REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

(1)

AD-A231 161

2. REPORT DATE: July 1990

3. REPORT TYPE AND DATES COVERED: THESIS/~~DISSERTATION~~

4. TITLE AND SUBTITLE
Oxygen Saturation During Transport to the Recovery Room in Patients over Age Sixty

5. FUNDING NUMBERS

6. AUTHOR(S)
Wilbur Ken Smith

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AFIT Student Attending: State University of New York-Buffalo

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/CI/CIA-90-134

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFIT/CI
Wright-Patterson AFB OH 45433-6583

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release IAW 190-1
Distributed Unlimited
ERNEST A. HAYGOOD, 1st Lt, USAF
Executive Officer

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

14. SUBJECT TERMS

15. NUMBER OF PAGES: 66

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet ***optical scanning requirements***.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

Block 12b. Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

134

OXYGEN SATURATION DURING TRANSPORT TO THE RECOVERY ROOM IN PATIENTS OVER AGE SIXTY

BY

WILBUR KEN SMITH, CAPT., USAF NC

A project submitted to the
Faculty of the Graduate School of State
University of N.Y. at Buffalo in partial
fulfillment of the requirements for the degree of
MASTER OF SCIENCE

July 1990

ABSTRACT

Post-anesthesia decline in arterial hemoglobin oxygen saturation (SaO_2) as it may occur during transport from the operating room to the post-anesthesia recovery room (PARR), has not been studied specifically in patients over 60 years of age. This study identifies alterations in oxygen saturation during post-anesthesia transport in this age group. Specifically, this investigation quantifies the incidence of a decrease in SaO_2 to 90% (defined in this study as "reduction in oxygen saturation," or "reduced oxygen saturation") during transport. This study provides crude estimates of the risk of reduced oxygen saturation as it might be associated with gender, smoking history, history of respiratory disease, history of cardiac disease, obesity, site of surgery, and duration of anesthesia. Roy's Adaptation model served as the theoretical background for this investigation.

This study employs a case-control design. Risk estimates of reduced oxygen saturation were determined by means of odds ratios (OR) and the 95% confidence intervals (CI) surrounding them. Cases and controls were selected from patients over age sixty who underwent a variety of surgical procedures under general endotracheal anesthesia at the Erie County Medical Center, Buffalo, New York. Cases were defined as patients who experienced a decline in SaO_2

to 90% during transport. Controls consisted of patients over age 60 who underwent general endotracheal anesthesia for surgery during the same time period as cases (June 1 to June 30, 1990). Seventeen of the 30 patients (57%) developed a reduction in oxygen saturation during transport. Crude associations were found for the relation between this decline and obesity (OR = 8.0; 95% CI = 1.2, 60.9), a positive history of smoking (OR = 1.8; 95% CI = 0.3, 10.1), the presence of cardiovascular disease (OR = 2.9; 95% CI = 0.5, 17.0), and ASA category III (OR = 2.3; 95% CI = 0.4, 17.6). However, only obesity demonstrated a 95% confidence interval greater than 1.0 (95% CI = 1.2, 60.9). Crude associations were not found between reduced oxygen saturation and gender (OR = 0.6; 95% CI = 0.1, 3.2), respiratory disease (OR = 0.5; 95% CI = 0.1, 3.7), site of surgery (OR = 1.0; 95% CI = 0.1, 8.7), or duration of anesthesia (OR = 0.4; 95% CI = 0.04, 8.9).

OXYGEN SATURATION DURING TRANSPORT TO THE RECOVERY ROOM IN PATIENTS OVER AGE SIXTY

BY

WILBUR KEN SMITH, CAPT., USAF NC

A project submitted to the
Faculty of the Graduate School of State
University of N.Y. at Buffalo in partial
fulfillment of the requirements for the degree of
MASTER OF SCIENCE

July 1990

STATE UNIVERSITY OF NEW YORK AT BUFFALO
SCHOOL OF NURSING

MASTER'S PROJECT APPROVAL FORM

This is to certify that Wilbur Ken Smith, in the Graduate Program, School of Nursing, has successfully completed his research project entitled, OXYGEN SATURATION DURING TRANSPORT TO THE RECOVERY ROOM IN PATIENTS OVER AGE SIXTY in partial fulfillment of the requirements for the degree of Masters of Science.

Signature of: ______________________
Thomas E. Obst
(Committee Chair)

____
Timothy S. Sievenpiper
(Committee Member)

____
Mollie B. Hassett
(Committee Member)

Date: Nov. 19, 1990

ACKNOWLEDGEMENTS

The author wishes to acknowledge all those who assisted in the development and completion of this project. A special thanks to my Committee Chair, Thomas E. Obst, CRNA, MS., for his patience and guidance.

Gratitiude is extended to the anesthesia department of the Erie County Medical Center and all the nurse and physician anesthetists and residents who supported this project.

I would also like to acknowledge my family. Special thanks to my mother for her love and support to pursue my educational endeavors. Thank you to my precious children, Ricky, Jennifer, and Sara, for their patience and cooperation during the time I spent writing this project. Thank you to my wife Martha, who has given me the encouragement, love and time that I needed, and who helped me to believe that one day this would all be over. Most of all, I want to say thank you to my Lord, Jesus Christ, who gave me this opportunity in answer to my prayers, the perseverance to endure, and the faith to accomplish a most worthy achievement.

ABSTRACT

Post-anesthesia decline in arterial hemoglobin oxygen saturation (SaO_2) as it may occur during transport from the operating room to the post-anesthesia recovery room (PARR), has not been studied specifically in patients over 60 years of age. This study identifies alterations in oxygen saturation during post-anesthesia transport in this age group. Specifically, this investigation quantifies the incidence of a decrease in SaO_2 to 90% (defined in this study as "reduction in oxygen saturation," or "reduced oxygen saturation") during transport. This study provides crude estimates of the risk of reduced oxygen saturation as it might be associated with gender, smoking history, history of respiratory disease, history of cardiac disease, obesity, site of surgery, and duration of anesthesia. Roy's Adaptation model served as the theoretical background for this investigation.

This study employs a case-control design. Risk estimates of reduced oxygen saturation were determined by means of odds ratios (OR) and the 95% confidence intervals (CI) surrounding them. Cases and controls were selected from patients over age sixty who underwent a variety of surgical procedures under general endotracheal anesthesia at the Erie County Medical Center, Buffalo, New York. Cases were defined as patients who experienced a decline in SaO_2

to 90% during transport. Controls consisted of patients over age 60 who underwent general endotracheal anesthesia for surgery during the same time period as cases (June 1 to June 30, 1990). Seventeen of the 30 patients (57%) developed a reduction in oxygen saturation during transport. Crude associations were found for the relation between this decline and obesity (OR = 8.0; 95% CI = 1.2, 60.9), a positive history of smoking (OR = 1.8; 95% CI = 0.3, 10.1), the presence of cardiovascular disease (OR = 2.9; 95% CI = 0.5, 17.0), and ASA category III (OR = 2.3; 95% CI = 0.4, 17.6). However, only obesity demonstrated a 95% confidence interval greater than 1.0 (95% CI = 1.2, 60.9). Crude associations were not found between reduced oxygen saturation and gender (OR = 0.6; 95% CI = 0.1, 3.2), respiratory disease (OR = 0.5; 95% CI = 0.1, 3.7), site of surgery (OR = 1.0; 95% CI = 0.1, 8.7), or duration of anesthesia (OR = 0.4; 95% CI = 0.04, 8.9).

TABLE OF CONTENTS

LIST OF TABLES

Table

CHAPTER I

INTRODUCTION

During the intraoperative period, the nurse anesthetist monitors adequate oxygenation through the measurement of arterial hemoglobin oxygen saturation (SaO_2) by pulse oximetry. This monitoring of the oxygen saturation often continues into the postoperative period where the PARR (post-anesthesia recovery room) nurse usually assumes responsibility for its management. However, during the time between tracheal extubation in the OR and the arrival of that patient in the PARR, SaO_2 is often unmonitored and may be subject to clinically significant changes. Hypoxemia (SaO_2 less than 90%), the potentially inadequate oxygenation of arterial blood, may develop during this time.[2] This study investigated oxygen saturation during transport in persons over sixty years of age, and utilized oxygen therapy when necessary to prevent hypoxemia in transit.

Older patients may be more susceptible to the development of postoperative reductions in oxygen saturation. There is a normal, progressive, and irreversible decrease of organ function that occurs in all patients with increasing age. Organ function declines approximately 1 percent per year of the functional capacity present at age 30.[9] Another cause of organ function deterioration is the onset of pathologic changes from one or more of the diseases frequently encountered in patients over age 60. These two major dilemmas of older patients may make them vulnerable to adverse effects of anesthesia such as post-operative hypoxemia.

PROBLEM STATEMENT

Do patients over 60 years of age develop reductions in oxygen saturation warranting oxygen therapy during the immediate postoperative transport period?

What are the variables associated with a reduction of oxygen saturation in patients greater than 60 years of age?

OBJECTIVES

This study was designed to serve as a pilot for the development of a mechanism by which data on oxygen saturation during transport (from the operating room to the PARR) might be systematically collected and evaluated within the Department of Anesthesia at the Erie County Medical Center. It may also serve to generate hypotheses to form the basis of future research. This investigation examined the following questions:

1. What percent of patients over 60 years of age experience significant reductions of oxygen

saturation during transport?

2. Is there a relationship between a reduction in oxygen saturation during transport and gender?
3. Is there an association between a reduction in oxygen saturation and smoking?
4. Is there an association between reduced oxygen saturation and a history of respiratory disease (COPD, asthma, or bronchitis)?
5. Is there an association between reduced oxygen saturation and a history of cardiac disease?
6. Is there a relationship between a reduction in oxygen saturation and obesity?
7. Is there a correlation betweeen reduced oxygen saturation and site of surgery (upper abdominal/thoracic versus lower abdominal/extremity)?
8. Is there a relationship between a reduction in oxygen saturation and duration of anesthesia?

THEORETICAL FRAMEWORK

Roy's Adaptation Model provided the theoretical framework for this study. In describing Roy's theory, Chinn and Jacobs define a person as an adaptive system, with survival as the priority goal.[1] In response to a stressor (which in this case may be a clinically significant decrease in SaO_2) a person's adaptive response may be competent (increasing minute volume to prevent hypoxemia) or ineffective (inability to maintain adequate oxygenation). The nurse anesthetist promotes adaptive responses in the patient during transport by stimulating the patient to breathe. Behavior (sufficient ventilation to prevent hypoxemia) can be assessed by observation and measurement (pulse oximeter). A tentative judgment on whether the behavior is adaptive or ineffective is then made (acceptable SaO_2 or not). Stimuli influencing the adaptive system are then identified (sufficient inspired oxygen concentration, reactive airways due to smoking history, etc.). A nursing diagnosis follows (deficit in oxygen saturation) goals are set (prevent hypoxemia), and interventions selected (stimulate the patient to breathe, administer oxygen if necessary). Evaluating the patient's level of adaptation and the adequacy of the intervention is a continual process during the transport period, as well as the entire course of nursing care while hospitalized.

DEFINITION OF TERMS

Arterial Hemoglobin Oxygen Saturation (SaO_2) - The SaO_2 indirectly measures the partial pressure of arterial oxygen. As such, the SaO_2 indicates the presence of adequate oxygenation under the conditions of normal body pH (7.35-

7.45), temperature (37 degrees centigrade), $PaCO_2$ (35-45 torr, or 35-45 mm Hg), and 2,3 DPG concentration. Arterial hemoglobin oxygen saturation will be directly measured by pulse oximetry in the sample population.

<u>2,3 Diphosphoglycerate (2,3 DPG)</u> - An end product of red blood cell glycolysis, 2,3 diphosphoglycerate is increased in conditions of chronic hypoxemia. A raised serum 2,3 DPG level may shift the oxyhemoglobin dissociation curve to the right. This right shift signifies a reduction in the affinity of hemoglobin for oxygen, promoting tissue oxygenation.[2]

<u>pH</u> - An expression of the concentration of hydrogen ions (H^+) per volume of solution, pH is defined as the negative logarithm of this concentration. Human blood normally contains 40 nanoequivalents of H^+ per liter. Expressed as a negative log, it therefore has a pH of 7.4. A pH greater than 7.4 shifts the oxyhemoglobin dissociation curve to the left which increases the affinity of hemoglobin for oxygen, hindering oxygen delivery to tissues.[2]

<u>Partial Pressure of Carbon Dioxide in Arterial Blood ($PaCO_2$)</u> - In humans, the normal range for $PaCO_2$ is 35-45 torr. A moderately increased $PaCO_2$, such as caused by hypoventilation, stimulates the respiratory drive and shifts

the oxyhemoglobin dissociation curve to the right.

<u>Partial Pressure of Oxygen in Arterial Blood (PaO_2)</u> - The PaO_2 is a reliable indicator of tissue oxygenation.[7,8,9,27] Within a region of the sigmoidal oxyhemoglobin dissociation curve, PaO_2 can be extrapolated from SaO_2 values (see Table 1). This extrapolation, however, can only be done on the steeper portion of the curve where SaO_2 and PaO_2 are related. It should be recognized that a patient may be 100% saturated over a wide range of PaO_2 values (eg, 104 - 600 torr or greater) on the upper flat portion of the curve.

Table 1

PaO_2 Values for Specific SaO_2 Readings (at pH=7.4, T=37C)[8]

SaO_2	PaO_2
100	600
100	200
100	104
97	100
96	90
95	80
93	70
90	60
84	50
75	40
57	30
50	27
35	20
14	10

Pulse Oximeter - A non-invasive device that measures SaO_2. Pulse oximeters are standardly used intra-operatively. See further explanation under LITERATURE REVIEW (pages 15-21).

American Society of Anesthesiologists Classification of Physical Status (ASA Classification) - A classification system developed by Dripps to categorize patients on the basis of degree of underlying illness. This classification system correlates well with the risks of anesthesia and surgery based on the patient's preoperative health status.[2,9,27] Categories range from I-V and include an additional "emergency" (E) descriptor which may apply to any category. This study will include patients in categories I-III and will exclude patients undergoing emergency surgery. Catergories I-III are defined as follows:

ASA I - "The patient has no organic, physiologic, biochemical, or psychiatric disturbance. The pathologic process is localized and does not entail a systemic disturbance".

ASA II - "The patient has a mild to moderate systemic disturbance caused either by the conditions to be treated surgically or other pathophysiologic process; e.g., controlled hypertension". For purposes of this study, a history of smoking will automatically place a subject in category ASA II or higher, depending on what other health problems exist.

ASA III - "The patient has severe systemic disturbances that impact on activities of daily living".[2]

Aldrete Scale - a method by which the level of consciousness and physical condition of patients can be quickly and easily evaluated after anesthesia during the recovery period.[12] Analagous to the universally accepted Apgar score, the Aldrete scale evaluates the patient's level of consciousness, activity level, respiratory effort, circulatory status, and skin color to provide objective information on the patient's status. A rating of 0, 1, or 2 is given for each of five evaluative criteria. For purposes of this study, a total score of 7 or greater was considered acceptable for transport. Table 2 defines the five patient assessment categories.

Table 2

ALDRETE SCALE

CATERGORY	RATING	DEFINITION
Activity	2	Able to move all extremities
	1	able to move two limbs
	0	unable to move
Respiration	2	Breathe deeply and cough
	1	dyspnea
	0	no spontaneous respirations
Circulation	2	Systolic BP +/- 20% of baseline
	1	Systolic BP +/- 20-50% baseline
	0	Systolic BP > +/- 50% baseline
Consciousness	2	Able to answer questions
	1	aroused only if called by name
	0	no response to auditory stimuli

(Aldrete Scale continued)

CATEGORY	RATING	DEFINITION
Color	2	normal "pink" color
	1	pale, "dusky", or "blotchy"
	0	frank cyanosis

The independent variables in this investigation were:

Gender

Females may experience greater postoperative morbidity, such as nausea, vomiting, and post lumbar puncture headache.[18] This study will attempt to identify any correlation between sex and postoperative reduction of SaO_2.

Obesity

As a result of increased fatty tissue mass on the abdominal wall, there is an elevated abdominal pressure in obesity, causing an upward displacement of the diaphragm. Due to the supplemental adipose tissue on the chest wall, obese persons have a decreased chest wall compliance. Both of these problems associated with obesity cause a marked fall in static lung volumes, especially in the supine position. Expiratory reserve volume (ERV) and functional residual volume (FRC) are often reduced so that tidal ventilation may fall within the range of closing capacity (CC) with ensuing ventilation/perfusion (V/Q) abnormalities, or left-to-right shunt with ensuing reductions in SaO_2.[9] Coupling these decreases in lung volumes with the normal reduction of respiratory function due to aging makes the obese person over age sixty vulnerable to a reduction in oxygen saturation in the immediate post-operative period.

Cardiovascular

In the cardiovascular system, arteriosclerotic vascular changes and reduced myocardial reserve decrease cardiac output and stroke volume, prolong circulation time, and decrease perfusion of the vital organs. As a result, the cardiovascular sytem of the older patient may be unable to cope with the increased oxygen requirements caused by shivering in the immediate post-operative period. Shivering increases oxygen consumption up to 700%, which may make normally adequate cardiac output incapable of meeting the metabolic demands of the body. This may lead to a decrease in oxygen saturation.[9]

Respiratory Disease

In the respiratory system, significant changes that occur with aging include decreased breathing capacity, stiffening and rigidity of air passages due to fibrosis, distension of peripheral air sacs, reduction of forced expiratory volume and forced vital capacity, decrease in diffusion properties, shunting, V/Q mismatching, inadequate gas exchange, and an increase in closing volume. As a result, there is a small margin of error for alterations in oxygen saturation, such as that often created immediately after general anesthesia.[9]

History of Cigarette Smoking

Cigarette smoking increases the risk of chronic lung disease and malignancy, as well as the incidence of postoperative pulmonary complications. Studies on heavy smokers have shown that about 15% of the oxygen-binding sites on hemoglobin may be occupied by carbon monoxide, thus reducing the oxygen supply available to tissues. The number of pack-years (packs smoked per day multiplied by the number of years) is directly related to measurable changes in air flow and closing capacity, making these patients prone to postoperative atelectasis and a decline in SaO_2.[16]

Site of Surgery

Decreases in the SaO_2 (and thus the PaO_2) in the immediate postoperative period are common. The PaO_2 may decrease as much as 20 torr following upper abdominal or thoracic surgery. The decrease in PaO_2 is less after lower abdominal or peripheral surgery.[16]

Duration of Anesthesia

A long exposure time to anesthesia may make attempts at spontaneous ventilation inadequate to prevent postoperative reduction of oxygen saturation in the older patient. Protein-binding is often diminished due to a decline of albumin production, which results in higher levels of free drug. Renal clearance may be decreased due to a decline in renal blood flow, which leads to increased blood levels and prolonged elimination half-times. Drug metabolism may be decreased in the older patient due to reduced hepatic blood flow or diminished hepatic enzyme activity. The relative increase in adipose tissue can change the volume of distribution and elimination half-life of many drugs.[16] Prolonged exposure to anesthetic drugs can thus delay satisfactory emergence and thereby depress adequate ventilation.

Level of Consciousness

A patient not awake enough to respond to voice command may not be able to voluntarily take deep breathes if his\her ventilatory effort is deemed inadequate. In this study, all patients had an Aldrete score of 7 or greater, and demonstrated an ability to open their eyes to voice command before extubation and transport to the PARR.

CHAPTER II

REVIEW OF LITERATURE

Hemoglobin binds oxygen in arterial blood and transports it to the tissues. At the cellular level, mitochondria use oxygen in producing the energy needed to run the various biochemical processes of the body. The measure of the percentage of arterial hemoglobin that is saturated with oxygen is defined as the SaO_2. The SaO_2 may serve as an indirect estimate of the partial pressure of oxygen in arterial blood (PaO_2) as described on page 5. Therefore the SaO_2 and the PaO_2 may be clinically evaluated by a pulse oximeter. At an SaO_2 of 90%, the PaO_2 is approximately 60 torr, assuming a pH of 7.4, $PaCO_2$ of 40 torr, temperature of 37 degrees centigrade, and normal serum levels of 2,3 DPG.[27] For purposes of this study, only temperature was monitored as a possible extraneous variable affecting SaO_2. Arterial blood pH, arterial $PaCO_2$, and serum levels of 2,3 DPG were presumed to be constant.

The diffusion of oxygen throughout tissues follows the principles of Fick's Law.[6] Fick's Law states that the rate of diffusion of a substance (oxygen), across a surface (alveolar/capillary surface and capillary/tissue surface) is proportional to the concentration (pressure) gradient. At one atmosphere (sea level), the alveolar partial pressure of oxygen (PAO_2) is 100 torr (mm Hg), while the partial pressure of arterial oxygen (PaO_2) is 95 torr.[7] Therefore a pressure gradient of 5 torr promotes oxygen diffusion from the pulmonary alveoli to the arterial capillary. The pressure of oxygen in the tissue cell is 40 torr. Oxygen can therefore diffuse from the arterial capillary (pressure still 95 torr) into the cell (40 torr) because of the partial pressure gradient of oxygen.

The oxyhemoglobin dissociation curve plots the SaO_2 of hemoglobin at a given PaO_2. The sigmoid curve which describes this relationship can shift to the left or right depending on variables such as temperature, pH, pCO_2, or 2,3 DPG levels. Hypothermia, alkalosis, hypocarbia, or decreased levels of 2,3 DPG may shift the entire curve slightly to the left, assigning a lower PaO_2 value for a given SaO_2 reading. Conversely, hyperthermia, acidosis, hypercarbia, or increased levels of 2,3 DPG may shift the curve slightly to the right. This curve is usually depicted as it exists at 37 degrees centigrade, arterial blood pH of 7.4, $PaCO_2$ of 40, and usual serum concentrations of 2,3 DPG.[8] On the standard oxyhemoglobin curve, partial pressures of arterial oxygen less than 60 torr are associated with substantial reductions in hemoglobin saturation, whereas a PaO_2 greater than 60 torr produces only modest increases in the percentage of hemoglobin saturated with oxygen. For example, an increase of 40 torr, from PaO_2 of 60 torr to PaO_2 of 100 torr, is associated with only a 7% - 8% increase in hemoglobin saturation, whereas a 30 torr decrease, from PaO_2 of 60 torr to PaO_2 of 30 torr is associated with a 30% decrease in hemoglobin saturation. A "normal" PaO_2 (100 torr) represents 97% saturation.[9]

Pulse oximetry is a relatively new, non-invasive measurement of SaO_2. Historically, it's origins begin in the work of Nicolai, who, in 1931, applied the Beer-Lambert Law to the transmission of light through the hand to study the dynamics of tissue oxygenation (the Beer-Lambert Law relates the concentration of a solute in suspension exponentially to the intensity of light transmitted through the solution). By 1942, interest in aviation research enabled Millikan to develop a practical ear oxygen meter which he dubbed the "oximeter". This marked the beginning of modern day pulse oximeters. In 1974, Aoyagi utilized the variations in volume that occurs with pulsatile arterial blood flow to develop an oximeter that analyzed pulsatile light absorbances. Finally in 1980, Yoshiya et al., developed the technology of the currently used oximeter. By combining plethysmography (which measures the blood volume change during arterial pulsation) with oximetry (light absorbance of hemoglobin), Yoshiya's instrument compared light absorbance during arterial non-pulsation to arterial pulsatile flow to determine SaO_2.[10]

Thus the pulse oximeter utilizes the two physiologic concepts of pulsatile flow and light absorbance. Oxygenated hemoglobin and deoxygenated hemoglobin absorb light at two different, distinct wavelengths. This light absorption by hemoglobin varies with changing blood volumes during arterial pulsation.

Only since 1984 have pulse oximeters been developed that feasibly measure SaO_2 accurately.[11] A non-invasive detector is attached to a vessel-rich part of the body, such as a finger tip, ear lobe, nose, or toe. As blood pulses through the arterial system, the oximeter extrapolates the amount of non-oxygenated hemoglobin versus the amount of oxygenated hemoglobin by quantifying the diffference in light absorbance. The pulse oximeter therefore compares the amount of light absorption by the blood at the red (hemoglobin) and infrared (oxyhemoglobin) wavelengths.

Thus SaO_2 can be calculated by the equation:[11]

$$\text{Functional } SaO_2 = \frac{O_2\,Hb}{O_2\,Hb + Hb} \times 100\%$$

<u>Functional SaO_2</u> = arterial oxygen saturation not including any dyshemoglobins or dyes

<u>O_2Hb</u> = the fraction of oxygenated arterial hemoglobin

<u>Hb</u> = the fraction of deoxygenated venous hemoglobin

In addition to oxyhemoglobin and deoxyhemoglobin, there are two other forms of hemoglobin found in adult blood; methemoglobin and carboxyhemoglobin. Neither of these two dyshemoglobins bind oxygen, but they can cause errors in pulse oximeter readings. Carboxyhemoglobin absorbs light at 660 nanometers (nm), the same infrared wavelength as oxyhemoglobin. It's presence may give a falsely high SaO_2 reading for the actual PaO_2 value, causing unrecognized hypoxemia leading to inadequate tissue oxygenation (hypoxia). Methemoglobin absorbs both the red and infrared spectrums of light. At high methemoglobin concentrations, the SaO_2 will be approximately 85%, regardless of the PaO_2.[30] Since methemoglobin is unable to bind oxygen, the conversion of hemoglobin to methemoglobin may also lead to cyanosis and frank hypoxia. Fortunately, these last two hemoglobin species are usually found only in small, insignificant concentrations, except in pathologic conditions such as carbon monoxide poisoning (as in smoke inhalation trauma) or congenital methemoglobinemia. Some high dose intravenous medications, such as nitroglycerin, have also been reported to cause methemoglobinemia in susceptible individuals.[27] Intravenous dyes, such as methylene blue, indigo carmine, and indocyanine green, also may cause transient decreases in pulse oximeter values by absorbing red and infrared wavelengths.[11,30]

The reduction of oxygen saturation in the pediatric population durirg transfer to the PARR has been well documented.[13,14] Kataria, et al. noted that declines in SaO_2 occurred more quickly in young infants than in older children. These investigators studied 60 ASA I and II patients between 1 month and 14 years of age. Subjects were divided into three groups: 0-6 months of age (n=10); 7-12 months of age (n=10); and 13 months - 14 years of age (n=40). Total transport time was between 120-180 seconds. One data point, the lowest SaO_2 reading recorded during transport, was collected for each child. Group I (0-6 months), had a mean transport SaO_2 of 88.1%. Group II's (7-12 months) average reading was 91.8%, while the last group had a mean SaO_2 of 93.3% during transport. The researchers hypothesized that differences in infant physiology (immature pulmonary system, fetal hemoglobin stores, halothane-induced muscle fatigue) accounted for this rapid reduction of oxygen saturation in the very young.

In the adult population, only one study concerning oxygen saturation during transport from the operating room (OR) to the PARR was found in the literature.[15] In this study, Tyler, et al. found that postoperative changes in SaO_2 did not correlate significantly with age, duration of anesthesia, level of consciousness, or anesthetic agent. Three of the patients with a history of asthma all developed a reduction in oxygen saturation and there was a significant correlation between a decreased SaO_2 and obesity. The study was in an adult, predominantly female population with a mean age of 41 years. The surgical procedures were primarily gynecologic or lower abdominal, with a mean duration of anesthesia of 108 +\- 70 minutes. The type of general anesthetic was not controlled for. Thirty-five percent of the ASA I or II patients developed an $SaO_2 < 90\%$. Twelve percent developed an $SaO_2 < 85\%$, at which time the patient was given 100% O_2 via bag and valve. The time to reach an SaO_2 of 85% varied widely, with a mean of 155 +\- 74 seconds.

There has not been any specific study on anesthesia-induced alterations of SaO_2 in patients over the age of sixty during transport to the PARR.

CHAPTER III

METHODOLOGY

RESEARCH DESIGN

This study uses a case-control design.[19] It's purpose is to estimate:

1. The incidence of reduced oxygen saturation in patients greater than 60 years of age during transport from the OR to the PARR.

2. The risk of a reduction in oxygen saturation as it is associated with specific exposure variables.

The dependent variable in this study is a reduction in oxygen saturation. Independent (exposure) variables include gender, cardiovascular disease, respiratory disease, history of smoking, obesity, length of anesthesia, and site of surgery. This investigation serves as a pilot to design methodology for a larger, future departmental study whose purpose will be to implement standards to assure quality patient care.

Case-control design provides a methodology to identify factors associated with the occurrence of disease. This methodology is particularly useful where ethical/practical considerations prevent the use of experimental designs.

Estimates of risk in a case-control study are provided by means of the odds ratio (OR). The OR provides a measure of disease occurrence with and without a specific exposure.[21] As such, it provides a ratio measure of risk. The confidence interval addresses the random variation around the point estimate, approximates a range of possible values, and deals with the relation of these factors to the null value (OR = 1.0). Point estimates and confidence intervals provide more meaningful information than a p-value "level of significance", for even though the effect of a treatment (independent variable) on the outcome (dependent variable) may not show a statistical significance, it may often demonstrate a moderate to high degree of clinical significance. In a review of 71 clinical trials that reported no statistical significance (p-value less than 0.05) for the effects of various treatments, Freiman et al. found that in the great majority of such trials the data indicated a moderate or even reasonably strong effect of the treatment on the outcome. In all of these trials, the original investigators interpreted their data as indicative of no effect because the p-values were not "statistically significant". The misinterpretations arose because the investigators relied solely on "significance" testing for their statistical analysis rather than on a more descriptive and informative analysis such as confidence interval functions.[28]

Odds ratios and confidence intervals were determined by use of TR[illegible] EPISTAT. Confidence intervals were determined using Kleinbaum's technique.[29]

SAMPLE POPULATION

The study sample consisted of 30 ASA I,II, and III male and female patients over 60 years of age. The study did not include any prisoners, mentally retarded, or mentally disabled persons. Cases were defined as any patient over age sixty undergoing general anesthesia with endotracheal intubation, who experienced a reduction in oxygen saturation (SaO_2 equal to 90%) during transport from the OR to the PARR. Controls were defined as patients over 60 years of age who underwent general anesthesia with endotracheal intubation, but did not experience this decline during transport to the PARR.

ASA classification was determined after reviewing the patients' charts, including past health history, lab values, X-rays, EKGs, and both surgical and anesthesiology consultations. A brief interview and physical assessment of each patient was the final criteria for ASA determination. Persons with a history of carboxyhemoglobinemia, methemoglobinemia, or recent intravenous dye injection were excluded from the study, since these factors can interfere with the pulse oximeter's accuracy.

SETTING

The study took place at the Erie County Medical Center (ECMC), Buffalo, New York. Each subject's SaO_2 was monitored during transport from the operating suite to the PARR. The study was approved by the Institutional Review Boards of the School of Nursing and ECMC (School of Medicine) at the State University of New York at Buffalo. Permission was obtained from the Department of Anesthesiology of ECMC. Informed consent was secured from the patients. The data for this study was collected from June 1 to June 30, 1990 by the primary investigator.

DATA COLLECTION INSTRUMENT

The instrument used in this study was a self-designed data collection sheet. The tool was designed to identify common variables which may be related to the development of immediate post-operative reduction of oxygen saturation in persons over age sixty. The instrument was divided into three basic parts: preoperative data, intraoperative data, and immediate postoperative data (see Appendix B - Data Collection Tool).

PULSE OXIMETER

The Ohmeda model #3760 was utilized in this study.

This a portable, lightweight pulse oximeter which gives a continuous digital readout and printout of both pulse and SaO_2. In addition, it has the capability of reproducing a histogram of each patient's SaO_2 trend during transport.

METHODS OF COLLECTING DATA

The following variables were recorded prior to surgery: age, gender, ASA status, SaO_2, temperature, weight, height, cardiovascular history, respiratory history, smoking status, type of surgery, type of anesthetics used, and length of general anesthesia.

Preoperatively, each subject was brought to the OR and the SaO_2 monitored by pulse oximetry on both room air and 100% oxygen to obtain baseline readings. Forehead skin temperature were monitored using non-invasive liquid-crystal adhesive thermometers (Crystaline[R]).

Intraoperatively, SaO_2 was monitored continuously by pulse oximetry. The type of general anesthetic was not controlled, since the literature shows that clinically significant changes in SaO_2 do not correlate significantly with the type of anesthetic agent used.[16] Muscle relaxants, when used, were fully reversed with neostigmine 2.5-3.0 mg, and glyccopyrolate 0.5-0.6 mg prior to extubation. To assess reversal of neuromuscular blockade, a peripheral nerve stimulator was used to determine a train-of-four ratio of at least 95% percent, which is defined as full recovery (without fade) of all four twitches. The ability to open the eyes on command, initiate an effective cough, sufficient spontaneous respirations, return of normal tidal volume, a negative inspiratory pressure of at least -15 cm H_2O, and a purposeful, sustained head lift were other criteria for extubation.[27] Two patients (6%) were kept intubated, and transferred from the operating room with oxygen and ventilatory support by means of a bag and valve ("Ambu" bag with a reservoir). One of these two patients had undergone a pneumonectomy requiring temporary postoperative mechanical ventilation. The other patient simply did not meet the criteria for extubation. Neither of these patients were included in the study.

Postoperatively, all general anesthesia was discontinued and the patients placed on 100% oxygen for at least 3 minutes until they met the criteria for extubation. At this point each patient was suctioned, extubated, and allowed to deep breathe 100% oxygen via face mask for a minimum of one minute or until his/her SaO_2 was at least 97%. The total amount of time that each patient breathed 100% oxygen was sufficient to prevent any diffusion hypoxia which may result from alveolar filling with nitrous oxide (if used) during it's washout.[2] A score of at least 7 on the Aldrete scale was required to objectively determine each patient's readiness for transport. The subject was then breathing room air. The pulse oximeter remained attached to the patient during the move from the OR to the PARR to detect any variations in SaO_2. The investigator also constantly evaluated each patient for adequate ventilatory effort during transport, and stimulated patients by verbal command and/or light touch when required.

Patient safety was ensured during this study by administering oxygen by face mask for any subject whose SaO_2 reading dropped to 90%. An oxygen mask, oxygen cylinder, non-rebreathing bag and valve, laryngoscope and blade, endotracheal tube, and succinylcholine accompanied each patient during transport.

Confidentiality was maintained utilizing the criteria provided by the Institutional Review Board of the State University of New York at Buffalo. All information related to the subjects was treated in strict confidence. Identity of subjects will not be associated with any published results. Any disclosure of results required by government agencies will be coded so as not to reveal the subjects' identity. All code numbers and subject identities were kept in a locked file of the principal investigator.

ASSUMPTIONS

The study assumed that the SaO_2 readings recorded during transport were actual and not an artifact of movement or sensor dislodgement.

METHOD OF DATA ANALYSIS

Cases and controls consisted of patients over 60 years of age undergoing general endotracheal anesthesia. Cases were defined as patients who experienced a reduction in oxygen saturation during postanesthesia transport; controls were defined as those not experiencing this decline. The risk of reduced oxygen saturation in this age cohort as it related to the independent (exposure) variables of gender, obesity, history of respiratory disease, history of smoking, history of cardiac disease, ASA category equal to or less than III, upper abdominal/thoracic surgery, lower abdominal/extremity surgery, and duration of anesthesia was quantified by means of odds ratios and the 95% confidence intervals around these ratios. The TRUE EPISTAT software system was used in this data analysis.[25]

CHAPTER IV
ANALYSIS OF DATA

Analysis of the data focused upon the characteristics of the sample group, the overall incidence of a reduction in oxygen saturation, and the crude effect estimates of each independent variable on SaO_2.

CHARACTERISTICS OF THE SAMPLE GROUP

The sample consisted of thirty ASA I, II, and III patients over the age of sixty undergoing a broad range of surgical procedures that required general anesthesia and endotracheal intubation. Fourteen (47%) of the subjects were male, while sixteen (53%) of the subjects were female. Age ranged from 61 to 83 years, with a mean age of 71.1 years. The categorization of ages by decade, with cases and controls for each age group, are listed in Table 3.

Table 3

Age by Decade

Age	Number of Cases (% of Sample)	Number of Controls (% of Sample)	Total by Age Group
61-69	8 (27%)	5 (16%)	13
70-79	7 (23%)	6 (20%)	13
80-83	2 (7%)	2 (7%)	4

Two-thirds of the total sample were ASA I or II (Table 4).

Table 4

ASA Status

ASA Status	Number of Cases (% of Sample)	Number of Controls (% of Sample)	Total by ASA Status
I	2 (7%)	3 (10%)	5
II	8 (27%)	7 (23%)	15
III	7 (23%)	3 (10%)	10

The body mass index (BMI), was calculated for each individual and was determined by dividing body weight (kilograms) by height (meters^2). Patients with a BMI greater than 28 are regarded as obese.[9] Fifteen of the thirty subjects (50%) had a BMI of greater than 28. BMI ranged from 28 to 47 in these obese patients.

Examination of patient medical histories revealed a wide range of pre-existing obstructive respiratory disease (asthma, COPD, or bronchitis), history of cardiovascular disease (myocardial infart, angina, congestive heart failure, or hypertension) and cigarette use (pack/years ranging from 10 to 99). In this study, two or more medical conditions from the same category (eg, history of MI and CHF) counted as one condition (ie, a history of cardiovascular disease).

The incidence of reduced oxygen saturation in relation to these three exposure variables (history of smoking, cardiovascular disease, respiratory disease) appeared to increase in direct proportion to the number of these medical conditions present in any one individual. Of the six patients who had no medical problems, two (33%) developed a reduction of oxygen saturation in transit; of the fourteen people who had one pre-existing medical condition, eight (57%) developed this post-anesthesia decline; of the six patients with two pre-existing conditions, four (67%) developed a reduced oxygen saturation during transport; and of those individuals with three pre-existing medical problems, three of four (75%) developed a decrease of SaO_2 to 90% during transport from the OR to the PARR. All individuals (10) who had at least two of the three defined preexisting medical problems in this study were in ASA category III. Of these ten, seven (70%) had a reduction in oxygen saturation during post-anesthesia transport (Table 5).

Table 5

Preexisting History of Smoking, Cardiac and/or Respiratory Disease

Number of Medical Problems	Number of Cases	Number of Controls	Total
0	2	4	6
1	8	6	14
2	4	2	6
3	3	1	4

Intraoperatively, twenty-three (77%) patients had lower abdominal/extremity surgery, compared to seven (23%) who underwent upper abdominal surgery (refer to Table 8, page 36).

Initial room air SaO_2 ranged from 92%-97%, with a mean of 94%. Values for SaO_2 on 100% oxygen prior to intubation ranged from 97%-100%, with a mean of 98.1% (Table 6).

Table 6

Baseline SaO_2 Values on Room Air and FiO_2 of 1.0 (Tight Fitted Mask) in Cases and Controls

Average SaO_2 on Room Air		Average SaO_2 on FiO_2 = 1.0 (approx.)	
Cases (x_1)	Controls (x_2)	Cases (x_3)	Controls (x_4)
93.9	94.2	97.8	98.3

Length of anesthesia/intubation time ranged from 35-420 minutes, with a mean of 127.5 minutes. No patients in the study developed a body temperature (forehead skin measurement) less than 35 degrees centigrade. All patients included in the study had Aldrete scores of 7-8, with a mean of 7.3.

Postoperatively, seventeen (57%) subjects developed reduced oxygen saturation during transport. These results are presented in Table 7.

Table 7

Lowest SaO_2 During Transport

SaO_2	Frequency	Percent
90	17	57.0
91	1	3.0
92	4	13.0
93	2	7.0
94	3	10.0
95	1	3.0
96	2	7.0

The time to reach the lowest SaO_2 ranged widely from 30-320 seconds, with a mean of 154 seconds. Timing began from the moment the oxygen mask was removed from patients after extubation.

Table 8 shows that the estimated risk of reduced oxygen saturation is increased with obesity (OR = 8.0), a positive history of smoking (OR = 1.8), the presence of cardiovascular disease (OR = 2.9), and ASA category III (OR = 2.3). However, only obesity demostrated a 95% confidence interval greater than 1.0 (95% CI = 1.2, 61).

Table 8

Crude Odds Ratios and 95% Confidence Intervals

SaO_2 to 90%

	Cases	Controls	OR	95% CI
Male	7	7	0.6	(0.11, 3.22)
Female	10	6		
Obese	12	3	8.0	(1.22, 60.98)
Non Obese	5	10		
Resp. Dis.	3	4	0.48	(0.06, 3.70)
No Resp. Dis.	14	9		
Smoking Hx.	9	5	1.8	(0.33, 10.11)
No Smoking Hx.	8	8		
CV Dis.	11	5	2.93	(0.53, 17.00)
No CV Dis.	6	8		
ASA III	7	3	2.33	(0.36, 17.61)
ASA I or II	10	10		
Exist. Med. Cond.				
Less than 2	10	10	2.33	(0.36, 17.61)
2 or More	7	3		
Up. Abd/Thor	4	3	1.03	(0.14, 8.66)
No Up. Abd/Thor	13	10		
Over 60 Min.	12	11	0.44	(0.04, 8.92)
Under 60 Min.	5	2		

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this project was to explore the relationship between select variables and postoperative oxygen saturation during transport to the recovery room. The investigation was based on a review of the literature and personal experience in assessing oxygen saturation during anesthesia care.

This study consisted of thirty ASA I, II, and III patients over age sixty undergoing a broad range of surgical procedures requiring general anesthesia with endotracheal intubation. After procuring informed consent and a review of each individual's health history, every patient's SaO_2 was monitored during transit to the recovery room with pulse oximetry. Any patient who developed an SaO_2 of 90% was immediately given oxygen. Preoperative, intraoperative and postoperative information was compiled on a self-designed data collection sheet during the month of June, 1990 at the Erie County Medical Center. The variables examined in their relationship to oxygen saturation in this age cohort included: gender, obesity, history of respiratory disease, smoking history, history of cardiac disease, ASA status less than or equal to category III, surgical site, and duration of anesthesia. The study used a case-control design.

One goal of this project was to serve as a pilot for the development of a mechanism by which transport SaO_2 data might be systematically collected and evaluated. It may also serve to generate hypotheses to form the basis of future research.

Another objective of this investigation was to perform a preliminary, crude analysis of variables using odds ratios and confidence intervals. Data was collected on mutiple variables and their effect on reductions of oxygen saturation in this age cohort.

DISCUSSION OF FINDINGS

Fifty-seven percent (17 of 30) of patients over the age of sixty developed a reduction in oxygen saturation during transport to the PARR. Further data analysis revealed crude associations between reduced oxygen saturation during transport and obesity (OR = 8.0; 95% CI = 1.2, 61), a positive smoking history (OR = 1.8; 95% CI = 0.33, 10.1), the presence of cardiovascular disease (OR = 2.93; 95% CI = 0.53, 17.0), and ASA category III (OR = 2.33; 95% CI = 0.36, 17.6).

Considering the physiologic changes occurring with advanced age, the overall high incidence of reduced oxygen saturation (57%) in this study was not surprising. The estimates of risk associated with obesity (8.0), a positive history of smoking (1.8), the presence of cardiovascular disease (2.93), and ASA III status (2.33) all established a point estimate of greater than 1, as would be expected from the review of literature.[9,16,18] The exposure variables of respiratory disease, gender, and duration of anesthesia over 60 minutes did not reveal an odds ratio of greater than 1, and the variable of upper abdominal/thoracic surgery site had a point estimate of just over 1 (1.026), essentially making it a null value.

Although Tyler showed a relationship between asthma and postoperative declines in oxygen saturation [15], only three patients in his study had asthma. In a larger study of immediate postoperative reductions of oxygen saturation in the PARR, Canet showed that patients with preexisting respiratory disease had SaO_2 levels that were not significantly different from those patients without preexisting pulmonary disease. The effects of preexisting pulmonary disease were found to be more evident several hours after the end of surgery and to last for several days.[23] Also in Canet's study, women were found to have lower SaO_2 readings than men, but he acknowledges that this may be due to the higher incidence of obesity in females.

Prolonged exposure to mechanical ventilation and depressant anesthetic drugs would seem to depress spontaneous ventilation postoperatively, but this was not verified in this study. Tyler's study also showed no relationship between duration of anesthesia and the postoperative reduction of oxygen saturation.[15]

Surgery on the upper abdomen or thorax has been well documented to cause a decrease in PaO_2 due to incisional pain, splinting, and mismatching of ventilation to perfusion.[16] In this small sample, of the seven subjects with upper abdominal surgery, four developed a reduced oxygen saturation. It should be noted, however, that of the three remaining persons who did not develop this decline after upper abdominal surgery, two of them had the benefit of an epidural catheter for pain relief.

LIMITATIONS OF THE STUDY

There were two major limitations with this study. The small sample size limited the power of the data analysis. This resulted in rather large variances in the 95% confidence intervals. Although there was a tendency to show a clinical effect of many of the exposure variables on oxygen saturation, the modest sample size prevented any definite conclusions being drawn out.

This study used a univariate analysis for estimating crude effects. It did not use a multivariate analysis and, therefore, cannot account for interaction or confounding effects. For example, in obese individuals who smoke, is it obesity, smoking history, or a combination of both that contributes more to post-anesthesia reductions of oxygen saturation? A multivariate data analysis utilizing logistic regression might address such interactions or confounding effects,[24] but unfortunately that was beyond the scope of this preliminary investigation.

RECOMMENDATIONS FOR FUTURE RESEARCH

As a result of this project, it has become evident that further research is needed on the monitoring of SaO_2 during transport. Little information on this topic is currently avaliable in the literature. This pilot study was the first specific investigation on post-anesthesia oxygen saturation during transport to the PARR in patients over 60 years of age.

A replication of this investigation using a larger sample size would increase the power of this study. Small sample sizes may not reflect the actual occurrence of a given effect on the population. A modest sample size also causes the magnitude of the confidence interval to be extremely wide. This makes it difficult to reliably predict an effect if in fact it occurs. Larger sample sizes would narrow the ranges of the 95% confidence intervals, making the results more reassuring.

Other future studies might compare patients undergoing MAC (monitored anesthesia care) or regional anesthesia to general anesthesia to determine if a decline in SaO_2 is due to the general anesthesia itself, or is a reduction in oxygen saturation merely a by-product of the decreased functional capacity of advanced age.

Each individual variable examined in its relationship to oxygen saturation could stand alone as a project in itself. For example, investigating oxygen saturation in patients who have asthma, but who do not have other extraneous variables such as obesity, history of smoking, etc. Granted, however, it would be difficult to find appropriate subjects for such a confined sample, especially in the elderly, where chronic diseases often co-exist. As previously mentioned, dealing with confounding variables using logistic regression analysis on a large sample group would seem the most appropriate method of studying oxygen saturation in persons over age sixty.

CONCLUSIONS

In this analysis of transport SaO_2 in patients over age sixty, 57% of the sample developed a reduction in oxygen saturation during transit. Margin of safety and capacity for compensation are reduced appreciably at the extremes of life. Due to chronic disease states and the normal deterioration of functional capacity with increased age, satisfactory oxygen saturation should be considered as important in older patients as it is in the very young.

The final question that arises is quite simple: Is the transient fall of SaO_2 to 90% an adverse outcome? The clinical signs of this decline (hypertension, hypotension, tachycardia, bradycardia, cardiac dysrhythmias, agitation, confusion) are nonspecific.[16] Unfortunately, there is a lack of evidence that adverse clinical experiences are related specifically to transient reductions of oxygen saturation.[17] As a result, it is probably impossible to prove that a transient decrease of SaO_2 to 90% in and of itself is detrimental. However, the elderly are often frail individuals with multiple co-existing medical problems. It appears unreasonable to transport these high risk patients without every effort being made to minimize potential complications. If future studies continue to reveal a high incidence of reduced oxygen saturation during transit in this population, then it would seem prudent to administer oxygen to these individuals during transport to the PARR.

REFERENCES

(1) Chinn PL, Jacobs MK. 1987. Theory and Nursing. Toronto: The CV Mosby Co. pp. 181-200.

(2) Waugaman WR, et al. 1988. Principles and Practice of Nurse Anesthesia. Norwalk, Conn.: Appleton and Lange. pp. 146-147,151-156, 174, 330, 499-501.

(3) Polit GD, Hungler BP. 1987. Nursing Research, Principles and Methods, 3d ed. New York: JB Lippincott Co. pp. 141-154, 507-522.

(4) Guyton AC. 1986. Textbook of Medical Physiology, 7th ed. Philadelphia: WB Saunders Co. pp. 11-25, 493-503.

(5) Morris RW, et al. 1988. The prevalence of hypoxemia detected by pulse oximetry during recovery from anesthesia. Journal of Clinical Monitoring. 4(1):16-20.

(6) Parbrook GD, Davis PD, Parbrook ED. 1986. Basic Physics and Measurements in Anesthesia, 2d ed. East Norwalk, Conn.: Appleton Century Crofts. pp. 246-261.

(7) Cecil RL, ed. by Anreoli TE, et al. 1986. Essentials of Medicine. Philadelphia: WB Saunders Co. pp. 126-133, 139-146.

(8) Comroe JH, et al. 1962. The Lung. Chicago: Yearbook Medical Publishers Inc. pp. 140-155.

(9) Barash PG, Cullen BF, Stoelting RK. 1989. Clinical Anesthesia. Philadelphia: JB Lippincott Co. pp. 677-685, 1117-1119, 1301-1333.

(10) Cohen DE, Downes JJ, Raphaely RC. 1988. What difference does pulse oximetry make? Anesthesiology. 68(2):181-183.

(11) Tremper KK, Barker SJ, ed. by Biebuyck JF. 1989. Pulse oximetry. Anesthesiology. 70(1):98-108.

(12) Aldrete JA, Kroulik D. 1970. Current Researches. Anesthesia and Analgesia. 49(6):924-934.

(13) Kataria BK, et al. 1988. Postoperative arterial oxygen saturation in the pediatric population during transportation. Anesthesia Analog. 67:280-2.

(14) Montoyama EK, Glazener CH. 1986. Hypoxemia after general anesthesia in children. Anesthesia Analog. 65:267-272.

(15) Tyler IL, et al. 1985. Continous monitoring of arterial oxygen saturation with pulse oximetry during transfer to the recovery room. Anesthesia Analog. 64(1):108-1,112.

(16) Stoelting RK, Miller RD. 1984. Basics of Anesthesia. New York: Churchhill Livingstone. pp. 403-410, 421-423.

(17) Bilotta J. 1989. Researchers find oxygen desaturation level during endoscopy not predictive of morbidity. Anesthesiology News. 15(9):21.

(18) White PF. 1989. Outpatient anesthesia for the adult patient. American Society of Anesthesiologists 1989 Annual Refresher Course Lectures. American Society of Anesthesiologists Inc. Printed in the United States. pp. 1-7.

(19) Schlesselman JJ. 1982. Case-Control Studies: Design, Conduct, and Analysis. New York: Oxford University Press. pp. vii -ix, 71-85.

(20) Rothman KJ. 1986. Modern Epidemiology. Boston: Little, Browne, and Company. pp. 115-128.

(21) Kramer MS. 1988. Clinical Epidemiology and Biostatistics. New York: Springer-Verlag Berlin Heidelberg. pp. 93-111.

(22) Sullivan KM, Foster DA. 1990. Use of the confidence interval function. Epidemiology. 1(1):39-41.

(23) Canet J, et al. 1989. Early postperative arterial oxygen desaturation. Anesthesia Analog. 69:207-212.

(24) Kleinbaum DG, et al. 1988. Applied Regression Analysis and Other Multivariable Methods. Boston: PWS-Kent Publishing Company. pp. 512-518.

(25) Gustafson TL. 1989. True Epistat Manuel. Richardson, Tex.: Epistat Services.

(26) Lilienfeld AM. 1980. Foundations of Epidemiology. New York: Oxford University Press. pp. 342-352.

(27) Miller RD. 1986. Anesthesia, volume 2. New York: Churchill Livingstone. pp. 871-885.

(28) Freiman JA, et al. 1978. The importance of beta, the Type 2 error, and sample size in the design and interpretation of the randomized control trial; Survey of seventy-one "negative" trials. New England Journal of Medicine. 299:690-694.

(29) Kleinbaum DG, et al. 1982. Epidemiologic Research: Principles and Quantitative Methods. Belmont, CA: Wadsworth, Inc.

(30) Tremper KK. 1987. Oxygen transport and monitoring during anesthesia. In: Tremper KK, Barker SJ (Eds.). International Anesthesia Clinics. Advances in Oxygen Monitoring. 25:91-96.

APPENDIX A

State University of New York
School of Nursing
Adult Nurse Practitioner Program
Nurse Anesthesia Option
Primary Investigator - Wilbur Ken Smith, RN, BSN, MS candidate

STATEMENT OF CONSENT

The purpose of this study is to examine the oxygen level of patients greater than 60 years of age during their transport from the operating room to the recovery room. Your participation in this study is strictly voluntary. You may refuse to participate or withdraw from the study at any time with no penalty or loss of benefits to you.

If you agree to participate, you will receive additional monitoring during transport from the operating room to the recovery room. This monitoring will be performed by means of a pulse oximeter, which is routinely used in both the operating room and the recovery room. This device clips onto your fingertip and measures oxygen levels by light. The pulse oximeter is painless, and does not require any sample of blood to be drawn. You will be given oxygen immediately if the pulse oximeter indicates that you are beginning to show a need for it, and before low oxygen levels could pose a risk to you. We will also record some information from your chart, such as history of smoking, type of surgery, etc.

Information related to you will be treated in strict confidence and your identity will not be associated with any published results.

PATIENT RISK/BENEFITS

By agreeing to participate in this study, you will receive the benefit of additional monitoring of your oxygen level during your movement from the operating room to the recovery room. If you do not agree to join the study, you will receive the usual care during transport to the recovery room. Patients do not routinely receive this additional monitoring.

The short-term use of the pulse oximeter has not been shown to pose any risk to patients.

I, ________________________________ agree to be enrolled in this study. I acknowledge that I have had the above explained.

Signature of participant_____________________________________

Witness____

date_______________

Professional Contact: Timothy Sievenpiper, MD, Anesthesia Dept.
W. Ken Smith, SRNA, Anesthesia Dept.

Phone # for questions: 898-3549

APPENDIX B

OXYGEN SATURATION DATA FORM

PREOPERATIVE PHASE

Name ______________________________

Code # ____________________________

Age - _____

gender - M F

ASA I II III

weight - _____

heighth - _____

Resp. Disease: Asthma - Y N COPD - Y N Bronchitis - Y N

Cardiac Disease: MI - Y N CHF - Y N Other - Y N

Smoke: Pack/years - _____

Type Surgery - lower abdominal/extremity

upper abdominal/thoracic

INTRAOPERATIVE PHASE (OR)

Placement of finger detector - (R) 1 2 3 4 5

(L) 1 2 3 4 5

SaO_2: Room air _____

100% O_2 _____

Anesthesia time in minutes (intubation to extubation) ____

Initial Temperature (just after intubation) - _______

Final Temperature (just prior to extubation) - ______

Andrete Score - < 8 8 9 10

Lowest SaO_2 during transport - _____

Time to reach lowest SaO_2 (seconds) - _____

TYPES OF ANESTHETIC AGENTS USED (list name and total dose)

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________

APPENDIX C

UNIVERSITY AT BUFFALO
STATE UNIVERSITY OF NEW YORK

School of Nursing
709 Stockton Kimball Tower
Buffalo, New York 14214
(716) 831-2510
Fax# (716) 831 2021

May 11, 1990

Mr. Wilbur Ken Smith
1436 Sweethome Road
Amherst, New York 14228

Dear Mr. Smith:

Your proposal entitled "Oxygen Saturation in Patients Over Age 60 During Transport to the Recovery Room" has been reviewed and approved for a period of 12 months. At the end of 12 months, approval for continuation of the study must be obtained from the Human Subjects Review Committee. The forms for the continuation review can be obtained from the Committee Secretary.

Please inform the Human Subjects Review Committee if any eventuality should arise with your research which raises additional issues with respect to risks to the subjects and/or confidentiality of the data.

Sincerely,

Gail P. Brown, RN, Ph.D.
Chairperson
Human Subjects Review Committee

GPB:fmg
Enc.
cc-T. E. Obst

APPENDIX D

UNIVERSITY AT BUFFALO
STATE UNIVERSITY OF NEW YORK

Department of Medicine
School of Medicine
Faculty of Health Sciences
Erie County Medical Center
462 Grider Street
Buffalo, New York 14215
(716) 898-3000

May 4, 1990

Roger E. Kaiser, Jr., M.D.
Clinical Director
Department of Anesthesiology
Erie County Medical Center
462 Grider Street
Buffalo, New York 14215

Dear Roger:

The proposal "Oxygen saturation in patients over age 60 during transportation to the recovery room" with Mr. Wilbur Ken Smith has been approved by the SUNY School of Medicine and Biomedical Sciences Institutional Review Board. You will need patient consent, however, since Federal Regulations specify the need for this when data are collected for research purposes even from clinically indicated routine procedures which you describe.

The signed HS-1A form has been sent to the office of Sponsored Programs.

Sincerely yours,

James B. Lee, M.D.
Professor of Medicine
IRB Chair

JBL/al

APPENDIX E

STATE UNIVERSITY OF NEW YORK AT BUFFALO

SCHOOL OF NURSING

ABSTRACT APPROVAL FORM

STUDENT NAME Wilbur Ken Smith
Printed

AREA OF CONCENTRATION Nurse-Anesthesia

PROJECT X THESIS ☐ DISSERTATION ☐

General Area of Investigation Oxygen Saturation Levels Immediately After General Anesthesia

Tentative Project, Thesis or Dissertation Title Oxygen Saturation During Transport to the Recovery Room in Patients Over Age 60

Abstract should be approximately 350-400 words. Keep in mind that your description of the research may be reviewed by representatives from other disciplines. Thus, while there is the inescapable necessity of employing technical terms to describe much of what you propose to do, it is also important to explain the significance of your research so that the non-specialist can understand and better appreciate the merits of your proposal. Please consult the most current copy of the School of Nursing Graduate Student Handbook for a more complete description of project/thesis/dissertation requirements. Attach additional sheets for the abstract as necessary.

While post-anesthesia oxygen saturation during transport from the operating room to the recovery room has been studied in pediatric patients and the general adult population (average age 41 years), it has not been studied exclusively in persons over the age of 60.

The purpose of this pilot study is to identify any clinically significant alterations in oxygen saturation (SaO_2) during transport to the recovery room in patients over the age of 60. In addition, variables which may modify oxygen saturation in this age cohort, (eg., smoking, chronic health problems, type of surgery, etc.) will be analyzed.

This study will use a case-control design. Cases and controls will consist of patients over 60 years of age undergoing general endotracheal anesthesia. Cases will be defined as patients who experience hypoxemia during postanesthesia transport; controls will be defined as those not experiencing hypoxemia.

The sample will consist of 30 people above the age of 60 undergoing a wide range of surgeries and general anesthetics. The study will take place at the Erie County Medical Center. Data on oxygen saturation will be collected during transport from the operating suite to the post-anesthesia recovery room.

During transport, subjects whose SaO_2 reaches 90% will be given oxygen therapy. To protect patient confidentiality, no names will be use in this study, and all records will be kept in a locked file. The study will not include any prisoners, mentally retarded, or mentally disabled persons.

A pulse oximeter will be used to monitor each patient's SaO_2 during transport. The pulse oximeter utilizes a detector which fits onto a person's fingertip. It analyzes the differentials in light wavelength absorbance between oxygenated and deoxygenated blood as arterial blood pulsates, thus measuring the oxygen saturation of arterial blood. The pulse oximeter is painless and does not require any sample of blood to be drawn.

Descriptive statistics will be use to study any alterations of oxygen saturation in (cont.)

Student [signature] Signature — 9/11/90 Date

Committee Chair [signature] Signature — Thomas E. Obst, CRNA, MS Printed — 9/12/90 Date

Committee Member [signature] Signature — Timothy Sievenpiper, MD Printed — 9/12/90 Date

Committee Member Mollie B. Hassett Signature — Mollie B. Hassett, CRNA, MS Printed — Date

Abstract approved by School of Nursing Divisional Committee

Cathleen Getty Signature of Committee Chair — 9/28/90 Date

Cathleen Getty Printed