	%	Cumulative %
Translucent green	2	3.7	3.7
Translucent yellow	26	48.1	51.9
Orange or white	2	3.7	55.6
Cloudy white	11	20.4	75.9
Cloudy green	13	24.1	100.0
Total	54	100.0	

obtained with this procedure was .961. This value shows the correlation between the predictor variables on one hand and the dependent variable (TP tube placement by radiograph) on the other. The value of .965 indicates that the clinical indicators accounted for approximately 92% of the variance in group membership ($.961^2$ = .923). The chi-square statistic for Wilks' lambda was 127.998, which is significant beyond .00005. Thus, the four clinical indicators, as a set can reliably be used to discriminate tubes that are in transpyloric position with those that are not. Pooled-within-group correlations between discriminating variables and canonical discriminant functions shown in Table 7 revealed that clinical indicators that discriminate the most between the two groups were, in descending order, aspirate color, pH, auscultation, and vacuum effect. The predictors are listed here in order of

the structure coefficient's magnitude. Thus, the predictor that contributed most to the discrimination between the two groups of tubes that were "in" or "out" of transpyloric placement was aspirate color.

Table 7

Pooled-Within-Group Correlations Between Discriminating Variables

Structure matrix	Function 1
Aspirate color	.851
pH	-.599
Ausculatory findings	.494
Vacuum effect	.308

Data presented in Table 8 regarding group centroid data reveal that pH was more closely associated with a tube being transpyloric, while color, ausculatory findings, and vacuum effect were more closely associated with tubes being out of transpyloric position. The positive structure coefficient indicated a predictor variable that was associated with tubes being out of transpyloric placement, while the negative structure coefficient was associated with tubes that were in transpyloric placement.

As displayed in Table 9, 100% of the two original groups were initially classified correctly. That is, actual group membership as determined by radiograph and predicted

group membership as predicted by the clinical indicators was exactly the same.

Table 8

Group Centroid Data

Radiographic results	Function 1
Tubes in transpyloric placement	-3.032
Tubes out of transpyloric placement	3.790

Table 9

Classification Analysis

Actual group membership by radiograph	Number of cases	Predicted group membership "in"	"out"
Tubes in transpyloric placement	30	30	0
Tubes not in transpyloric placement	24	0	24

Summary of Findings

A total of 54 subjects composed the convenience sample. There were 29 female subjects and 25 male subjects. Patient age ranges were from neonate to adolescent, with neonates having the largest percentage (48.1%) of participation. Gastrointestinal fluid pH values ranged from

4.5 to 7.5, depending on tube placement. Staff found vacuum effect to be present in 50% of the tubes, absent in 46.3% of the tubes, with staff unsure of findings 3.7% of the time. Ausculatory findings presented the most variability of responses among staff nurses, while aspirate color produced the most consistent findings.

CHAPTER 5

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

Discussion

Sample

The participants in the study were 29 females and 25 males (n = 54). Of the participants, 26 were neonates (those in the first month of life) and 17 were infants (those in the first year of life). Thus, 43 of the total 54 participants were in their first year of life. This was expected in view of the fact that the study was conducted in the winter months. Many children in this age group are admitted to critical care units during this time of the year with respiratory diagnoses such as pneumonia, bronchiolitis, and respiratory syncitial virus. As noted earlier, half (50.9%) of the study participants had respiratory diagnoses.

Is pH a Predictor of TP Tube Placement?

Descriptive statistics for this analysis support the finding that pH is useful in predicting transpyloric tube placement. All tubes that were found to be in transpyloric position had pH values ranging from 6.0 to 7.5. Conversely, all tubes that were not in transpyloric position but were shown to be within the stomach by radiograph were found to

have pH values ranging from 4.5 to 5.0. Only one tube that was not in transpyloric position had a pH out of the 4.5 to 5.0 range because of esophageal placement. The pH from the esophageally placed tube was 7.5. This finding reveals that pH alone cannot predict transpyloric placement.

The study findings related to pH in this study are supported by prior studies. Botoman et al.,'s (1994) study supported pH changes from alkaline in the esophagus to acid in the stomach and back to alkaline in the duodenum. Additionally, the pH values of tubes in proper transpyloric placement in this study were found to be above a pH of 6.0, 93% of the time, whereas Eisenberg et al. (1989) found this to be true only 88% of the time.

Is Vacuum Effect a Predictor of TP Tube Placement?

Vacuum effect appears to be useful as a clinical indictor for TP tube placement as well. All tubes confirmed by radiograph to be outside the transpyloric position had absent vacuum effects. Twenty-eight of the 30 tubes in transpyloric tube placement by radiograph had vacuum effects which were present. Of the two remaining tubes that were in transpyloric placement, staff members were unsure of vacuum effect findings. In these two cases, the syringe plunger did not "snap" back forcefully to the end of the syringe barrel; however, the plunger did move actively, yet sluggishly, toward the end of the barrel. Since vacuum effect as an indicator of TP tube placement has not been described in the literature related to children, no

comparisons can be made to prior studies. However, one adult study has shown that vacuum effect, used alone or in commination with other clinical indicators, was not highly predictive of transpyloric placement (Foulks et al., 1994).

Are Ausculatory Findings a Predictor of TP Tube Placement?

Ausculatory findings showed the most variability of data. All tubes noted not to be in transpyloric position were heard in the center of the abdomen. However, in tubes that were in transpyloric placement, sounds were most intense on the right side in 21 of the 30 tubes, equal in 3 of the tubes, and staff members were unsure of findings in 6 tubes. These findings may be related to two factors. One factor is the size of the child and the child's anatomy. Staff noted ausculatory findings for neonates and infants frequently as equal or unsure. This may be due to the small size of the abdomen of this age group and, therefore, the possibility of referred sounds. Additionally, some of the children had congenital gastrointestinal deformities which may have affected placement and auscultation. The second factor, staff expertise at auscultation, may also be a reason for the variability of the findings. Various techniques for auscultation were seen as staff assisted in data collection. Although auscultation while insufflating air through transpyloric tubes has been traditionally used by staff to determine placement (Barry-Walker et al., 1994), this practice has been shown to be an unreliable

predictor (Baxter et al., 1992; Dettenmeier et al., 1990; Ravish & Roubenhoff, 1989; Thurlow, 1986; Zalaga, 1991).

Is Aspirate Color a Predictor of TP Tube Placement?

Aspirate color and clarity data support the use of these indicators as predictors of TP placement. All tubes that were not in transpyloric placement had aspirate described as cloudy white or green. Twenty-eight of the 30 tubes in proper transpyloric placement were noted as having translucent green or yellow aspirate. Therefore, it appears that the translucent nature of the fluid may be more important than the color as a predictor of transpyloric placement. Two of the tubes that were in transpyloric position had aspirate that did not support proper placement. One of the aspirate samples was orange but remained translucent. This sample was orange because of contamination with remnants of the drug Rifampin. The second tube had aspirate that was described as creamy white because of residual barium present due to a radiograph procedure from the previous day.

Prior studies support that color and clarity of aspirate changes as feeding tubes move through the gastrointestinal tract (Baxter et al., 1992; Berglund et al., 1994; Clark, Metheny et al., 1993; Dettenmeier et al., 1990; Lencher et al., 1991). The one tube that experienced esophageal placement had a pH of 7.5 which was a "usual" pH for tubes in transpyloric placement in this and other studies; however, the aspirate color was noted as creamy

white, which would have negated instituting tube feedings by the nursing staff. Thus, it appears, supported by the findings, that pH and aspirate color together are highly predictive of proper placement.

Is There a Predictive Relationship Between Predictor Variables and the Dependent Variable?

The discriminate function analysis revealed a high (92%) correlation between the predictor variables (pH, ausculatory findings, aspirate color, and vacuum effect) and the dependent variable (TP tube placement by radiograph). That is, there is a high correlation between the clinical indicators and whether tubes are in or out of transpyloric position. Additionally, it was found from the discriminate analysis that the four clinical indicators as a set can be used reliably to discriminate tubes that are transpyloric from those that are not. The clinical indicators of color and pH were found to discriminate the most between the two groups. Color was most predictive of tubes not in transpyloric position, whereas pH was most predictive of tubes that were transpyloric. The findings from the discriminate function analysis should make staff feel "reasonably comfortable" with initiating tube feedings utilizing the clinical indicators as predictors of transpyloric placement.

Incidental Findings

One incidental finding that was noted was the difference in the viscosity of the various aspirate

samples. All respiratory and gastric aspirates were mucoid and stretchy when pulled apart. Transpyloric aspirates, on the other hand, were thin and poured easily from containers. This information regarding viscosity should be assessed as another possible clinical indicator. If another clinical indicator can be identified as a predictor of TP tube placement, nursing staff may feel more comfortable about beginning tube feedings without obtaining a confirmatory radiograph.

Another incidental finding noted was the lack of knowledge of the nurses regarding gastrointestinal anatomy. This was evidenced by the positions that the nurses placed the children in after TP tube insertion. Some children were noted to be in a left side-lying position or supine. Neither position promotes the movement of tubes into transpyloric placement.

Summary

The findings of this study can be used to support the position statement used as the guiding framework for this study. Specifically, during times of health care reform, health care providers must balance quality care with cost cutting measures, however, cost cutting should not mean a decrease in quality patient care nor an increase in negative patient outcomes. At the study hospital, there was a patient charge of $98 for each confirmatory radiograph for TP tube placement, along with a physician charge of $29. In 1996, there were 560 of these procedures performed,

for a total annual patient charge of $71,120. Additionally, some physicians often send patients directly to fluoroscopy for TP tube placement with no attempt made at the bedside to place the tube. This was the case in the burn center in this study. The cost in 1996 for a fluoroscopy was $116, along with a physician charge of $54. This procedure was performed 192 times, for a total annual patient charge of $32,640. The total patient charge in 1996 for radiography for TP tube placement totaled $103,760. These charges could be drastically reduced with the use of the four clinical indicators.

As suggested by AACN, SSCM, and NACHRI, patients truly only receive quality care when care is based on research rather than tradition, routine, habit or even territorially. If routine confirmatory radiography for TP tube placement could be decreased or eliminated by the use of the four clinical indicators, then the patient and staff would not be exposed to additional radiation, there would be a more judicious use of the professional radiologist, and the patient and hospital could realize cost savings.

Conclusions

Based on the findings, clinical indicators were found to be predictors of transpyloric tube placement in critically ill children, but predicted most accurately in combination with each other. Aspirate color and pH were the clinical indicators which discriminated most between the tubes that were in or out of transpyloric position. The

alkaline pH of intestinal aspirate was found to be a predictor of transpyloric placement. However, the pH of an esophageal aspirate was also found to be alkaline. Therefore, pH alone cannot be used to predict transpyloric placement. In tubes that were not transpyloric, aspirate color, and clarity predicted placement best.

Recommendations

The recommendations of the investigator are as follows:

1. This study be replicated with fewer data collectors so that techniques for data gathering can occur under more controlled situations while looking more specifically at vacuum effect, ausculatory findings, and aspirate viscosity.

2. Staff should use information that is presently available regarding the clinical indicators of pH and color and clarity to decrease the use of routine confirmatory radiographs for TP placement.

3. Physicians should allow staff nurses to use the four clinical indicators to predict TP tube placement instead of ordering confirmatory radiographs.

4. Outcomes from the use of clinical indicators should be monitored.

5. Total radiation exposure should be measured in critically ill children and staff along with the long-term effects.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Office of the Institutional Review Board for Human Use

FORM 4: IDENTIFICATION AND CERTIFICATION OF RESEARCH PROJECTS INVOLVING HUMAN SUBJECTS

THE INSTITUTIONAL REVIEW BOARD (IRB) MUST COMPLETE THIS FORM FOR ALL APPLICATIONS FOR RESEARCH AND TRAINING GRANTS, PROGRAM PROJECT AND CENTER GRANTS, DEMONSTRATION GRANTS, FELLOWSHIPS, TRAINEESHIPS, AWARDS, AND OTHER PROPOSALS WHICH MIGHT INVOLVE THE USE OF HUMAN RESEARCH SUBJECTS INDEPENDENT OF SOURCE OF FUNDING.

THIS FORM DOES NOT APPLY TO APPLICATIONS FOR GRANTS LIMITED TO THE SUPPORT OF CONSTRUCTION, ALTERATIONS AND RENOVATIONS, OR RESEARCH RESOURCES.

PRINCIPAL INVESTIGATOR: PATE, MARY FRANCES D.

PROJECT TITLE: CLINICAL INDICATORS AND TRANSPYLORIC FEEDING TUBE PLACEMENT IN CRITICALLY ILL CHILDREN

_____1. THIS IS A TRAINING GRANT. EACH RESEARCH PROJECT INVOLVING HUMAN SUBJECTS PROPOSED BY TRAINEES MUST BE REVIEWED SEPARATELY BY THE INSTITUTIONAL REVIEW BOARD (IRB).

__X__2. THIS APPLICATION INCLUDES RESEARCH INVOLVING HUMAN SUBJECTS. THE IRB HAS REVIEWED AND APPROVED THIS APPLICATION ON JUNE 11, 1997 IN ACCORDANCE WITH UAB'S ASSURANCE APPROVED BY THE UNITED STATES PUBLIC HEALTH SERVICE. THE PROJECT WILL BE SUBJECT TO ANNUAL CONTINUING REVIEW AS PROVIDED IN THAT ASSURANCE.

_____ THIS PROJECT RECEIVED EXPEDITED REVIEW.

__X__ THIS PROJECT RECEIVED FULL BOARD REVIEW.

_____3. THIS APPLICATION MAY INCLUDE RESEARCH INVOLVING HUMAN SUBJECTS. REVIEW IS PENDING BY THE IRB AS PROVIDED BY UAB'S ASSURANCE. COMPLETION OF REVIEW WILL BE CERTIFIED BY ISSUANCE OF ANOTHER FORM 4 AS SOON AS POSSIBLE.

_____4. EXEMPTION IS APPROVED BASED ON EXEMPTION CATEGORY NUMBER(S)_____.

DATE: JUNE 11, 1997

Ferdinand Urthaler, MD

FERDINAND URTHALER, M.D.
CHAIRMAN OF THE INSTITUTIONAL REVIEW BOARD

The University of Alabama at Birmingham
1170R Administration Building • 701 South 20th Street
Birmingham, Alabama 35294-0111 • (205) 934-3789 • FAX (205) 975-5977

APPENDIX B

STUDY HOSPITAL'S APPROVAL

CHILDREN'S
HOSPITAL

To: Chairperson,
Institutional Review Board,
University of Alabama at Birmingham

From: Beverly Barrett, RN
Divisional Director, Critical Care
Chairperson, Nursing Research Review Board
Children's Hospital

Date: May 26, 1997

Re: Support for Research Activities

In an endeavor to increase the production and utilization of research in the clinical area, I support the research that Mary Frances D. Pate, RN, MSN wishes to conduct. I asked her to not only utilize one critical care area, as she first requested, but all four critical care areas. This was done because, the results from this research has the potential to affect patient outcomes in each of the units (Burn Unit, Neonatal Intensive Care Unit, Special Care Unit, Pediatric Intensive Care Unit), as well as, becoming a benchmark for other pediatric institutions. Potentially, this research could assist us in decreasing costs to the patient and hospital, as well as, decreasing radiation exposure to patients and staff.

APPENDIX C

INFORMED CONSENT

INFORMED CONSENT
CLINICAL INDICATORS AND TRANSPYLORIC FEEDING TUBE PLACEMENT IN CRITICALLY ILL CHILDREN

Explanation of procedures

You are being asked to allow your child to participate in research designed to look at the possibility that some assessments by nurses may decrease the need for x-rays when feeding tubes are placed. Mary Frances D. Pate, a doctoral student at the University of Alabama School of Nursing, is conducting this study. The feeding tube will be placed as usual by hospital policy and the investigator will complete a data collection tool by reviewing your child's chart and speaking to your child's nurse.

Risks and discomforts

There are no risks or discomforts that are anticipated from your child's participation in the study.

Benefits

The anticipated benefit of participation is the opportunity to assist nurses in better understanding of assessment information that may reduce the need for x-rays during feeding tube placement.

Confidentiality

The information gathered during this study will be kept confidential. Your child's name or hospital number will not be on the data collection materials. The data collection materials will be destroyed at the end of the study.

The results of the research will be published in the form of a dissertation and may be published in a professional journal or presented at professional meetings.

Withdrawal without prejudice

You are free to withdraw your consent and to discontinue participation in this study at any time without prejudice. Your decision whether or not to participate will not influence in any way the care you or your child will receive.

Costs to subject from participation in research

There will be no cost to you for participation in the research.

Payment for participation in the research

You will receive no payment for participation in the research.

Payment for research-related injuries

There is no provision for monetary compensation in the event of injury.

Written May 1997

Participant's initials_____

APPENDIX D

DATA COLLECTION INSTRUMENT

Clinical Indicators and Transpyloric Feeding Tube Placement in Critically Ill Children

Data Collection Record

Unit_____ Patient Age_____

Gender_____ Diagnosis_____

Medications:

Date	Time	Tube Type	pH	Vacuum Effect	Ausculatory Findings	Aspirate Color	X-ray Report

GRADUATE SCHOOL
UNIVERSITY OF ALABAMA AT BIRMINGHAM
DISSERTATION APPROVAL FORM
DOCTOR OF SCIENCE IN NURSING

Name of Candidate Mary F. Pate

Major Subject Maternal Child Health Nursing

Title of Dissertation Clinical Indicators of Transpyloric Feeding Tube Placement in Critically Ill Children

I certify that I have read this document and examined the student regarding its content. In my opinion, this dissertation conforms to acceptable standards of scholarly presentation and is adequate in scope and quality, and the attainments of this student are such that she may be recommended for the degree of Doctor of Science in Nursing.

Dissertation Committee:

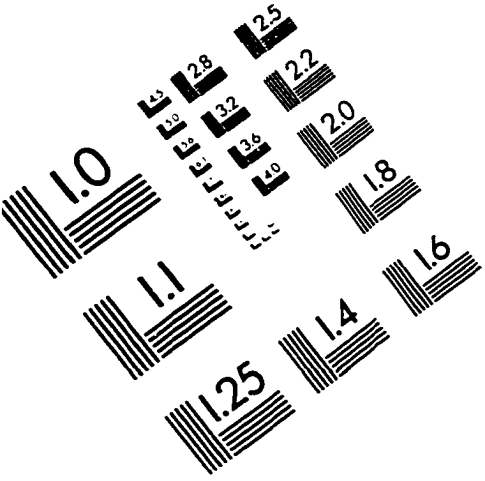
Name		Signature
Dr. Ann Edgil	**, Chair**	Ann Edgil
Dr. Lyn Reilly		Lyn Reilly
Dr. Garris Conner		Garris Conner
Dr. Pamela Fordham		Pamela Fordham
Dr. Dale Wisely		Dale Wisely /se
Dr. Imad Haddad		Imad Haddad /se

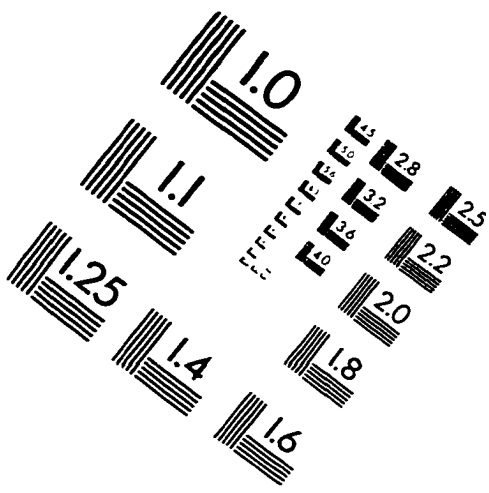
Director of Graduate Program Carol J Lasley

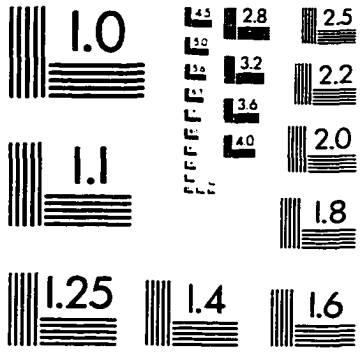
Dean, UAB Graduate School James L Roden

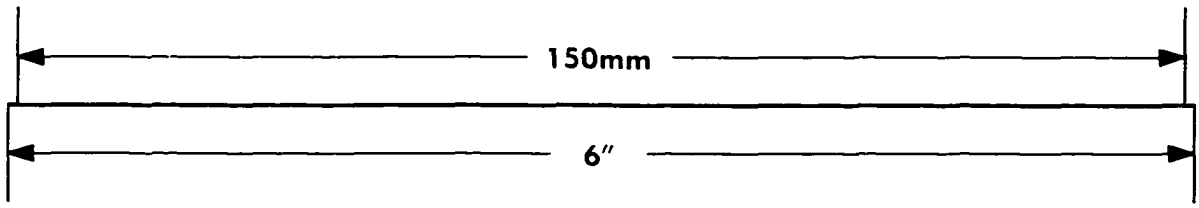
Date 7/6/98

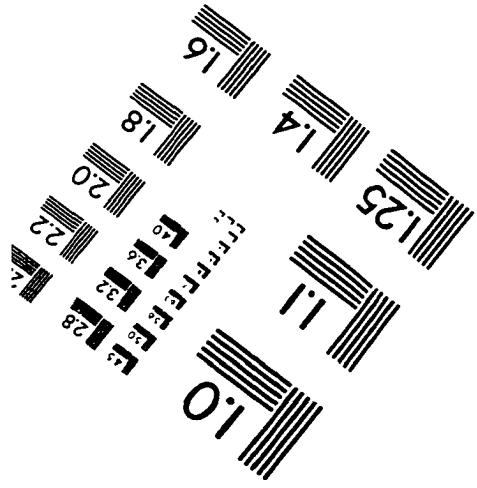
IMAGE EVALUATION TEST TARGET (QA-3)

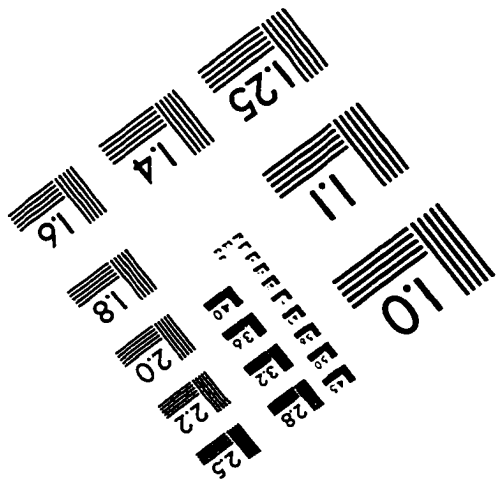












APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989