1997

Monitoring of oxygen saturation during and after endoscopy

George Paul Van Lawick
Edith Cowan University

Monitoring of Oxygen Saturation During and After Endoscopy

by

George Paul van Lawick R.N., B.N., M.R.C.N.A.

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of Bachelor of Nursing with Honours

School of Nursing
Faculty of Health and Human Sciences
Edith Cowan University
Western Australia

Date of Submission: 21st February, 1997

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

Fibreoptic endoscopy is a common and relatively safe diagnostic and therapeutic procedure used to examine the gastrointestinal tract. Previous research has established that oxygen desaturation is common among patients undergoing endoscopy and is one of the few complications which may arise during, and after the procedure. Oxygen saturation (SaO_2) is a measurement of the percentage of oxygen carried by the haemoglobin and can be measured noninvasively and accurately using a pulse oximeter. Oxygen desaturation is generally described as SaO_2 levels at or below 90%. Currently there are no clear guidelines for the duration of SaO_2 monitoring following endoscopy. It is also unclear whether all patients, or some groups of patients, would benefit most from such monitoring. The purpose of this study was twofold. Firstly, the study sought to describe the oxygen saturation levels in patients prior to, during, and after endoscopy using pulse oximetry. Secondly it sought to identify patient characteristics (variables) which may help to predict which patients are most vulnerable to desaturation. The study was conducted within the Gastroenterological Department of a major teaching hospital in Perth, Western Australia, using a convenience sample of 218 patients.

The results have clearly shown there to be a decrease in the mean SaO_2 relative to baseline after endoscopy, and that there is an increase in the range and variance of SaO_2 measurements after endoscopy. There was no statistically significant difference between the mean SaO_2 measurement for patients undergoing gastroscopy and colonoscopy. There was a greater incidence of

desaturation after endoscopy compared with during endoscopy. The majority of desaturation events occurred both within the first five minutes of the procedure, and within the first five minutes of the recovery phase.

From the literature, baseline oxygen saturation levels, age, smoking history, sedation, and cardiac and respiratory problems were identified as possible predictors of oxygen desaturation. Following hierarchical multiple regression analysis, baseline SaO_2 level and age made a statistically significant contribution to the prediction of desaturation among patients undergoing endoscopy. The addition of the variables smoking history, level of sedation, cardiac condition, and respiratory condition to the regression analysis did not significantly improve the prediction of desaturation. Age and a low baseline SaO_2 were identified in this study as being the variables which may help to predict which patients will be at a greater risk of desaturation.

This study has indicated that the identification of those variables that contribute to an increased risk of desaturation, and further monitoring of high risk patients using pulse oximetry, allows for nursing interventions to be implemented before the potentially serious consequences of desaturation occur. The recommendations of this study are to continue pulse oximetry monitoring and to administer supplemental oxygen for high risk patients into the recovery period.

Declaration by Candidate

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or a diploma in any institution of higher education and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature of Candidate

1/9/97.

Date

Acknowledgements

To Sue Nikoletti for her ongoing support and guidance throughout the duration of this study.

To Andrew Guilfoyle and Mary Smyth for their assistance with statistical analysis.

To Maxine Serrell for her assistance with the conceptual framework.

To Julie Harper for her support and assistance throughout the duration of this study.

To Paul van Lawick for showing me how a computer ought to be used.

To Dr Geoff Forbes and Anne Burvill for their input and assistance throughout the study.

To all the staff of the Gastroenterology Department for their support and effort.

To Ian Lewis from Western Biomedical for the usage of the portable Nellcor pulse oximeters.

Contents

	Page
Abstract	iii
Acknowledgements	vi
List of Figures and Tables	ix
Chapter One Introduction	1
Background and Significance	1
The Problem	3
The Purpose	3
Research Questions	4
Theoretical and Operational Definitions	4
Research Variables	7
Chapter Two Review of Literature	8
Introduction	8
Incidence of Desaturation During Endoscopy	8
Characteristics Which May Predict the Potential for Desaturation	10
Supplemental Oxygen During Endoscopy	12
Clinical Assessment by Nurses	13
Pulse Oximetry	14
Potential Sources of Error When Using a Pulse Oximeter	15
Summary	16
Research Focus	17
Chapter Three Theoretical Framework	18
Chapter Four Methodology	20
Design	20
Setting and Sample	21
Instruments	24
Pulse Oximeters	24
Data Collection Sheets	25
Reliability and Validity	26
Procedure	27
Ethical Considerations	30
Chapter Five Results	31
Research Question 1	31
Research Question 2	33

Research Question 3 34
Research Question 4 35
Summary 43

Chapter Six: Discussion 45
Ranges and Means of SaO_2 Before, During and After Endoscopy 46

Difference in Means of SaO_2 Between Gastroscopy and Colonoscopy 48

Incidence of Oxygen Desaturation During and After Endoscopy 49

Variables Which May Help to Predict Which Patients Will Desaturate 51

Baseline SaO_2 51
Age 52
Smoking History 53
Sedation 54
Cardiac and Respiratory Conditions 55

Discussion of Conceptual Framework 57

Implications for Clinical Practice 58

Limitations of the Study 60

Recommendations for Further Research 61

References 62

Appendices
Appendix A 67
Appendix B 68
Appendix C 69
Appendix D 70
Appendix E 71
Appendix F 72
Appendix G 73

List of Figures and Tables

Page

Figures

Figure 1. Conceptual Framework 19

Tables

Table 1. Demographic Information For All Endoscopy Patients 23

Table 2. Ranges, Means and Standard Deviations of SaO_2 in Patients Prior to (Baseline), During and After Endoscopy (N = 218) 32

Table 3. SaO_2 Range, Means and Standard Deviation for Gastroscopy Vs Colonoscopy 33

Table 4. Incidence of Oxygen Desaturation During and After Endoscopy 35

Table 5. Desaturation By Age 37

Table 6. Desaturation Among Smokers and Nonsmokers 38

Table 7. Desaturation Among Patients With Respiratory and/or Cardiac Conditions During Endoscopy (N = 218) 39

Table 8. Desaturation Among Patients With Respiratory and/or Cardiac Conditions After Endoscopy (N = 218) 40

Chapter One

Introduction

Background and Significance

Fibreoptic endoscopy is a common and relatively safe diagnostic and therapeutic procedure used in the gastrointestinal tract. The few complications that do arise often relate to the actual procedure (the physical presence of the endoscope may interfere with respiration, for example), or the effect of sedation on conscious level or level of oxygen saturation (Bailey et al., 1990; Rozen, Fireman & Gilat, 1982). Oxygen saturation (SaO_2) is a measurement of the percentage of oxygen carried by the haemoglobin. Oxygen desaturation is generally described as SaO_2 at or below 90% (Fennerty, Ernest, Hudson & Sampliner, 1990; Poser & Ladik, 1995; Rostykus, McDonald & Albert, 1978). Supplemental oxygen is routinely administered during endoscopy in order to prevent oxygen desaturation (Bell, Bown, Morden, Coady & Logan, 1987).

Pulse oximetry is a noninvasive method of determining oxygen saturation (SaO_2) levels within the arterial circulation. This involves placing a sensor on the finger which warms and increases the blood flow to the tissue. One half of the sensor transmits light which passes through the tissue, and the degree of light absorbed determines the SaO_2 of the blood. This is measured by the detector on the other half of the sensor (Taylor & Whitwam, 1986). Severinghaus and Astrup (1986) described pulse oximetry as being significant in patient monitoring essential to the care and safety of patients during sedation and in the recovery period following surgery.

There is a difference of opinion in the literature regarding the incidence of oxygen desaturation and the need for monitoring SaO_2 and administering supplemental oxygen during endoscopy. Although it is common practice to use pulse oximetry on all patients during endoscopy, there is disagreement regarding the use of pulse oximetry following the procedure (Barkin et al., 1989; Froehlich et al., 1995; Keefe & O'Connor, 1990). Poser and Ladik (1995) recommended that all patients receiving sedation and analgesia prior to, and during, endoscopy, be monitored with pulse oximetry in the recovery phase but added that it might be more practical to observe only those patients more likely to desaturate. This group may include those with lower baseline SaO2 levels, those with a smoking history, and the elderly.

The Gastroenterology Department at the hospital participating in the present study was concerned about the adequacy of the current level of monitoring of SaO_2 in view of the different opinions expressed in the literature. Currently in the Department, if patients maintain their SaO_2 levels at an adequate level during the procedure, SaO_2 monitoring is ceased at the end of the procedure and the patients are commenced on routine clinical assessments such as blood pressure, pulse, respirations and skin colour observations. Registered nurses have a key responsibility for the safety and accurate monitoring of patients. However, since signs of low SaO_2 (cyanosis for example) are not evident until the SaO_2 is under 80% (Hanning & Alexander-Williams, 1995), a more sensitive indicator is required and pulse oximetry could prove to be a significant addition to routine clinical assessments in the recovery period.

The Problem

Currently there are no clear guidelines for the duration of SaO_2 monitoring following endoscopy. It is also unclear whether all patients, or some groups of patients, would benefit most from such monitoring. Several studies have examined oxygen desaturation during endoscopic procedures but little is known about SaO_2 and desaturation levels following a procedure. Research conducted by Poser and Ladik (1995) focused on the recovery phase of the procedure, but was limited due to the lack of information on sedation type and dosage.

Further research is therefore required to build on this study and to aid in establishing a monitoring protocol for endoscopy by examining SaO_2/desaturation patterns and characteristics of patients in this specific setting, thus adding to knowledge regarding the need for pulse oximetry following endoscopy.

Research Purpose

The purpose of this study is twofold. Firstly, the study aims to describe the oxygen saturation levels in patients prior to, during and after endoscopy (gastroscopy and colonoscopy) using pulse oximetry. Secondly, this study aims to identify those variables which may be associated with the occurrence of oxygen desaturation after endoscopy.

Research Questions

1. What are the ranges and means of SaO_2 before, during, and after endoscopy?
2. Is there a statistically significant difference in mean SaO_2 between two groups of patients, one undergoing gastroscopy and the other colonoscopy?
3. What is the frequency of oxygen desaturation during endoscopy and during the twenty minute period following endoscopy?
4. Do patient variables such as smoking history, sedation, cardiac, and respiratory disease, improve the prediction of desaturation after endoscopy, beyond the variables baseline SaO_2 and age, which are generally recognised as predictors of oxygen desaturation?

Theoretical and Operational Definitions

Baseline SaO_2 level. The SaO_2 measurement taken by nurses using pulse oximetry prior to the administration of sedation and analgesia and prior to the commencement of the endoscopy.

Body mass index (BMI). BMI is the measurement derived from the height and weight of the patient and may be used to determine the correct dosage of sedation and analgesia. The BMI was calculated by dividing patients' weight (kg) by their height squared (m^2).

Cardiac conditions. Any condition which directly affects the function of the heart and circulatory system leading to cardiac ischaemia, cardiac insufficiency and/or arrhythmias.

Colonoscopy. Provides visualisation of the lining of the large intestine through a flexible endoscope, which is inserted rectally.

Endoscopy. Provides direct visualisation of the gastrointestinal system by means of a lighted flexible tube (endoscope) equipped with a camera to provide photographic imagery. The types of endoscopy used in this study were colonoscopy and gastroscopy.

Gastroscopy. Provides visualisation of the oesophagus, the stomach, and the duodenum through a flexible endoscope, which is inserted via the mouth.

Hypoxaemia. A low partial pressure of oxygen within the arterial circulation (low saturation of oxyhaemoglobin).

Hypoxia. An insufficient (decreased) amount of oxygen within the body tissues.

Midazolam dose per BMI. The dose of Midazolam administered per BMI, allowing a direct comparison to be made between all patients undergoing endoscopy in this study.

Oxygen desaturation. A lower than normal value of circulating oxyhaemoglobin. For the purpose of this study desaturation is SaO_2 at or below 90%.

Oxygen saturation (SaO_2). SaO_2 shows the percentage of oxygen carried by haemoglobin (oxyhaemoglobin) within the arterial circulation.

Pulse oximetry. A non-invasive method of measuring the ratio of oxygenated haemoglobin to the total amount of haemoglobin to determine oxygen saturation levels. An oximeter with a finger probe was used.

Recovery. The period in which a patient is assessed by nursing staff as they recover from the effects of sedation and analgesia. For the purpose of this study 20 minutes was designated as the recovery period commencing at the end of the procedure when supplemental oxygen was ceased and the portable pulse oximeter was connected.

Respiratory conditions. Conditions in which the ability of the lungs to take up oxygen is affected, either by disease or exposure to toxins.

Sedation. Midazolam was the drug used as sedation for all patients undergoing endoscopy. The small sedation effect caused by analgesia was not measured in this study. Only those patients undergoing colonoscopy received analgesia.

Smoking history. This study defined a smoker as anyone who had ever smoked.

Research Variables

Dependent variable. The lowest SaO_2 reading after endoscopy for each patient who participated in the study.

Independent variables. The independent variables used in this study are baseline SaO_2, age, smoking history, sedation, cardiac condition, and respiratory condition and were defined in the previous section.

Chapter Two

Literature Review

The following review examines the literature on the incidence of desaturation during and following endoscopy (gastroscopy and colonoscopy), characteristics of patients which may predict the potential for desaturation during endoscopy, and the use of supplemental oxygen during endoscopy. The review will also examine conventional clinical assessment of oxygen saturation, alternative means of assessing oxygen saturation levels, the use of pulse oximetry as a means of monitoring the oxygen saturation levels of the patient, and the potential sources of error when using a pulse oximeter.

Incidence of Desaturation During Endoscopy

Much has been written about the use of endoscopy as a common and relatively safe diagnostic and therapeutic tool for the gastrointestinal tract. In a study conducted on 104 patients, Fennerty et al. (1990) monitored the patients for incidence of desaturation and other physiological parameters. It was found that of those patients who desaturated, desaturation was associated with anaesthetic induction, endoscope looping, and pain. Whorwell, Smith and Foster (1976), concluded that with an increase in endoscopy procedures there would be a significant increase in the incidence of desaturation, in particular in those patients with a respiratory disease and with the use of a respiratory depressant (such as Midazolam) as a pre-medication. According to Iber, Sutberry, Gupta and Kruss

(1993), endoscopy is increasingly used as a diagnostic and therapeutic tool due to its benefits to patient care and the safety of such a procedure. The few complications that do occur are most often related to the actual procedure, for example, the physical presence of the endoscope may interfere with respiration. In addition, sedation and analgesia cause a decrease in respiration which may induce cardiopulmonary complications (Barkin et al. 1989; Froehlich et al. 1995; Rozen et al., 1982). The studies by Barkin et al. (1989) and Rozen et al. (1982) are limited due to the relatively small patient populations examined and the diversity of sedation methods used. Both studies focused on the elderly and from the results it was concluded that age was a patient characteristic to be considered as a predictor for desaturation.

A sample of 32 elderly patients undergoing endoscopy was studied by Barkin et al. (1989) to determine the incidence of desaturation. They documented that previous studies had indicated the physical presence of the endoscope may interfere with respiration. However, their study found that approximately 50% of elderly patients who desaturated, did so in the pre-medication phase. Sedation used prior to endoscopy was the suspected cause of respiratory changes, hypoxaemia and therefore desaturation.

In the current study Midazolam was the drug of choice by practitioners as it has a short half life and the residual effects are therefore considerably less (Gamble, Kawar, & Dundee, 1989; Wilmot, 1996). Previous studies have found the incidence of desaturation to be greater when a benzodiazepine (Midazolam) is combined with a narcotic analgesic such as pethidine or fentanyl (Rozen et al., 1982; Wilmot, 1996).

In a double-blind, randomised, placebo-controlled study of the effect of conscious sedation use on 194 patients, Froehlich et al. (1995) concluded that the incidence of desaturation with low-dose Midazolam was rare, and the benefits of conscious sedation throughout endoscopy outweigh the risks. Conscious sedation allows the patient to retain the ability to maintain a patent airway independently and continuously. The patient is able to respond to verbal command and physical stimulation, while the level of consciousness is depressed minimally. Conscious sedation, therefore, enables the endoscopy to be performed with a relaxed, responsive patient which, in turn, may reduce the incidence of desaturation (Council on Scientific Affairs, American Medical Association, 1993).

Characteristics Which May Predict the Potential for Desaturation

There is some contention in the literature about what factors might predict the occurrence of oxygen desaturation during endoscopy. Fennerty et al. (1990) conducted research using a sample size of 104 patients undergoing colonoscopy. This study found no correlation between pre-existing cardiopulmonary conditions, sedation, age, or medications and the potential for desaturation. Barkin et al. (1989) identified age and administration of sedation as affecting respiratory performance resulting in oxygen desaturation, and suggested that a pre-existing pulmonary illness may influence oxygen saturation. Their study, however, was limited due to a small sample size (n = 32).

Iber et al.(1993) used a consecutive sample of 508 patients undergoing endoscopy. This study was conducted with the specific purpose of determining the value of pulse oximetry and identifying patients at risk of desaturation, who may therefore require continuous monitoring with a pulse oximeter both during and in the recovery phase of the procedure. Iber et al. identified old age as the only notable predictor of desaturation, with other possible risk factors being pre-existing disease which may constitute an anaesthetic risk, and recent drug or alcohol withdrawal.

Another study by Poser and Ladik (1995) reported that 115 of their 475 participants (24%) experienced desaturation during the recovery stage. Poser and Ladik (1995) found that oxygen desaturation in the recovery period was influenced by the pre-procedure baseline SaO_2 level, smoking history, and age. This study continued monitoring patients for a full hour after the procedure in contrast to Iber et al. (1993) who monitored patients for 30 minutes after the procedure. The study by Barkin et al. (1989) monitored patients during the procedure only and Fennerty et al. (1990) continued monitoring for 15 minutes.

Bell, Reeve et al. (1987) concluded that age, sex, respiratory status, sedation, and initial SaO_2 levels were not predictors of oxygen desaturation. In this study of 100 patients it was concluded that small doses of intravenous Midazolam produced a statistically significant fall in oxygen saturation levels prior to and during endoscopy, but the mean SaO_2 levels remained above 92% and were therefore not at a desaturation level. The fall in SaO_2 levels was attributed to the central respiratory depressant effect of Midazolam which induced hypoventilation followed by hypoxaemia.

Supplemental Oxygen During Endoscopy

The literature clearly indicates that the administration of supplemental oxygen, and the measuring of oxygen saturation (and therefore desaturation) by pulse oximetry and other clinical observations, is routine during endoscopy (Bell, Bown et al., 1987; Fennerty et al., 1990; Poser & Ladik, 1995). Opinions in the literature differ as to what extent these measures are effective. Several studies have indicated that the incidence of oxygen desaturation during endoscopy can be reduced by the administration of supplemental oxygen (Barkin et al., 1989; Griffin Chung, Leung & Li, 1990). In the studies conducted by Barkin et al. (1989); Bell, Bown et al. (1987); Griffen et al. (1990), the administration of supplemental oxygen prior to the administration of sedation increased the baseline SaO_2. Although there was a reduction in respiration rate, the SaO_2 levels remained above 95% (Barkin et al., 1989; Bell, Bown et al., 1987; Griffen et al., 1990).

Barkin et al. (1989) further advised that supplemental oxygen should be administered during endoscopy to those with baseline hypoxaemia, significant cardiac disease, and the elderly. This recommendation is supported by the results of the study documented by Bell, Bown et al. (1987). In this study patients sedated with intravenous Midazolam had a reduced potential for desaturation when provided with supplemental oxygen at a rate of 2 litres per minute via a nasal cannula. This study was compared with a previous study, by Bell, Bown et al.

(1987) using 100 participants who did not receive supplemental oxygen and 50 who did. Of those receiving supplemental oxygen, 12% desaturated, as compared to 35% of those who did not receive supplemental oxygen. Griffen et al. (1990) surveyed 80 patients, of which 41 did not receive supplemental oxygen (control group), and 39 did. Fifty-one percent of the control group desaturated, whereas only 10% of those receiving supplemental oxygen desaturated.

Clinical Assessment by Nurses

Accurate assessment of saturation levels during and following endoscopy is essential to avoid possible complications such as respiratory arrest or cardiac arrhythmias. Conventional clinical assessment for oxygenation is subjective and relies on the individual's perception. Clinical indications of desaturation are respiratory distress, an increased pulse rate, blood pressure elevation, and peripheral or central cyanosis. Two studies indicate that clinical signs of hypoxaemia are not evident until blood oxygen saturation levels are very low. Hanning and Alexander-Williams (1995) demonstrated that hypoxaemia became evident only when SaO_2 levels were under 80%, and McGough and Boysen (1989) have stated that cyanosis cannot be detected until SaO_2 is less than 85%. While clinical assessment is essential to the patient's well-being and provides information about the respiratory status of the patient, it has been shown to be an unreliable means of detecting hypoxia until a critical event occurs indicating a deterioration in the patient's condition. Factors reducing the effectiveness of clinical assessment are the reduction of ambient lighting to facilitate endoscopy within the procedure room, dark skin pigmentation of the patient, and the presence of nail polish which prevents assessment of peripheral cyanosis (Murray, Morran, Kenny & Anderson, 1990; Emery, 1987; Ries, Prewitt & Johnson, 1989).

An alternative method of detecting oxygen desaturation is by assessment of the arterial blood gases of each individual patient. However, this is time consuming and requires the insertion of an arterial line. This would be an added invasive procedure to the patient and may increase anxiety levels and the potential for infection. Another consideration is the practicality of such a procedure as it would require another staff member to take and assess blood samples which would be an additional cost to the hospital (Murray et al., 1990).

Pulse Oximetry

Pulse oximetry has been available in various forms since 1935 but it was not until 1985 that the pulse oximeter became accepted as an accurate means of assessing oxygen saturation levels (Tremper & Barker, 1989). Pulse oximetry is well established, within the operating room and other clinical settings, as a useful, sensitive detector of hypoxaemia, and is accepted as a supplement to clinical assessment for hypoxia (Hanning & Alexander-Williams, 1995; Severinghaus & Kelleher, 1992). Early detection of desaturation using a pulse oximeter allows for immediate intervention by nursing staff such as administering supplemental oxygen, reposturing, verbal stimulation, or in some cases drug reversal (Bell, McCloy et al., 1991).

Froelich et al. (1995) suggest that routine pulse oximetry in average risk patients might not have any effect on patient outcomes due to the rare and short-lived alterations of cardiorespiratory function. However, Murray et al. (1990) have shown that oxygen desaturation can occur quickly and can be profound. In their study of arterial oxygen saturation during upper gastrointestinal endoscopy, using an oxygen saturation (%) by time graph, Murray et al. (1990) showed that desaturation could be precipitated by the use of sedative drugs and endoscope insertion. This study was limited, however, due to a small sample size (n = 20).

From the literature reviewed, there is agreement that pulse oximeter monitoring during the procedure and in recovery is an important aspect of patient care, in particular in those patients considered to be at risk of desaturation. Strong recommendations for the use of pulse oximetry and supplemental oxygen measures have been made (Bell, McCloy et al., 1991; Griffen et al., 1990; Poser & Ladik, 1995) but a standard of care for providing pulse oximetry monitoring during, and particularly following, endoscopy has not been established. Additional research is required to identify the potential predictors of oxygen desaturation in order to determine if it is important to monitor all patients or only those considered to be at risk.

Potential Sources of Error When Using a Pulse Oximeter

While pulse oximetry is recognised as a useful monitor for detection of oxygen desaturation (Murray et al., 1990) there are, however, potential sources of error in pulse oximetry as found in the studies by Stoneham, Saville, & Wilson

(1994); Ralston, Webb & Runciman (1991); Ries et al. (1987). Their findings indicated that accuracy of pulse oximetry readings was influenced by nail varnish, peripheral vasoconstriction, cardiac arrhythmias, carbon monoxide poisoning and overhead lighting. These potential errors are minor and pulse oximetry readings alter minimally. Errors can be avoided by assessing the patient prior to oximetry use.

Summary

In summary it is clearly established that there is the potential for a patient to desaturate in the recovery period. Studies investigating the incidence of desaturation have attributed the decrease in oxygen saturation levels to the drugs used to sedate patients, the introduction of the endoscope, and pain. Other studies have attempted to identify the patient characteristics which may predict the potential for desaturation. The conclusions vary with each study, however, age appears to be a significant factor with most studies, while other possible predictors have been found to be baseline SaO_2, respiratory status, pre-existing cardiopulmonary disease, and smoking history. The administration of supplemental oxygen during endoscopy has been determined by several studies as an effective measure in reducing the incidence of desaturation. Previous studies have shown pulse oximetry to be a simple, effective and reliable means of determining oxygen saturation levels of patients, and of alerting the operator to an incident of desaturation. Although there may be a potential for errors with pulse oximetry use, factors contributing to error are easily assessed prior to use and readily avoided.

As oxygen desaturation can occur rapidly, pulse oximetry is seen to be a more accurate means of assessment than clinical assessment as desaturation is detected early before critical events may occur. The literature, however, does not clearly establish guidelines for oxygen saturation monitoring. In particular, the value of monitoring after the procedure has not been adequately studied.

Research Focus

This study sought to determine the extent to which oxygen desaturation occurred in the recovery period following endoscopy in a sample of patients attending the Gastroenterology Department of a major teaching hospital. It sought to determine what patient characteristics were associated with the incidence of oxygen desaturation in this population. This study also aimed to build on the research conducted by Poser and Ladik (1995) which described monitoring in the recovery phase but was limited due to the lack of information on sedation type and dosage. The results of this study could prove valuable in establishing a protocol for providing pulse oximetry monitoring for patients undergoing and recovering from endoscopy.

Chapter Three

Theoretical Framework

The theoretical framework developed for this research is based on Ludwig von Bertalanffy's General Systems Theory (1968). The Theory describes systems as wholes composed of related parts, between which interaction occurs. Systems contain interdependent variables, have the ability to increase their complexity, can change and develop over time, and can be open or closed to outside influences (Putt, 1978).

Von Bertalanffy's theory consists of a system which has inputs, throughputs and outputs (Figure 1.). For this study, input involved attempting to identify patients at risk of oxygen desaturation by assessing and examining patient characteristics which were considered to be study variables. Age, cardiac condition, respiratory condition and smoking history were included as variables which may determine a patients' baseline SaO_2 level. The SaO_2 level for patients included in the study was established by nursing staff using a pulse oximeter prior to the administration of sedation and oxygen and prior to the commencement of the endoscopic procedure (throughput). If patients desaturated during the endoscopy and required reversal agents, they were then excluded from the study.

Output involved the monitoring of patients' SaO_2 levels during the recovery period by the researcher using pulse oximetry. This was an extension of routine monitoring and the results of the study will have a direct impact on the current monitoring procedures of the Gastroenterology Department by indicating which patients are likely to desaturate and therefore require pulse oximetry or supplemental oxygen after the procedure. The recovery period commenced immediately after the endoscope's removal and the cessation of supplemental oxygen. Where SaO_2 levels remained satisfactory during recovery, patients were discharged according to Department protocol. Patients who desaturated during this time were roused and received oxygen. When the SaO_2 returned to a satisfactory level they were then discharged according to Department protocol.

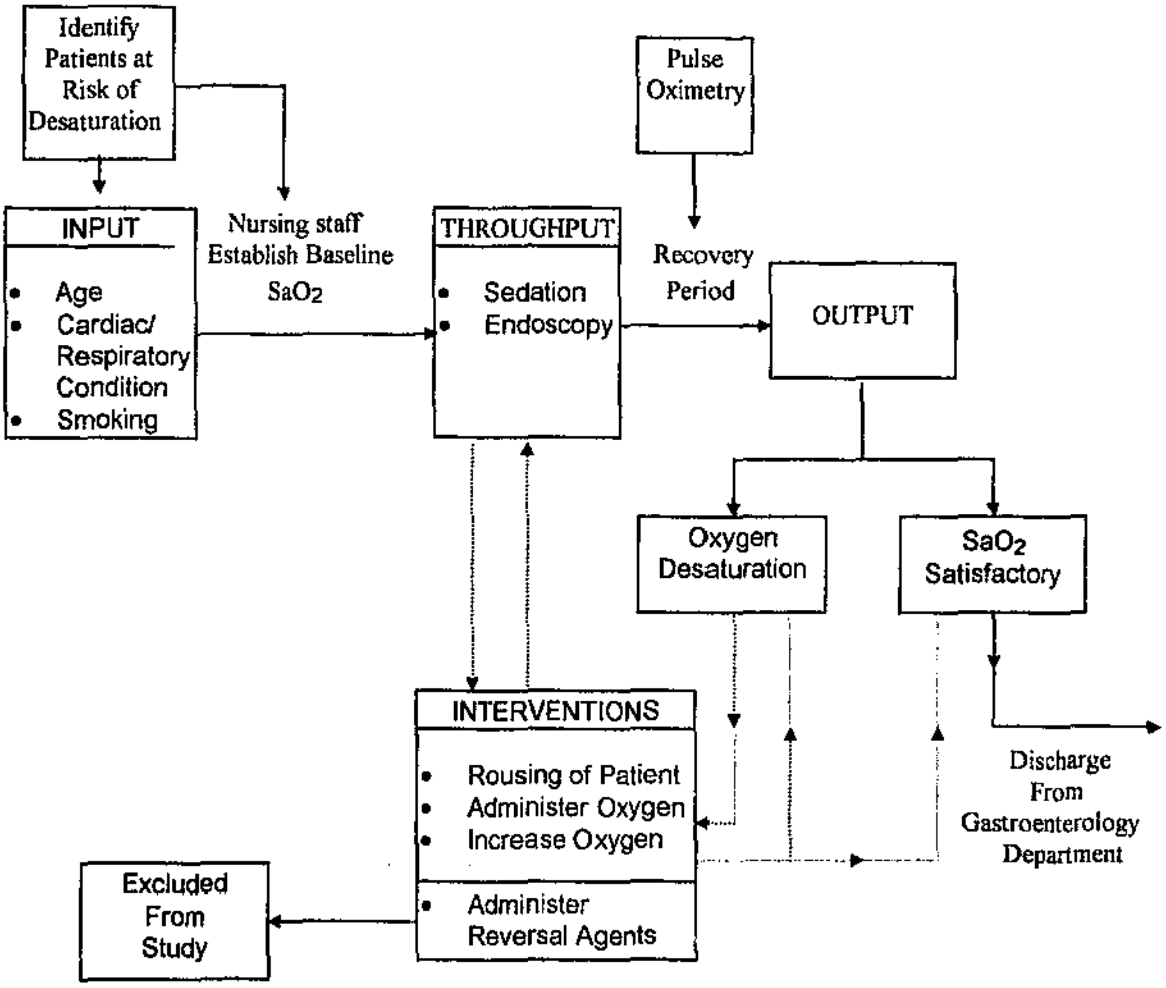

Figure 1. Conceptual Framework for the study based on Von Bertalanffy's General Systems Theory.

Chapter Four

Methodology

This chapter identifies the research design of the study and describes the setting and sample, and ethical considerations. The instruments used for data collection are described and discussed in terms of their validity and reliability. Data collection procedures are also outlined.

Design

A descriptive, correlational design was used in the study. The descriptive component was used to a) describe the ranges, means and variance of SaO_2 before, during, and after endoscopy; b) describe the difference in the ranges and means of SaO_2 between gastroscopy and colonoscopy; and c) describe the frequency of oxygen desaturation during and for twenty minutes following endoscopy, comparing gastroscopy and colonoscopy. In this component SaO_2 levels were monitored with pulse oximeters prior to, during, and for twenty minutes following endoscopy. SaO_2 levels for these times were recorded on data collection sheets specifically designed for this study (Appendix A, B, C). The correlational component of the study was used to identify patient characteristics which helped to predict the development of oxygen desaturation during the 20 minute recovery period. From the literature, baseline SaO_2, age, smoking history, sedation, and cardiac or respiratory problems were generally identified as possible predictors of oxygen desaturation during and after endoscopy.

Setting and Sample

The study was conducted at the Gastroenterology Department of a major teaching hospital in Perth, Western Australia, which averages five thousand procedures per year. The Department treats all classifications of patients (private, public, inpatients and outpatients) all of which were included in the sample.

A convenience sample of 218 inpatients and outpatients undergoing endoscopy (120 gastroscopy and 98 colonoscopy) were included in the study. It was not possible to sample all patients as the turnover of patients was high. Data collection was carried out on weekdays between the 27th of June and 6th of August. No data were collected during the hospital's low activity days (last Friday of each month) and on weekends (emergency standby only) which were considered to be nonrepresentative as there were no booked admissions at these times.

Criteria for exclusion were: patients under 18 years; those who were receiving continual oxygen therapy; inability to obtain oxygen saturation readings with the pulse oximeter; those undergoing both gastroscopy and colonoscopy; communication deficit (such as inability to speak English or dementia); and refusal to participate in the study. Out of 432 potential participants, 214 were excluded from the study for the following reasons: three were under 18 years of age; four were receiving continuous oxygen therapy; two were unable to display a $SaO2$ reading by pulse oximeter (one due to dark skin pigmentation, and one due to nail polish); 31 patients underwent both gastroscopy and colonoscopy procedures; 22 were unable to speak English and seven suffered from dementia. The remaining 145 patients could not be included in the study due to the high turnover of patients.

Table 1 describes the demographics of the sample. The sex, age, medical problems, reason for procedure, and smoking history of the total sample are listed. The table shows that slightly more males than females underwent gastroscopy, but slightly more females underwent colonoscopy. The ages of patients undergoing endoscopy ranged between 18 and 95. Haemorrhage and pain were two common reasons for undergoing endoscopy, and polyps accounted for over 50 percent of patients undergoing colonoscopy. Vomiting and nausea, in the category 'other', were two very common reasons for undergoing both gastroscopy and colonoscopy. Cardiovascular problems were the most common medical problem among both the gastroscopy and colonoscopy patients. Seventy gastroscopy patients, and 53 colonoscopy patients had other medical problems, such as back or neck pain, but these were not considered to be relevant for the purpose of this study. In the two smoking categories both the gastroscopy and colonoscopy groups of patients were represented equally.

Table 1

Demographic Information for all Endoscopy Patients.

	GASTROSCOPY (N = 120)	COLONOSCOPY (N = 98)
Sex		
Male	67 (56%)	47 (48%)
Female	53 (44%)	51 (52%)
Age		
18 - 45	32 (26%)	28 (29%)
46 - 58	24 (20%)	24 (25%)
59 - 70	37 (30%)	23 (24%)
71 - 95	29 (24%)	21 (22%)
Reason for Procedure		
1. Haemorrhage	38 (32%)	34 (35%)
2. Constipation	3 (2%)	7 (8%)
3. Diarrhoea	5 (4%)	9 (10%)
4. Pain	77 (64%)	31 (32%)
5. Weight Loss	9 (8%)	1 (1%)
6. Familial	0 (0%)	16 (17%)
7. Polyps	3 (2%)	53 (54%)
8. Other	59 (49%)	29 (30%)
Medical Problems		
0. Nil	21 (18%)	19 (19%)
1. Respiratory	24 (20%)	18 (18%)
2. Cardiovascular	51 (43%)	43 (44%)
3. Renal	11 (9%)	9 (9%)
4. Metabolic	7 (6%)	10 (10%)
5. Neurological	23 (19%)	5 (5%)
6. Other	70 (58%)	53 (54%)
Smoking		
Ever Smoked	65 (54%)	54 (55%)
Never Smoked	55 (46%)	44 (45%)

Instruments

The research instruments consisted of pulse oximeters and data collection sheets.

Pulse oximeters. The instruments used to measure SaO_2 levels during endoscopy were Nellcor (N-200 Hayward CA 94545 USA) ward pulse oximeters already present in each of the procedure rooms. To measure SaO_2 levels following endoscopy Western Biomedical kindly provided this researcher with two portable pulse oximeters (Nellcor N-20 Pa) for the duration of the study. Both the standard and portable type pulse oximeters give a digital pulse reading and display the SaO_2 value as a percentage. Both types had identical finger probe attachments. Each portable model was powered by four C-cell batteries which were checked on a daily basis in accordance with the instruction manual. Nellcor pulse oximeters have their low alarm setting at 85% SaO_2. This was deemed too low for the purpose of this study and required resetting to 90% for each patient. The printer function was used in each case to allow the researchers to leave the room. A result was printed every 30 seconds for the duration of the 20 minute recovery period unless the SaO_2 fell below 90% and it would then alarm and print the level immediately. At the conclusion of the recovery period a printout was obtained from the pulse oximeter showing a summary with the minimum, maximum and mean SaO_2 and pulse reading, also highlighting any reading below the alarm setting.

Data collection sheets. Since no previous studies disclosed any suitable data collection sheets, these were specifically developed by the researcher for the purposes of this study. There were three data collection sheets used in the study.

Data sheet 1 (Appendix A) related to patient information and was used to record details such as age, sex, smoking history, current medications, medical problems, height and weight. Previous studies (Iber et al., 1993; Poser & Ladik, 1995) have shown age and smoking history to be significant factors in oxygen desaturation. Other medical problems were documented to gain an overall view of the type of patients undergoing treatment and compare them to similar studies. Height and weight measurements were recorded to calculate the body mass index (BMI) measurement which allowed comparison of the Midazolam dosages administered to patients by the doctors.

Data sheet 2 (Appendix B) contained information relating to the procedure and included:

1. The type of procedure. Only patients who underwent gastroscopy or colonoscopy were included. Those having both procedures were excluded as they were few in number and therefore not representative of the total number of cases.
2. Indication for procedure was used to describe the type of problems for which patients were treated and included haemorrhage, constipation,

diarrhoea, pain, weight loss, familial history of bowel cancer, polypectomy, and other.

3. The type and amount of sedation(s) used during the endoscopy.

Data sheet 3 (Appendix C) was used to record SaO_2 levels prior to, during and following the endoscopy. Prior to the procedure baseline measurement of SaO_2 was taken for each patient before and after commencement of oxygen and just before insertion of the endoscope. During the procedure SaO_2 levels were recorded at one minute, and then at five minute intervals throughout the procedure. If any episodes of desaturation occurred during or after endoscopy these were recorded in a separate section with time and amount of supplemental oxygen administered.

The rate of supplemental oxygen was kept uniform at 4 litres/minute for all patients included in the study, unless more oxygen was required due to persistent low SaO_2 readings.

Reliability and Validity

Nellcor pulse oximeters have an internal calibration system which is set in the factory. They are reported to be accurate in measuring SaO_2 to within 3% in the 70-100% range (Council on Scientific Affairs, American Medical Association, 1993). For the duration of the study the readings of the four pulse oximeters were compared on the Monday of each week. The researcher recorded the results for each pulse oximeter monitoring the research assistant's SaO_2 (using the same finger each time) over a period of 30 seconds. Over the six week period there was a 100% agreement between three pulse oximeters. The pulse oximeter located in procedure room 4 was consistently 1% lower than the three others for a period of a week. This pulse oximeter was subsequently replaced as another became available which resulted in a 100% agreement in SaO_2 readings between pulse oximeters for the remainder of the study. It is possible to get a lower (false) reading due to perfusion difficulties, nail polish (one patient excluded for this reason), and very dark pigmentation of the person's skin (one patient excluded for this reason).

Content validity for the data collection sheets was verified by three Gastroenterologists and two Clinical Nurses currently working in the hospital's Gastroenterology Department prior to the commencement of the pilot study. These staff members were asked to review the content and sequencing of information on the data collection forms. No changes were recommended.

Procedure

Staff in the Gastroenterology Department at RPH were informed about the study by a memo from the Nurse Manager and Gastroenterologist. This allowed for the introduction of the researchers and clarification of any issues which concerned staff. A copy of the proposal was left on the ward for staff to read and assurances were made that any questions would be answered fully. Prior to the study the researcher and assistant visited the Department to gain an overall impression of ward layout and routine. The research assistant who volunteered her time throughout the data collection phase was a Registered Nurse Division 2 (Enrolled

General Nurse) with eight years experience. The pilot study was conducted with 10 patients to trial the study's design and procedure. Only minor additions were made to the data collection sheets to increase clarity for data entry into the computer. The additions did not influence the data collection process and the patients were therefore included in the main study.

In addition to undertaking regular admission procedures such as the taking of routine baseline observations nurses had been asked to measure the height and weight of each patient and record their smoking history according to data sheet 1 (Appendix A). Whenever the researcher or assistant were not available, the nurses were asked to verbally inform patients about the study and ask if there were any objections to taking the extra measurements. Nursing staff had been instructed on the rights of patients to refuse (at any time) to participate in the study and that refusal would not affect treatment in any way. Staff also explained to patients that any questions would be answered fully by the researcher. Verbal consent was confirmed by the researcher prior to patients entering the endoscopy room and further explanations were given as required. All patients agreed to participate.

Patients arrived throughout the day from early morning to late afternoon. A morning list routinely commenced at 0830 and finished at approximately 1200. An afternoon list generally commenced at 1330 and finished at 1800. Commencement times depended on the availability of Gastroenterologists. On days where two Gastroenterologists were available for endoscopies two procedure rooms were used.

For the purpose of this study staff were asked to commence SaO_2 monitoring as soon as the patient was in a comfortable position and to keep the rate of supplemental oxygen at 4 litres per minute wherever possible. On only two occasions more oxygen was required and reversal drugs administered due to persistent low SaO_2 readings and non-responsiveness. These two cases were excluded from the study. During the procedure the researcher would observe the position of the pulse oximeter probe closely ensuring that blood flow was not restricted (lying on the arm may restrict flow) and replacing the probe when dislodged by patients who were anxious or affected by sedation. Patients undergoing gastroscopy were frequently more restless than those undergoing colonoscopies. With colonoscopies, however, there were many positional changes for the patient and there was the potential for more pain due to the endoscope's movement around the bowel.

At the end of the procedure, supplemental oxygen was ceased immediately and SaO_2 monitoring commenced with the portable pulse oximeters. The probes were then simply switched (as the procedure room pulse oximeter's probe was removed the portable pulse oximeter's probe was attached onto the same finger). The researcher escorted each patient back to the ward or holding bay and ensured that the probe remained in place. The pulse oximeter was designed to alarm when the probe was dislodged and the printer function illustrated this by printing zero across the printout. Staff or the researcher would respond to the alarms and reattach or remind the patient to leave the probe in place for twenty minutes. Following the twenty minute period a staff member or researcher removed the pulse oximeter. The total time of attachment was also printed on the printout and could therefore be checked quickly by staff or researcher.

Ethical Considerations

Written approval to conduct the study was obtained from the Nursing Research Review Committee, Royal Perth Hospital, and the Edith Cowan University Higher Degree Committee. Verbal permission was obtained from all Gastroenterologists, the Nurse Manager, and the Clinical Nurse Specialist of the Gastroenterology Department.

The Nursing Research Review Committee of RPH confirmed that the study complied with the Hospital's criteria for Quality Assurance (Appendix F) in that it used noninvasive monitoring procedures which were currently used in routine care and did not expose patients to any risks. Patients, in fact, would benefit from the extended monitoring period. The researcher was therefore instructed not to use the prepared information and consent forms (Appendix D, E). Verbal consent was obtained during admission and confirmed by the researcher prior to commencement of monitoring. All patients agreed to participate. Confidentiality of data was maintained throughout the study with the information being secured in a locked drawer, accessible only to the researcher. During data analysis anonymity of participants was achieved by using a coding system for entry of data into the computer.

Chapter Five

Results

This chapter outlines the results of the study under headings which relate to the specific research questions. Thus, the first section describes the ranges, means and standard deviation (SD) of SaO_2 before, during, and after endoscopy. The second section describes the difference in the ranges and means of SaO_2 between two groups of patients, one undergoing gastroscopy and the other colonoscopy. The third section describes the frequency of desaturation during, and for 20 minutes following, endoscopy. The final section reports the results of a hierarchical multiple regression which was carried out to determine which patient characteristics predict the development of oxygen desaturation during and after endoscopy.

The computer statistics programme SPSS for Windows, Release 6.0, Student Version, was used to analyse the data. Alpha was set at .05 for all statistical tests.

Research Question One: The Ranges and Means of SaO_2

The first research question sought to determine the ranges and means of SaO_2 before, during, and following the endoscopy. For each patient, SaO_2 level was recorded prior to (baseline), during and following endoscopy (Appendix C). The range and mean for each patient during and following endoscopy was then calculated. The ranges, means and SD for the whole group are presented in Table 2.

Table 2

Ranges, Means, and Standard Deviations of SaO_2 in Patients Prior to (Baseline), During and After Endoscopy (N = 218)

	SaO_2		
	Min Max (%)	Mean (%)	SD
Baseline	94.00 - 100.00	97.90	1.42
During procedure	86.00 - 100.00	98.50	1.69
After procedure	78.00 - 100.00	95.39	2.00

The mean SaO_2 baseline (97.9%), was slightly lower than the mean SaO_2 during the procedure (98.5%), and slightly higher than the mean SaO_2 after the procedure. There is an increase in variance (SD) in scores and a wider range from before the procedure to recovery from the procedure. Using a related samples analysis of variance a statistically significant difference was found between the mean SaO_2 measures for baseline, during and after the procedure [$F(2, 438) = 341$, $p < .001$].

Research Question Two: Difference in Means of SaO_2 Between Gastroscopy and Colonoscopy.

The second research question sought to determine if there was any statistically significant difference between the mean SaO_2 of patients undergoing gastroscopy or colonoscopy (either during the procedure or after the procedure). From Table 3, it can be seen that there was a slight difference in mean SaO_2 between gastroscopy and colonoscopy. The mean SaO_2 was slightly lower for gastroscopy than for colonoscopy during the procedure, but slightly higher after the procedure.

Table 3

SaO_2 Range, Means and Standard Deviation for Gastroscopy Vs Colonoscopy

	Gastroscopy (N = 120)			Colonoscopy (N = 98)		
	Min Max	Means	SD	Min Max	Means	SD
Baseline	94 - 100%	97.82%	1.47	94 - 100%	98.01%	1.35
During	86 - 100%	98.28%	1.95	88 - 100%	98.76%	1.24
After	82 - 100%	95.58%	2.13	78 - 100%	95.16%	1.82

During the procedure. Testing the assumptions underlying the use of the parametric t-test revealed that distribution of data during endoscopy was negatively skewed. This violated the normality of distributions assumption and therefore a Mann-Whitney U-test was used to determine if there was a statistically significant difference between the mean ranking of SaO_2 scores between gastroscopy and colonoscopy patients during the procedure. No statistically significant difference was found (U = 5654, p = .48).

After the procedure. Data collected after the procedure, did not violate any of the assumptions underlying the parametric independent samples t-test. As Levene's Test for Equality of Variances did not show a significant difference in variance between gastroscopy and colonoscopy, the t-value for equal means was used to determine if there was a statistically significant difference in the mean SaO_2 scores between gastroscopy and colonoscopy during the recovery period. Again, no statistically significant difference was found (t = 1.53, df = 216, p =.170).

Research Question Three: Frequency of Oxygen Desaturation During and After Endoscopy.

Overall, 72 (33%) patients desaturated in the 218 (100%) patient sample. As shown in Table 4, the number of patients who desaturated during endoscopy was 15 (21%), of which 6 were males and 9 were females. Nine of these 15 patients (6 gastroscopy and 3 colonoscopy) also desaturated after the endoscopy. The total number of patients who desaturated after the procedure was 57 (82% of 72; 28 males and 29 females), of which 30 underwent gastroscopy and 27 colonoscopy. The lowest SaO_2 level during gastroscopy was 86%, and during colonoscopy 88%. The lowest SaO_2 after gastroscopy was 82%, and after colonoscopy 78%. Periods of desaturation during and after endoscopy lasted between a few seconds to 2 minutes for both procedures.

Table 4

Frequency of oxygen desaturation during and after endoscopy

	Gastroscopy (N = 40)				Colonoscopy (N = 32)			
	Time (minutes)							
	0-5	5-10	10-15	15-20	0-5	5-10	10-15	15-20
During	11	0	0	0	3	1	0	0
After	21	8	1	0	18	6	0	3

Research Question Four: Do patient variables such as smoking history, sedation, cardiac conditions, and respiratory disease, improve the prediction of desaturation after endoscopy, beyond the variables baseline SaO_2 and age which are generally recognised as predictors of desaturation ?

In order to fully answer this question a descriptive analysis of all the independent variables which were used in the current study was carried out. This was followed by a hierarchical multiple regression analysis, the aim being to identify additional variables that could improve the prediction of desaturation beyond that afforded by information on baseline SaO_2 and age.

Descriptive Analysis of Variables

Baseline SaO_2.

Baseline SaO_2 levels for the whole group ranged from 94% to 100% (M 97.9%, SD 1.42). Of those patients with a baseline SaO_2 of less than 97%, 52% (17) desaturated after the endoscopy, compared to 20% (37) of those patients with a baseline SaO_2 of 97% or above. The reference point of 97% was used in order to make comparisons with previous research (Barkin et al., 1989; Bell, Bown et al., 1987; Iber et al., 1993; Poser & Ladik, 1995).

Age

Age for the whole group ranged from 18 to 95 (M 56.2, SD 16.7). Data was collected as a continuous variable, however in order to make a direct comparison with the study of Poser and Ladik (1995), four categories of age were used to identify patients who desaturated. Table 5 lists the ages (in 4 groups) of those patients who experienced desaturation after the endoscopy. Of those patients aged 45 years or younger 11% desaturated after the procedure. By age 59 one third of patients experienced desaturation and of those patients aged 71 years or older almost half experienced desaturation. As the patient's age increases the likelihood of desaturation occurring after the endoscopy also increases.

Table 5

Desaturation by Age

	Age				
	18-45	46-58	59-70	71-95	Total
N =	61	47	60	50	218
Desaturation	7 *(11%)*	8 *(17%)*	18 *(30%)*	24 *(48%)*	57
No Desaturation	54 *(89%)*	39 *(83%)*	42 *(70%)*	26 *(52%)*	161

Smoking history.

A total of 120 (55%) patients were classified as smokers. Three years was the minimum number of years smoked and 70 years the longest number of years (M 28.8, SD 15.62). Table 6 shows desaturation among smokers and nonsmokers (0 years smoked). The smokers were grouped by number of years smoked. Of those patients who smoked, 26 (22.3%) desaturated during the recovery period following endoscopy, and 16 (13.2%) of these patients had smoked for more than 30 years. Ninety four (77.7%) smokers did not desaturate during recovery from endoscopy.

Table 6

Desaturation Among Smokers and Nonsmokers

	Number of Years Smoked					
	0	<10	11-20	21-30	>30	Total
N =	98	23	14	26	57	218
Desaturation	31 *(32%)*	2 *(9%)*	4 *(29%)*	4 *(15%)*	16 *(28%)*	57 *(26%)*
No Desaturation	67 *(68%)*	21 *(91%)*	10 *(71%)*	22 *(85%)*	41 *(72%)*	161 *(74%)*

Sedation.

All 218 patients in this study received intravenous Midazolam as sedation. The lowest dose of Midazolam administered to a patient was 2.5 mg and the highest dose was 15 mg. In order to compare each patient's Midazolam dose per BMI, a BMI was calculated by dividing the patient's weight (kg) by his or her height (m^2). The dose cf Midazolam (mg) was then divided by the BMI value creating the "Midazolam dose per BMI" variable which was used to compare each patient. The lowest dose of Midazolam per BMI was 0.08mg, and the highest was 0.73mg.

A narcotic analgesic such as pethidine or fentanyl was given in conjunction with Midazolam in those patients undergoing colonoscopy. In this study, patients receiving Midazolam and fentanyl did not desaturate, but as there were only 4, this was not representative. From a total of 120 patients receiving only Midazolam, 30 (25%) desaturated, and among those receiving Midazolam and pethidine (N = 94) the number of desaturation events was 24 (25%).

Respiratory and cardiac condition(s).

Various research studies have shown that respiratory and cardiac conditions can affect SaO_2 levels during endoscopy (Barkin et al., 1989; Rostykus et al., 1980; Rozen et al., 1982). All patients during the current study were classed into four categories. These were: nil respiratory or cardiac conditions, only respiratory, only cardiac, and both respiratory and cardiac conditions. Table 7 shows the frequency of desaturation during endoscopy in patients classified according to these four categories. The majority of patients with cardiac conditions or cardiac and respiratory conditions did not desaturate. This suggests that these variables may not have a major role in the desaturation of patients during endoscopy. Desaturation was not observed in patients belonging to the respiratory group. This may be due to the small number of patients with a respiratory condition but no cardiac condition undergoing endoscopy in this study.

Table 7

Desaturation Among Patients with Respiratory and/or Cardiac Conditions During Endoscopy (N = 218)

	Respiratory and/or Cardiac Condition				
	Nil	Respiratory	Cardiac	Both	Total
N =	110	14	66	28	218
Desaturation	6 *(5%)*	0 *(0%)*	6 *(9%)*	3 *(11%)*	15 *(7%)*
No Desaturation	104 *(95%)*	14 *(100%)*	60 *(91%)*	25 *(89%)*	203 *(93%)*

Table 8 shows desaturation (in the same categories) after endoscopy, and reveals that there was a higher frequency of desaturation in the cardiac and cardiac/respiratory category than in those without a cardiac or respiratory condition. There were only three cases where desaturation occurred for the respiratory category. This may be due to the small number of patients with a respiratory condition undergoing endoscopy in this study.

Table 8

Desaturation Among Patients with Respiratory and/or Cardiac Conditions After Endoscopy (N = 218)

	Respiratory and/or Cardiac Condition				
	Nil	Respiratory	Cardiac	Both	Total
N =	110	14	66	28	218
Desaturation	22 *(20%)*	3 *(21%)*	22 *(33%)*	10 *(36%)*	57 *(26%)*
No Desaturation	88 *(80%)*	11 *(79%)*	44 *(67%)*	18 *(64%)*	161 *(73%)*

Hierarchical Multiple Regression Analysis

The final research question asked whether patient variables such as smoking history, sedation, cardiac and respiratory disease, improved the prediction of desaturation after endoscopy, beyond the variables baseline SaO_2 and age which are generally accepted as predictors of desaturation. As indicated in the introduction, the review of the literature suggested that all these variables are possible predictive factors. From a nursing perspective, the number of variables (predictors) used in assessing the risk of desaturation should be kept to a minimum in order to make the assessments as convenient as possible, reducing nursing time and cost while ensuring that high risk patients are identified.

A decision was made to use hierarchical multiple regression analysis rather than standard multiple regression analysis for two reasons. Firstly, there is general agreement in the literature regarding baseline SaO_2 and age as predictors of oxygen desaturation. Secondly, information on the predictors baseline SaO_2 and age are easily obtained through existing, routine assessments and information on the other variables is more difficult to obtain and to validate, and hence more time consuming for nursing staff. Hierarchical multiple regression analysis allows control over the order of entry of variables. Baseline SaO_2 and age were the first two variables entered followed by smoking history, sedation (Midazolam dose per BMI), cardiac and respiratory disease to see whether any of the latter variables added significantly to the prediction of desaturation over and above baseline SaO_2 and age.

Prior to analysis, these variables were examined through various SPSS programmes for accuracy of data entry, missing values, and fit between their distributions and the assumptions underlying this multivariate analysis. Four cases in the variable "Midazolam dose per BMI" were found to be univariate outliers. With the use of a $p < .001$ criterion for Mahalanobis distance three multivariate outliers were identified. These cases were excluded from the analysis. No cases had missing data. Two hundred and eleven cases remained.

The underlying assumptions for hierarchical multiple regression analysis regarding multicollinearity were met. There was some correlation between the variables smoking history and baseline SaO_2, and also between the variables Midazolam dose per BMI and respiratory condition (see correlation matrix - Appendix G). This study did not examine the impact of smoking history on baseline SaO_2, or the impact of sedation on respiratory condition. This may be a consideration for further study.

The lowest SaO_2 reading for the period of 20 minutes after endoscopy was entered into the analysis as the dependent variable to be predicted. The independent variables (predictors) were baseline SaO_2, age, smoking history, Midazolam dose per BMI, cardiac condition, and respiratory condition entered in that order.

After step one, with baseline SaO_2 in the equation, $R^2 = .237$, F_{inc} (1, 209) = 64.77, $p < .05$. After step two, with age added (as a continual variable) to the equation, $R^2 = .307$, F_{inc} (2,208) = 21.16, $p < .05$. Therefore addition of age to the equation resulted in a significant increment in R^2. After step three, with smoking history added to the equation, $R^2 = .307$, F_{inc} (3, 207) = .01, $p > .05$. After step four, with Midazolam dose per BMI added to the equation, $R^2 = .308$, F_{inc} (4, 206) = .25, $p > .05$. After step five, with cardiac condition added to the equation, $R^2 = .308$, F_{inc} (5, 205) = .16, $p > .05$. After step six, with respiratory condition added to, $R^2 = .31$ (adjusted $R^2 = .289$), F_{inc} (6, 204) = .398, $p > .05$. Thus while age significantly added to the prediction of desaturation by baseline SaO_2, the remaining variables smoking history, Midazolam dose per BMI, cardiac condition, and respiratory condition did not significantly improve $\underline{R}^2$.

Summary of Results

This study sought to describe the oxygen saturation levels in patients prior to, during and after endoscopy using pulse oximetry, and to identify patient characteristics which may help to predict which patients will desaturate.

The ranges, means and SD of SaO_2 before, during and after endoscopy followed similar patterns for both the gastroscopy and colonoscopy patient groups. The range of SaO_2 levels was lowest for baseline measurements and was greatest during the recovery period suggesting that the effects of sedation, analgesia and cessation of supplemental oxygen had an effect on individual patients.

The mean level of SaO_2 for patients undergoing and recovering from gastroscopy was not significantly different to the mean SaO_2 of patients undergoing and recovering from colonoscopy. However, the frequency of desaturations was higher in patients undergoing gastroscopy.

From the total of 218 patients, 15 desaturated during the endoscopy and 57 desaturated during the 20 minute recovery period following endoscopy. The majority of desaturation events occurred within the first 5 minutes during the procedure, and the first 5 minutes during recovery. Hierarchical multiple regression analysis was used and the variables baseline SaO_2, age, Midazolam dose per BMI, smoking history, cardiac condition, and respiratory condition were entered into the equation and analysed as predictors for oxygen desaturation after endoscopy. As expected, baseline SaO_2 level and age made a statistically significant contribution to the prediction of desaturation among patients undergoing endoscopy. The addition of smoking history, Midazolam dose per BMI, cardiac condition, and respiratory condition to the equation did not significantly improve the prediction of desaturation. The clinical significance of these findings will be discussed in the next chapter.

Chapter Six

Discussion

The aims of the study were to describe SaO_2 levels in the participating patients prior to endoscopy, during, and after endoscopy using pulse oximetry, and to identify those patient variables which may help to predict which patients will desaturate after endoscopy.

Previous research has established that oxygen desaturation is common among patients undergoing endoscopy (Fennerty et al., 1990; Iber et al., 1993; Murray et al., 1990). The review of the literature suggested that baseline SaO_2, age, smoking history, sedation (Midazolam dose per BMI), cardiac and respiratory disease are possible predictive factors of oxygen desaturation after endoscopy (Barkin et al., 1989; Bell, Bown et al., 1987; Iber et al., 1993; Poser & Ladik, 1995). This study confirmed that baseline SaO_2 levels and age are predictors of oxygen desaturation but, in a hierarchical regression analysis, additional variables such as smoking history, sedation (Midazolam dose per BMI), cardiac and respiratory disease did not significantly improve the prediction of desaturation.

The conceptual framework for this study was based on Von Bertalanffy's (1968) General Systems Theory. Systems are described by Von Bertalanffy as being composed of interrelated parts which interact with one another to form a 'whole'. The General Systems Theory consists of a system which is made up of 'input', 'throughput', and 'output'. For the purpose of this study the inputs were identified as the independent variables of baseline SaO_2, age, medical problems, and smoking history. The independent variable of sedation, and the endoscopic procedure itself were identified as throughput (those factors which may affect a system), and these data were recorded in order to determine the effect these variables had on desaturation. This study identified the recovery period as the output of the system, where each patient was monitored for twenty minutes using pulse oximetry. In addition to the observations performed as per the hospital's protocol, nursing interventions were implemented when oxygen desaturation occurred.

This chapter will discuss the results of the study under the headings of the ranges and means of SaO_2 before, during, and after endoscopy; difference in means of SaO_2 between gastroscopy and colonoscopy; incidence of oxygen desaturation during, and after endoscopy; and variables which may help to predict which patients will desaturate. Limitations of the study, implications for clinical practice, and recommendations for further research will also be discussed.

The Ranges and Means of SaO_2 Before, During, and After Endoscopy

In the current study, the mean SaO_2 levels were found to vary between the endoscopy measurements taken before (baseline), during and after the procedure. Relative to baseline, SaO_2 levels were increased during the procedure and decreased after the procedure. During the procedure patients are given sedation and analgesia which reduces the respiratory rate by depressing the respiratory centre within the brain (Barkin et al., 1989; Bell, Bown et al., 1987; Rozen et al., 1982). This effect is compensated for by the administration of supplemental oxygen during the procedure. In this study, however, the mean SaO_2 level during the procedure was higher in relation to the mean baseline SaO_2 suggesting that supplemental oxygen increases the level to above the baseline where the baseline was less than 100% (Barkin et al., 1989; Bell, Bown et al., 1987; Griffin et al., 1990).

The current study's findings concurred with previous studies (Barkin et al., 1989; Griffin et al., 1990) which found that the baseline SaO_2 levels were increased with the administration of supplemental oxygen prior to sedation which in turn reduced the incidence of oxygen desaturation during endoscopy. The studies of Barkin et al. (1989) and Griffin et al. (1990) were based on the results of two groups, one of whom received supplemental oxygen during the procedure and the other did not. There was a significant increase in desaturation during the procedure of those groups not receiving supplemental oxygen in these studies. Several studies indicate that SaO_2 levels remained above 95% during the procedure following supplemental oxygen and sedation, although the respiration rate may be reduced (Barkin et al., 1989; Bell, Bown et al., 1987; Griffin et al., 1990).

The mean SaO_2 level after endoscopy was lower than both the baseline SaO_2 measurement, and the SaO_2 measurements during the procedure. This could be explained by the continuing effects of sedation and analgesia, and the cessation of supplemental oxygen at the end of the procedure. In this study, when the patient desaturated after the procedure, oxygen was recommenced.

The range and variance of SaO_2 levels also varied before, during, and after endoscopy, increasing after the procedure. This was also attributed to the continuing effects of the sedation and analgesia, the discontinuation of supplemental oxygen, and the vulnerability of individual patients to the effects of sedation and analgesia and lack of supplemental oxygen.

In conclusion, the results have clearly shown there to be a decrease in the mean SaO_2 relative to baseline after endoscopy, and that there is an increase in the range and variance of SaO_2 measurements after endoscopy. This was attributed to the effects of sedation and analgesia, and the cessation of supplemental oxygen.

<u>Difference in Means of SaO_2 Between Gastroscopy and Colonoscopy</u>

The difference in mean SaO_2 between patients undergoing gastroscopy and colonoscopy were tested. Previous research has shown that patients undergoing gastroscopy are at risk of desaturation due to the presence of the endoscope restricting the patient's air intake (Bailey et al., 1990; Barkin et al., 1989; Rozen et al., 1982). These studies also identified factors such as patients being more anxious as a result of the restriction in air intake as the endoscope enters the airway, and that desaturation occurs as a result of patients struggling. In the current study, a greater number of gastroscopy patients desaturated during the procedure compared with colonoscopy patients, but there was a similar number of desaturation events after the procedure in the two groups. When comparing the mean SaO_2 between gastroscopy and colonoscopy, this study showed that both groups had lower SaO_2 means after the procedure compared with during the procedure. No statistically significant difference in the mean SaO_2 levels between gastroscopy and colonoscopy was found either during or after the procedure. The study conducted by Barkin et al. (1989) was the only study found to make a comparison of mean SaO_2 levels between gastroscopy and colonoscopy and concluded that oxygen desaturation occurred frequently during both procedures. However, the study was limited due to the small sample size (n = 32) of which 10 patients underwent gastroscopy and 22 patients underwent colonoscopy.

Gastroscopy is a much shorter procedure, whereas colonoscopy involves the endoscope having to move along the length of the bowel causing pain. This means that patients undergoing colonoscopy may receive more sedation and analgesia. Fennerty et al. (1990) however, found that the length of the procedure had no bearing on the potential to desaturate. Rather, they concluded that hypoxaemia was found to develop in association with looping of the colonoscope and with pain.

In summary, there was no statistically significant difference between the mean SaO_2 measures for patients undergoing gastroscopy and colonoscopy.

Incidence of Oxygen Desaturation During and After Endoscopy

The results of this study showed that only a small proportion of patients desaturated during endoscopy (6.8%), while there was a greater incidence of desaturation after the procedure (26%). This can be attributed to the cessation of supplemental oxygen at the end of the procedure, and continuing effects of sedation and analgesia. This concurred with previous research by Barkin et al. (1989), Froehlich et al. (1995), and Rozen et al. (1982) who also found that desaturation was more prevalent after endoscopy, and attributed this to be the result of sedation and analgesia in the absence of supplemental oxygen.

Of patients who desaturated after the endoscopy, the majority did so within the first five minutes of the recovery period. This supports the findings of Poser and Ladik (1995), who also found that the majority of patients desaturated shortly after completion of endoscopy. The time at which desaturation occurred was attributed to the difference in the half life of the medications used, which therefore poses a problem in deciding on the length of the monitoring period during recovery. While Poser and Ladik's (1995) study considered that monitoring should continue for at least forty minutes, this was not possible in the current study setting due to high patient turnover. For the purpose of the current study pulse oximeter monitoring was continued for a further 20 minutes after the procedure to accurately determine episodes of desaturation rather than relying on subjective observations. This differs from the hospital protocol, which was to cease pulse oximetry monitoring when the patient went to the recovery room and to monitor the patient using the clinical observations of pulse and respiratory rate, blood pressure, and patient behaviour such as difficulty breathing, distress, sweating, or skin colour change. In the study by Fennerty et al. (1990) it was found that patients desaturated after the procedure even when relatively alert and comfortable as was the case with the current study. Continued pulse oximetry indicated a desaturation event in several people who were sitting up and drinking cups of tea or having sandwiches.

In the current study when desaturation occurred nursing interventions such as verbal stimulation, encouragement by the nurse for the patient to perform deep breathing, or the administration of supplemental oxygen were used successfully to restore SaO_2 levels to within acceptable limits. Prior to this study these interventions were normally undertaken only when clinical signs of desaturation, described in the previous paragraph were apparent. This study therefore demonstrates that for patients attending this Department there may be a need for continued pulse oximetry monitoring following the procedure as there was a greater incidence of desaturation after the endoscopy which may not have been detected using the existing protocol. This concurs with previous studies by Bell, McCloy, et al. (1991), Griffen et al. (1990), Fennerty et al. (1990), and Poser and Ladik (1995).

Variables Which May Help to Predict Which Patients will Desaturate

The literature review suggested baseline SaO_2, age, smoking history, sedation (Midazolam dose per BMI), cardiac and respiratory disease as variables which may help to predict which patients will desaturate (Barkin et al., 1989; Fennerty et al., 1990; Froehlich et al., 1995; Iber et al., 1993; Rozen et al., 1982; Whorwell et al., 1976). This section will discuss each variable individually and then in a group context as a result of hierarchical regression analysis.

Baseline SaO_2

Baseline SaO_2 levels were taken in order to obtain a true indication of patient's normal SaO_2 levels prior to the effects of sedation, analgesia and stress of undergoing endoscopy, and to establish parameters against which SaO_2 levels could be compared during and after endoscopy. Variables that may affect baseline

SaO_2 are medical problems (Iber et al., 1993), age (Barkin et al., 1989; Iber et al., 1993; Poser & Ladik, 1995), and smoking history (Poser & Ladik, 1995). However, it was not within the scope of this study to examine the factors which may have an influence on the baseline SaO_2 measurements.

This study found there was a greater incidence of desaturation (52%) in those with a baseline SaO_2 below 97%. The study by Poser and Ladik (1995) concluded that those with a pre-procedure baseline SaO_2 less than 97% had a significantly higher incidence of desaturation (37% as compared to 16%). Using a hierarchical multiple regression analysis, with baseline SaO_2 as step one, the current study confirmed that a low baseline SaO_2 is a predictor for the development of desaturation after the procedure. This study concurred with all prior published studies in concluding that a low baseline SaO_2 is a predictor in the development of desaturation.

Age

The results of the current study indicate that the incidence of desaturation during recovery increases as the age of the patients increase. The age categories used by Poser and Ladik (1995) were also used in the current study. In the group of patients greater than 70 years of age almost half desaturated compared with only 11% in the 18 - 45 year old group. When the group of patients aged 59 - 70 years and the patient group aged over 71 years are combined they account for 74% of all desaturation episodes during the recovery period. These results are supported by the findings of Poser and Ladik (1995) and Iber et al. (1993). The effect of age was studied by two groups of researchers with some variation in study design, but both recommended that continuous oxygen saturation monitoring and supplemental oxygen be administered to the elderly during the recovery period (Barkin et al., 1989; Bell, Bown et al., 1987). Other studies did not find age to be a reliable predictor for desaturation, but these studies focused on the period during the procedure rather than the recovery phase (Bell, Reeve et al., 1987; Fennerty et al., 1990; Hinzmann et al., 1992).

When age was entered (as a continuous variable) as step two into the hierarchical multiple regression analysis it made a statistically significant contribution to the equation over and above the effect of baseline SaO_2 indicating that age was a significant predictor of desaturation after endoscopy in this sample of patients. This could be attributed to a greater incidence of medical problems in the elderly which may also significantly affect oxygen saturation levels. In conclusion it would seem appropriate to continue pulse oximeter monitoring and supplemental oxygen for elderly patients during the recovery period.

Smoking History

A smoker, for the purpose of this study, was defined as anyone who had ever smoked. Perhaps surprisingly, more nonsmokers desaturated in the recovery period than smokers. This does not concur with Poser and Ladik's (1995) study, which is the only one found that has examined the effect of smoking on desaturation during the recovery period. Other studies which found that there was no significant correlation between smoking and desaturation were those conducted by Hinzmann et al. (1992) and Pecora, Chiesa, Alloy, Santora and Lazarus (1984), but these studies focused only on the period during the procedure.

When smoking history was entered into the hierarchical multiple regression analysis as step three it did not make a significant contribution to the equation over and above the effect of baseline SaO_2 and age.

Sedation

All patients undergoing gastroscopy were administered sedation in the form of Midazolam, whereas all patients undergoing colonoscopy were administered pethidine, a narcotic analgesic, in addition to Midazolam. Fentanyl was substituted for pethidine in four patients due to allergy. Analgesia has a minimal sedation effect but this was not measured throughout the current study. Colonoscopy patients received a combination of both sedation and analgesia but despite this there was no significant difference in the incidence of desaturation between the gastroscopy and colonoscopy groups. This suggests that the effects of the drugs may have been diminished by the time SaO_2 monitoring commenced during the recovery phase and this may be attributed to the length of the procedure, and the short half life of the drugs.

In order to compare all patients the Midazolam dose per BMI variable was used. When this variable was entered as step four in the hierarchical multiple regression analysis it did not make a significant contribution over and above the variables baseline SaO_2, age, and smoking history. Bailey et al. (1990), however, found that Midazolam combined with a narcotic analgesic placed patients at risk of desaturation and apnoea. Their research focused on the incidence of hypoxaemia after sedation with Midazolam and fentanyl but as only four patients in the current study had this combination of drugs, a valid comparison could not made. The study by Bailey et al. (1990) was limited however, due to the small subject number (n=12) and all were young healthy males aged between 18 and 40 years. This also makes their findings somewhat unusual given the contrast between the ages of patients who participated in the current study (18 - 95 years). Bell, Reeve et al. (1987) using a sample of 100 patients with a mean age of 62.7, concluded that small doses of Midazolam produced a statistically significant fall in SaO_2 levels as a result of the central depressant effect of the drug.

While sedation may have an effect on SaO_2 levels, the purpose of this study was to identify predictors that nurses could easily use to determine the risk of desaturation. Sedation is therefore not included as an assessment because it does not add to the quality of nursing observations that identify the risk of desaturation which can be achieved by simple assessment like baseline SaO_2 and age. Only Midazolam was used in the hierarchical multiple regression analysis because every patient received it. The sedation effect of pethidine and fentanyl was not examined in this study.

Cardiac and Respiratory Condition

In determining whether cardiac or respiratory disease, or both, influenced desaturation the current study classified patients into four categories. These were, nil respiratory or cardiac condition, only respiratory, only cardiac, or a combination of both. The results of the study showed that there were very few episodes of desaturation among patients with cardiac, or cardiac and respiratory condition. There were no episodes of desaturation among patients with only respiratory conditions. This was attributed to there being a small number of patients having a respiratory condition alone.

Previous studies by Barkin et al. (1989), Rostykus et al. (1980), and Rozen et al. (1982) found that respiratory and cardiac conditions may affect SaO_2 levels of patients undergoing endoscopy. In their study on oxygen desaturation and breathing pattern changes, Barkin et al. (1989), concluded that desaturation was induced by sedation which altered the breathing pattern of patients and that those with a cardiorespiratory disease were more susceptible to desaturation. They were, however, unable to draw a definite conclusion as their study did not focus on cardiopulmonary disease as a predictor. Rostykus et al. (1980) whose study focused on those with normal pulmonary function of those with only a mild form of pulmonary obstruction found there was a significant increase in the incidence of desaturation in those patients with a moderate to severe pulmonary obstruction. Their conclusion was based on routine spirometry and blood gas readings prior to and after endoscopy. There were significant changes in both readings after endoscopy. Rozen et al. (1982), although not specifically focusing on cardiopulmonary disease, concluded that those patients with disease, in particular the elderly, may require supplemental oxygen to preclude hypoxia. Electrocardiograph changes showing cardiac arrhythmias, and hypoxaemia as indicated by increased arterial carbon dioxide values were the basis for these conclusions. In their study on the causes of hypoxaemia in elderly patients during endoscopy, Rozen et al. (1982) concluded that hypoxaemia was induced by narcotic drug administration, and the physical presence of the endoscope.

In the current study, cardiac condition was entered into hierarchical multiple regression as step five, and respiratory condition as step six. Following analysis, neither variable was found to make a significant contribution to the equation over and above baseline SaO_2, age, smoking history, and Midazolam dose per BMI.

Discussion of the Conceptual Framework

The purpose of this study was twofold. Firstly, the study aimed to describe the oxygen saturation levels in patients prior to, during, and after endoscopy (gastroscopy and colonoscopy) using pulse oximetry. Secondly, the study aimed to identify those variables which could be associated with the occurrence of oxygen desaturation, over and above baseline SaO_2 and age after endoscopy.

The establishment of the patient's baseline SaO_2 prior to the administration of supplemental oxygen, sedation, analgesia, and commencement of endoscopy, was considered important in order to establish parameters against which SaO_2 levels could be compared during and after endoscopy. This study found that the mean SaO_2 levels taken during the recovery period were lower in relation to baseline SaO_2 measures. The incidence of desaturation was also greater at this time. This means that nurses must be particularly aware of the variables which help predict desaturation. The study also showed that there was no statistically significant difference between the mean SaO_2 measures for patients undergoing gastroscopy and colonoscopy. This means that both groups of patients can be considered together when developing a policy for pulse oximetry monitoring after endoscopy.

Regression analysis found that over and above baseline SaO_2 and age no other variable from either the input phase (medical problems and smoking history), or throughput phase (sedation), significantly improved the prediction of desaturation. Based on this information and previous research, nurses can continue current assessments and note a patient's baseline SaO_2 and age before the commencement of the endoscopy. This information can then be used in the output phase where a decision is made regarding the continuing of supplemental oxygen and pulse oximetry.

Implications for Clinical Practice

The results of this study have shown that a patient's baseline SaO_2 and age are good predictors of desaturation after endoscopy. It makes sense then, for nurses working in the Gastroenterology Department to be aware of these patient factors throughout the process (admission through to discharge), in addition to current nursing assessments and observations. The current problem is that patients are desaturating after endoscopy but are not being monitored for oxygen desaturation via pulse oximetry, nor are high risk patients receiving supplemental oxygen which has been shown to reduce the risk of desaturation (Barkin et al., 1989; Bell, Bown et al., 1987; Griffen et al., (1990). A combination of these measures, or where appropriate, the use of oxygen alone may assist nurses in maintaining saturation levels.

The study has indicated that there is greater frequency of desaturation in those patients who have a low baseline SaO_2 and the elderly. Identification of these variables, and further monitoring of high risk patients using pulse oximetry will allow for interventions to be implemented. Supplemental oxygen, to rapidly raise SaO_2 levels, and pulse oximetry may be continued until the patient has established oxygen saturation levels within acceptable limits. Those patients who have a low baseline SaO_2 and are elderly could benefit from the administration of supplemental oxygen while in recovery, therefore decreasing or avoiding the incidence of desaturation. The decision about the duration of supplemental oxygen and pulse oximetry monitoring could be based on the results of this and other studies, given that the majority of desaturation events occurred within the first 5 minutes, and some at 10 minutes following endoscopy. As this decision may require a further 15-20 minutes supplemental oxygen and pulse oximetry, factors such as Department resources, (bed space and cost), need to be considered. For inpatients this may mean that oxygen is continued whilst being transferred back to their hospital ward, but pulse oximetry may not be possible until arrival at ward level.

The continued use of pulse oximetry in the recovery period for those patients thought to be at risk, is a consideration for nursing staff as an extension of routine observations. While clinical assessment is essential to quality nursing care, an episode of desaturation may not be detected until such time as the patient is in some respiratory distress. The use of a portable pulse oximeter, similar to that used in the current stud would allow nursing staff to attend other patients and still be aware of desaturation episodes. Pulse oximetry offers the highest level of monitoring to all patients, and is an effective non-invasive method of monitoring oxygen saturation levels. However the cost of pulse oximetry equipment should be considered. If cost is a prohibitive factor given the throughput of patients, another option would be to continue supplemental oxygen in high risk patients during recovery.

A protocol concerning the use of a pulse oximeter in the recovery phase would benefit the patients attending the Gastroenterological Department within the hospital in which the research was conducted, in particular those patients identified as being at greater risk of desaturation. The development of a guideline for oxygen saturation level monitoring for nursing staff to follow would allow the detection of an event of desaturation thereby enabling the nurse to intervene before the potentially serious consequences of desaturation occur.

Limitations of the Study

It was not possible within the time frame available to access a larger sample size. No data was collected on patients who underwent both gastroscopy and colonoscopy because fewer cases were admitted. It was not possible to have a longer period of pulse oximetry monitoring after the endoscopy due to the high turnover of patients and the need for bed space. This study was conducted within one hospital in a specific geographical location and therefore may not be generalizable to other hospitals.

Another limitation is that this study did not change the order of entry of the different independent variables within the hierarchical multiple regression analysis, and therefore did not look at their individual effects on desaturation after endoscopy. The study also did not examine the effect of pethidine and fentanyl in the hierarchical multiple regression analysis.

Recommendations for Further Research

Gastroscopy and colonoscopy are just two of the procedures conducted at the Department, but with a greater time limit patient groups undergoing other procedures, such as endoscopic retrograde cholangiopancreatography, could be studied to determine the incidence of oxygen desaturation. Using the same research questions, the research could be extended using a larger population as a sample in more than one hospital. A comparison of the cost effectiveness of the use of supplemental oxygen and pulse oximetry to reduce the incidence of oxygen desaturation may be a useful study to assist in the implementation of a protocol concerning the use of routine pulse oximetry and supplemental oxygen.

The effect of pethidine and fentanyl on the incidence of desaturation could be included in further studies, as could smoking history and cardiac and respiratory disease. By using hierarchical multiple regression analysis and varying the order of entry, these variables could become the focus of further study.

Council on Scientific Affairs, American Medical Association. (1993). The use of pulse oximetry during conscious sedation. Journal of the American Medical Association, 270(12), 1463-1468.

Emery, J. R. (1987). Skin pigmentation as an influence on the accuracy of pulse oximetry. Anesthesiology, 75(3), 329-330.

Fennerty, M. B., Earnest, D. L., Hudson, P. B., & Sampliner,R. E. (1990). Physiologic changes during colonoscopy. Gastrointestinal Endoscopy, 36(1), 22-25.

Froehlich, F., Schwizer, W., Thorens, J., Kohler, M., Gonvers, J. J., & Fried, M. (1995). Conscious sedation for gastroscopy: Patient tolerance and cardiorespiratory parameters. Gastroenterology, 108, 697-704.

Gamble, J. A. S., Kawar, P., & Dundee, J. W. (1989). Evaluation of Midazolam as an intravenous induction agent. Anaesthesia, 36, 868-873.

Griffen, S. M., Chung, S. C. S., Leung, J. W. C., & Li, A. K. C. (1990). Effect of intranasal oxygen on hypoxia and tachycardia during endoscopic cholangiopancreatography. British Medical Journal, 300, 83-84.

Hanning, C. D., & Alexander-Williams, J. M. (1995). Pulse oximetry: A practical review. British Medical Journal, 311, 367-370.

Hinzmann, C. A., Budden, P. M., & Olsen, J. (1992). Intravenous conscious sedation use in endoscopy: Does monitoring of oxygen saturation influence timing of nursing interventions? Gastroenterology Nursing, 15, 6-12.

Iber, F. L., Sutberry, M., Gupta, R., & Kruss, D. (1993). Evaluation of complications during and after conscious sedation for endoscopy using pulse oximetry. Gastroenterology Endoscopy, 39(5), 620-625.

Keeffe, E. B., & O'Connor, K. W. (1990). 1989 Survey of endoscopic sedation and monitoring practices. Gastrointestinal Endoscopy, 36, 513-518.

McGough, E. K., & Boyson, P. G. (1989). Benefits and limitations of pulse oximetry in the ICU. Journal of Critical Illness, 35, 23-31.

Murray, A. W., Morran, C. G., Kenny, G. N. G., & Anderson, J. R. (1990). Arterial oxygen saturation during upper gastrointestinal endoscopy: the effects of a midazolam/pethidine combination. Gut, 31, 270-273.

Pecora, A. Chiesa, J. C., Alloy, A. M., Santora, J., & Lazarus, B. (1984). The effect of upper gastrointestinal endoscopy on arterial O_2 tension in smokers and nonsmokers with and without premedication. Gastrointestinal Endoscopy, 30(5), 284-288.

Poser, G., & Ladik, S. (1995). Oxygen saturation post-gastroscopy and post-colonoscopy. Gastroenterology Nursing, 18(4), 128-132.

Putt, A.M. (1978). General systems theory applied to nursing. Boston: Little Brown & Co.

Ralston, A. C., Webb, R. K., & Runciman, W. B. (1991). Potential errors in pulse oximetry. III; Effects of interference, dyes, dyshaemoglobin and other pigments. Anaesthesia, 46, 291-295

Ries, A. L., Prewitt, L. M., & Johnson, J. J. (1989). Skin color and ear oximetry. Chest, 96, 287-290.

Rostykus, P. S., McDonald, G. B., & Albert, R. K. (1978). Upper intestinal endoscopy induces hypoxemia in patients with obstructive pulmonary disease. Gastroenterology, 78(3), 488-491.

Rozen, P., Fireman, Z., & Gilat, T. (1982). The causes of hypoxemia in elderly patients during endoscopy. Gastrointestinal Endoscopy, 28(4), 243-246.

Severinghaus, J.W., & Austrup, P.B. (1986). Treatment of blood-gas analysis via oximetry. Journal of Clinical Monitoring, 2, 270-288.

Severinghaus, J.W., & Kelleher, J. F. (1992). Recent developments in pulse oximetry. Anesthesiology, 76, 1018-1038.

Stoneham, M. D., Saville, G. M., & Wilson, I, H. (1994). Knowledge about pulse oximetry among medical and nursing staff. The Lancet, 70, 1339- 1342.

Taylor, M. B., & Whitwam, J. G.(1986). The current status of pulse oximetry. Anaesthesia, 41, 943-949.

Tremper, K. K., & Barker, S. J. (1989). Pulse oximetry. Anesthesiology, 70, 98-108.

Von Bertalaffy, L. (1968). General systems theory: Foundations, development, applications. New York: Braziller.

Whorwell, P. J., Smith, C. L., & Foster, K. J. (1976). Arterial blood gas tensions during upper gastrointestinal endoscopy. Gut, 17, 797-800.

Wilmot, A. (1996). Fundamentals of gastroenterological nursing assessment. Journal of Gastroenterological Nurses Society of Australia, 5(4), 14-17.

SHEET 1. PATIENT INFORMATION.

Addressograph : ____________________.

Code : ________. **Sex** ☐ m ☐ f **Age :** ___ yrs.

Smoking history
Ever smoked? Yes ☐ No ☐

If yes. Currently smoking? Yes ☐ No ☐ When started 19___
If no. When stopped 19___

Current medication(s)

name medication	dosage (mg)	times per day
a)		
b)		
c)		
d)		
e)		
f)		

Other medical problems : Respiratory ☐ Renal ☐

Cardiovascular ☐ Metabolic ☐

Gastric ☐ Neurological ☐

Other ☐

Please Specify : ________________________.

Wt : ___ Kg. **Ht :** ___ cm. **B.M.I measurement :** ______ ____.

Code n°. ____.

SHEET 2. DATA RELATING TO THE PROCEDURE.

Procedure : gastroscopy ☐ colonoscopy ☐

Indication for procedure(s) :

- haemorrhage ☐
- constipation ☐
- diarrhoea ☐
- pain ☐
- weight loss ☐
- familial ☐
- polyps ☐
- other ☐

please specify : ____________________.

Sedation(s) used :

midazolam ☐		dosage	________ mg.	____ mg/BMI.
pethidine ☐		dosage	________ mg.	____ mg/BMI.
both ☐	midazolam:	dosage	________ mg.	____ mg/BMI.
	pethidine:	dosage	________ mg.	____ mg/BMI.
other ☐	please specify :		________ mg.	____ mg/BMI.

Additional sedation used : Yes ☐ No ☐

If yes.	Type	midazolam ☐	______ mg.	____ mg/BMI.
		pethidine ☐	______ mg.	____ mg/BMI.
		other ☐		

please specify : ________. ___ mg. ___ mg/BMI.

Code n°.____.

SHEET 3. OXYGEN SATURATION LEVELS.

Baseline (O_2 off) : __________ %

Post-oxygenation/before sedation : _________ %

Rate of supplemental O_2 : _______ L/min.

Start time (procedure) : _______ am/pm

Time removal of scope : _______ am/pm **SaO_2 :** _____ %

Start time (recovery) : _______ am/pm

SaO_2 LEVELS

During Procedure %
before start :
1 min :
5 min :
10 min :
15 min :
20 min :
25 min :
30 min :
35 min :
40 min :
45 min :
50 min :
55 min :
60 min :

After Procedure %
arrival recovery:
1 min :
5 min :
10 min :
15 min :
20 min :

O_2 DESATURATION EVENTS

Time	%	Supp. O_2

Time	%	Supp. O_2

PATIENT INFORMATION SHEET

Monitoring of oxygen levels in your blood during and after gastroscopy or colonoscopy.

My name is George van Lawick. I am a registered nurse enrolled in the Bachelor of Nursing (Honours) programme at the School of Nursing, Edith Cowan University. I am inviting you to participate in a study which will contribute towards this award. This study involves the monitoring of oxygen levels in the blood of patients undergoing gastroscopy or colonoscopy. The oxygen levels will be monitored by placing a sensor (like a peg) on your finger.

Currently routine monitoring of oxygen in the blood ends when the procedure has finished. The Royal Perth Hospital Gastroenterology Department wishes to know whether this is adequate or whether the monitoring period should be extended into the recovery phase. Routine monitoring of your heart rate and blood pressure will continue as normal.

If you agree, I (or my assistant) will measure your oxygen saturation levels prior to, during, and for 20 minutes following your procedure using the sensor described above. This will not cause you any discomfort. I (or my assistant) will also collect some information about your medical history either directly from you or from your records, but this will remain confidential and your identity will be concealed by a code when the details are entered onto a computer.

Your participation in this study is entirely voluntary and you are free to withdraw at any time without affecting your treatment. If you have any concerns about this study, or if you require further information, please ask to speak with me or I may be contacted after hours on [redacted]

If so desired, correspondence regarding any concerns about this project can be directed to Dr S. Nikoletti, School of Nursing, Edith Cowan University, Pearson St. Churchlands, 6018, or Anne Burvill, Nurse Coordinator for Gastrointestinal Services Division, RPH.

PATIENT CONSENT FORM

Monitoring of oxygen levels in your blood during and after gastroscopy or colonoscopy.

My name is George van Lawick. I am a registered nurse enrolled in the Bachelor of Nursing (Honours) programme at the School of Nursing, Edith Cowan University. I am inviting you to participate in a study which will contribute towards this award. This study involves the monitoring of oxygen levels in the blood of patients undergoing gastroscopy or colonoscopy. The oxygen levels will be monitored by placing a sensor (like a peg) on your finger.

Currently routine monitoring of oxygen in the blood ends when the procedure has finished. The Royal Perth Hospital Gastroenterology Department wishes to know whether this is adequate or whether the monitoring period should be extended into the recovery phase. Routine monitoring of your heart rate and blood pressure will continue as normal.

If you agree, I (or my assistant) will measure your oxygen saturation levels prior to, during, and for 20 minutes following your procedure using the sensor described above. This will not cause you any discomfort. I (or my assistant) will also collect some information about your medical history either directly from you or from your records, but this will remain confidential and your identity will be concealed by a code when the details are entered onto a computer.

Your participation in this study is entirely voluntary and you are free to withdraw at any time without affecting your treatment. If you have any concerns about this study, or if you require further information, please ask to speak with me or I may be contacted after hours on [redacted]

I,______________________________have read the information above and
(print name)
any questions I have asked have been answered to my satisfaction. I agree to participate in this study, realising that I may withdraw at any time. I understand that if I have any concerns or further questions I may contact the people listed on the information sheet given to me.

Signature of patient________________________ Date_________.

Signature of witness________________________ Date_________.

Royal Perth Hospital

GPO Box X2213, Perth, Western Australia 6001
Ph: (09) 224 2244 Fax: (09) 224 3511

Telephone Enquiries: (09) 224 1794
Facsimile No: (09) 224 1790
Our Ref: GDL:CMD

27 June 1996

Ms P Percival
Co-ordinator of Postgraduate Studies
School of Nursing
Edith Cowan University
Pearson Street
Churchlands W A 6018

Dear Patricia,

Re: Study Proposal - Oxygen Saturation and desaturation monitoring during and following endoscopy, George P van Lawick

After review by the Nursing Research Review Committee and supporting Physician, Dr Geoff Forbes, this study has been assigned clinical audit status. As it presents no threat to patients and in fact may be beneficial, and is not a new practice for this patient group, the requirement for a patient consent form has been considered unnecessary.

Royal Perth Hospital has agreed to the Principle Investigator, George van Lawick, assessing data and results from this audit as part of his honours study. We would expect that the principles of patient anonymity, confidentiality and record security would be upheld as stated in the proposal.

We view this as a joint project and understand any report or publication beyond George's academic requirements would reflect this undertaking.

Yours sincerely,

[redacted]

Gavin D Leslie
CHAIRPERSON
NURSING RESEARCH REVIEW COMMITTEE

c.c. Dr S Nikoletti, Edith Cowan University
Dr G Forbes, Gastrointestinal Division
Ms A Burvill, Nurse Co-ordinator, Gastrointestinal Division
Ms J Lord, Research Nurse, Royal Perth Hospital

Correlation Matrix

	LOWSAO2A	BASEO2	AGE	SMOKED	MGPRBMI	CARDIAC	REPIRAT
LOWSAO2A	1.0000 (216) P= .	.4890 (216) P= .000	-.3992 (216) P= .000	-.0472 (216) P= .490	.2403 (212) P= .000	.2458 (216) P= .000	.0548 (216) P= .423
BASEO2	.4890 (216) P= .000	1.0000 (218) P= .	-.3450 (218) P= .000	.0142 (218) P= .835	.2461 (214) P= .000	.2372 (218) P= .000	.1605 (218) P= .018
AGE	-.3992 (216) P= .000	-.3450 (218) P= .000	1.0000 (218) P= .	.2312 (218) P= .001	-.4191 (214) P= .000	-.4452 (218) P= .000	-.0620 (218) P= .362
SMOKED	-.0472 (216) P= .490	.0142 (218) P= .835	.2312 (218) P= .001	1.0000 (218) P= .	-.0999 (214) P= .145	.1058 (218) P= .119	.0718 (218) P= .291
MGPRBMI	.2403 (212) P= .000	.2461 (214) P= .000	-.4191 (214) P= .000	-.0999 (214) P= .145	1.0000 (214) P= .	.2835 (214) P= .000	.0125 (214) P= .856
CARDIAC	.2458 (216) P= .000	.2372 (218) P= .000	-.4452 (218) P= .000	.1058 (218) P= .119	.2835 (214) P= .000	1.0000 (218) P= .	.2323 (218) P= .001
REPIRAT	.0548 (216) P= .423	.1605 (218) P= .018	-.0620 (218) P= .362	.0718 (218) P= .291	.0125 (214) P= .856	.2323 (218) P= .001	1.0000 (218) P= .

(Coefficient / (cases) / 2-tailed Significance)
"." is printed if a coefficient cannot be computed.