REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1996	Unknown

4. TITLE AND SUBTITLE
Nebulized lidocaine to attenuate the cardiovascular response to direct laryngoscopy and tracheal intubation

5. FUNDING NUMBERS

6. AUTHOR(S)
MAJ Judith A. Bock
CPT Jody L. Borg
CPT Jeffrey W. Ashby

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Unknown

8. PERFORMING ORGANIZATION REPORT NUMBER
HSC-SN-96-xxx

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Unknown

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
NA-1996-01

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; Distribution is unlimited

13. ABSTRACT *(Maximum 200 words)*
The purpose of this study was to determine the strength of the relationship between patient height versus vertebral column length and the level of subarachniod sensory blockade following administration of 15 mg of 0.75% hyperbaric bupivacaine. Patient height has traditionally been used to determine the dose of local anesthetic for patients undergoing spinal anesthesia. It has been proposed that a patient's vertebal column length may be more reliable than patient height when estimating local anesthetic dosages. This study offers sound methodology, an adequate sample size, and the data to support the continued use of patient height to safety estimate the dose of local anesthetic for subarachniod blockade. This study was conducted at Darnall Army Community Hospital, Fort Hood, Texas. A nonprobability, convenience sample was selected from patients presenting for elective surgical procedures in which subarachniod blockade was appropriate. The researchers measured the patient's height and vertebral column length to the nearest centimeter. Interrater reliability was established among the researchers. Twenty minutes after the anesthetic was administered, the level of sensory blockade was assessed by a blinded observer using the pinprick method and recorded on the data collection tool.Interrater reliability was established among the four blinded observers. There was a weak, but statistically significant correlation between patient height and the level of sensory blockade. There was no correlation between vertebral column length and the level of sensory blockade. Study findings demonstrated that ASS I and II male subjects achieved an average level of sensory blockade of T6. The generalizability of this finding offers the anesthetist a quick and reliable anesthesia plan. Having a reliable anesthetic plan benefits both the patient and organization by limiting the complications associated with an inadequate or excessively high spinal blockade.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Lidocaine, Laryngoscopy,Tracheal Intubation, Cardiovascular Response	65
	16. PRICE CODE

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

NEBULIZED LIDOCAINE TO ATTENUATE THE CARDIOVASCULAR RESPONSE TO DIRECT LARYNGOSCOPY AND TRACHEAL INTUBATION

By

MAJ Judith A. Bock, BSN, MSN

CPT Jody L. Borg, BSN

CPT Jeffrey W. Ashby, BSN

A Thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in Nursing

The University of Texas Health Science Center at Houston

School of Nursing

December, 1996

ABSTRACT

This study described the use of 120 mg nebulized lidocaine to attenuate the cardiovascular response to direct laryngoscopy and tracheal intubation in ASA I and ASA II patients undergoing various surgical procedures. A convenience sample of 53 patients requiring general endotracheal anesthesia was included in the study. An experimental study design was utilized. Patients were randomly assigned to one of two treatment groups (3 ml of 4% nebulized lidocaine or 3 ml of nebulized saline via an anesthesia face mask). All subjects were given midazolam (0.03 mg/kg IV) preoperatively and then either nebulized lidocaine or saline according to the group assigned. After preoxygenation, all subjects were given fentanyl (1.5 mg/kg IV), thiopental (4.0 mg/kg IV 1 minute after injection of the fentanyl) and rocuronium (0.6 mg/kg IV after apnea and establishment of a patent airway). Intubation with a MacIntosh blade was accomplished after a loss of four twitches in a train-of-four ratio. Heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were recorded at 30, 90, and 180 second intervals after laryngoscopy. Immediately following intubation, 1% isoflurane was dialed in to maintain anesthesia. In response to laryngoscopy and tracheal intubation, there were no statistically significant differences between the nebulized lidocaine and saline groups. The study implication, therefore, is that anesthesia care providers should continue their current practice of using other agents such as IV lidocaine, opioids or beta blockers to attenuate post-intubation cardiovascular responses. Time of laryngoscopy should, however, be during the topical peak effect of lidocaine which is 2 to 5 minutes after completion of nebulization, as opposed to the effective anesthesia time of 30 minutes.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

THE UNIVERSITY OF TEXAS
HEALTH SCIENCE CENTER AT HOUSTON
SCHOOL OF NURSING

REPORT OF THESIS EXAMINING COMMITTEE

TO: The Associate Dean for Academic Affairs
Report of the Cluster Research Examining Committee

STUDENTS' NAMES: Judith A. Bock, MAJ, SRNA; Jody L. Borg, CPT, SRNA
Jeffrey W. Ashby, CPT, SRNA

TITLE OF CLUSTER RESEARCH: Nebulized Lidocaine to Attenuate the Cardiovascular Response to Direct Laryngoscopy and Tracheal Intubation

DATE REVIEWED: _____

DECISION OF THE COMMITTEE

The student has been examined by the Committee with the following results:

✓ Approved _____ Rejected

SIGNATURES OF EXAMINING COMMITTEE MEMBERS

Mary D. Barnes RN, PhD
Chairperson

2. _____ RN MSN

3. Paula M. Varney AN, MHS

4. _____

_____
Associate Dean for Academic Affairs

THE DEAN OF THE SCHOOL OF NURSING ACCEPTS
THE COMMITTEE'S DECISION

_____ _____
Dean's Signature Date

_____ _____
Title of Degree Graduation Date

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

Introduction

Increases in arterial blood pressure and heart rate are well-documented responses to direct laryngoscopy and tracheal intubation during various forms of general anesthesia (Forbes & Dally, 1970; King, Harris, Greifenstein, Elder & Dripps, 1951; Wycoff, 1960). These increases in blood pressure and heart rate are elicited due to stimulation of the oropharynx and upper airway by the laryngoscope blade and insertion of the endotracheal tube. Increases in systolic blood pressure have been reported to range up to 90 mm Hg above preoperative levels while increases in heart rate have been reported as high as 66% above baseline (Chraemmer-Jorgensen, Hoilund-Carlsen, Marving, & Christensen, 1986).

Many researchers have emphasized that hypertensive patients are more prone than otherwise healthy patients to display significant increases in blood pressure during direct laryngoscopy and tracheal intubation (Fox, Sklar, Hill, Villanueva, & King, 1977; Prys-Roberts, Greene, Meloche & Foex, 1971). Prys-Roberts et al. (1971) found that patients on antihypertensive therapy with well-controlled blood pressures are also likely to develop this response to direct laryngoscopy and tracheal intubation. Reported complications of tachycardia and hypertension have included cardiac dysrhythmias, left ventricular failure, myocardial infarction, pulmonary edema, and cerebral hemorrhage (Fox et al., 1977; Sklar, Lurie, Ezri, Krichelli, Savir & Soroker, 1992).

It has been shown that deep levels of anesthesia limit or abolish the increases in blood pressure and heart rate due to direct laryngoscopy and tracheal intubation (King et al., 1951). While this is advantageous from a cardiovascular viewpoint, the use of

increased depth of anesthesia is not desirable in all patient populations. The anesthesia provider must balance the need of anesthetic depth with the risk of inducing significant increases in blood pressure and heart rate.

Many pharmacological approaches have been used to prevent and treat cardiovascular responses to direct laryngoscopy and tracheal intubation. Researchers have demonstrated that deep anesthesia obtunds or abolishes these responses, with increases in blood pressure affected more than heart rate (King et al., 1951). The use of alfentanil to attenuate increases in blood pressure and heart rate has shown varying effectiveness (Black, Kay & Healy, 1984; Crawford, Fell, Achola & South, 1987; Kirby, Norwood & Dodson, 1988). Topical and intravenous (IV) lidocaine have shown the greatest efficacy based upon dosage and time interval between medication administration and direct laryngoscopy (Abou-Madi, Keszler & Yacoub, 1977; Chraemmer-Jorgensen et al., 1986; Hamill, Bedford, Weaver & Colohan, 1981; Stoelting, 1977; Stoelting, 1978). Previous research efforts have found IV lidocaine to be effective in limiting cardiovascular responses associated with direct laryngoscopy and tracheal intubation (Miller & Warren, 1990). Of particular note, Sklar et al. (1992) reported a significant decrease in what was termed a circulatory response to direct laryngoscopy and tracheal intubation. He used 120 mg nebulized lidocaine before induction of anesthesia with ASA I and II patients having major abdominal surgery. These cardiovascular responses may be transitory and of no consequence in healthy patients, but they can have detrimental effects on patients with hypertension, coronary artery disease, or cerebrovascular disease (Denlinger, Ellison & Ominsky, 1974; Prys-Roberts et al., 1971).

Statement of the Problem

The focus of this study was to describe the effect of 120 mg nebulized lidocaine on patients' cardiovascular responses to direct laryngoscopy and tracheal intubation. The scope of the problem was limited to ASA I and ASA II patients presenting for various surgical procedures. However, the study still expanded on findings of the Sklar et al. (1992) study, in which a similar problem was addressed for ASA I and II patients having only abdominal surgery.

Theoretical Framework

Levine's Conservation Model (Riehl-Sisca, 1988) provides a scientific basis for nursing actions. Patients are in a state of dependence with constant interactions in their environment. The patient's environment consists of external and internal factors that have an effect on the individual. Two major components of this theory as defined by Levine are conservation of energy and organismic response. The conservation of energy refers to the bodily need to balance and constantly renew energy resources. Conserving structural integrity refers to preventing physical breakdown and promoting healing. The organismic response is defined as the course of action that a body uses to adapt to the environment. Levine theorizes that persons must exist in a symbiotic relationship with their environment to maintain the energy needed for homeostasis. Anesthesia providers play a crucial role in maintaining the patient's internal and external environment during the perioperative period.

The anesthesia provider's preoperative interventions have a direct impact on the patient's intraoperative responses and the prevention of postoperative sequelae. Nebulized lidocaine promotes the conservation of energy and structural integrity while lessening the

body's sympathetic response to the stressful situation of direct laryngoscopy and tracheal intubation. Attenuation of significant increases in blood pressure and/or heart rate attributable to the sympathetic stimulation of direct laryngoscopy and tracheal intubation decreases the risks of complications such as a myocardial infarction, left ventricular failure and cerebral vascular accident (Forbes & Dally, 1970). To conserve the patient's energy and structural integrity, the anesthesia provider can intervene by providing a pretreatment of nebulized lidocaine to attenuate the patient's cardiovascular response to direct laryngoscopy and tracheal intubation. This intervention reduces perioperative stress and conserves energy needed for postoperative healing.

Purpose

The purpose of the study was to describe the effect of 120 mg nebulized lidocaine on the cardiovascular response to direct laryngoscopy and tracheal intubation in ASA I and ASA II patients presenting for various surgical procedures. An experimental model was used to compare the cardiovascular responses of a group receiving 120 mg nebulized lidocaine with another group receiving nebulized normal saline. The study findings were used to evaluate the homeostatic effect of this intervention on the patient.

Definition of Terms

ASA I and ASA II Categories. American Society of Anesthesiologists (ASA) physical status category is based on a patient's physical state of health, not on the patient's age or planned surgical intervention. The physical status classification is not intended to represent an estimate of anesthetic risk. Instead, it serves as a "common language" among different institutions for subsequent examination of anesthetic morbidity and mortality. An

ASA I classification indicates a healthy patient, and an ASA II classification indicates a patient with mild systemic disease that results in no functional limitation (Stoelting & Miller, 1994).

Baseline blood pressure and heart rate. The systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate after the patient is transferred to the operating room bed and the monitors applied as measured by a Hewlett Packard ECG and oscillometric blood pressure monitor.

Cardiovascular response. An increase in mean arterial blood pressure equal to or greater than 25 mm Hg from baseline (Yao & Artusio, 1993) and an increase in heart rate of greater than 25 beats per minute from baseline measured at 30, 90, and 180 seconds post-intubation using a Hewlett-Packard non-invasive blood pressure (NIBP) monitor and an electrocardiographic (ECG) monitor. The cardiovascular response as used in this study includes increases in blood pressure and heart rate that occur after direct laryngoscopy and tracheal intubation; it does not include other organ responses.

Direct laryngoscopy and tracheal intubation. Direct laryngoscopy is the visual examination of the larynx utilizing a lighted instrument, a laryngoscope, for the purpose of passing an endotracheal tube past the vocal cords. During tracheal intubation, the tube is introduced orally until its tip rests below the vocal cords and above the carina (Miller, 1994).

Nebulization. Nebulizers suspend (aerosolize) water particles into a spray. The size of the droplets depends on the method of nebulization, with the high-pressure jet nebulizers producing droplets 5 - 30 microns in diameter. Jet nebulizers can be used for

the delivery of medications to the airway and the mobilization of secretions during respiratory therapy (Morgan & Mikhail, 1992).

Oscillometric blood pressure monitor. Automated non-invasive measure of arterial blood pressure. A cuff is placed around the patient's upper limb, and the artery is partially occluded. A microprocessor detects oscillations caused by pulsatile arterial flow. The amplitude of the oscillations is analyzed to measure mean arterial pressure (MAP), from which diastolic and systolic blood pressures are extrapolated (Hewlett-Packard Service Manual, 1993). Studies have shown that Hewlett-Packard oscillometric devices demonstrate a 95% confidence level in comparison to an intra-arterial device (Hewlett-Packard Application Note, 1989).

Train-of-four ratio. Train-of-four (TOF) ratio consists of four electrical stimulations at 2 HZ delivered every 0.5 seconds by a peripheral nerve stimulator. This is based on the concept that acetylcholine is depleted by successive stimulations. The ratio of responses to the first and fourth twitch is a sensitive indicator of nondepolarizing muscle relaxation (Morgan & Mikhail, 1992). Disappearance of the fourth twitch represents a 75% blockade, the third twitch an 80% blockade and the second twitch a 90% blockade (Morgan & Mikhail, 1992). A depression of 95% of the twitch response correlates with adequate skeletal muscle relaxation for intubation of the trachea (Stoelting & Miller, 1994).

Hypotheses

The following are the research question and four hypotheses of the study:

Research Question

Does the administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation attenuate the cardiovascular response of ASA I and ASA II patients presenting for various surgical procedures?

Hypothesis 1. The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in heart rate of ASA I and ASA II patients presenting for various surgical procedures.

Hypothesis 2. The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in systolic blood pressure of ASA I and ASA II patients presenting for various surgical procedures.

Hypothesis 3. The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in diastolic blood pressure of ASA I and ASA II patients presenting for various surgical procedures.

Hypothesis 4. The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in mean arterial pressure of ASA I and ASA II patients presenting for various surgical procedures.

Significance of the Problem

This study focused on ASA I and ASA II patients undergoing various types of surgeries to determine the effect of 120 mg nebulized lidocaine on their cardiovascular response to direct laryngoscopy and tracheal intubation. Study results contributed to the

body of knowledge related to the effects of nebulized lidocaine on patients' cardiovascular responses to direct laryngoscopy and tracheal intubation. Control of these responses in all patients undergoing direct laryngoscopy and tracheal intubation is important. Control may be even more crucial in patients with hypertension and/or coronary artery disease (CAD) because this patient population displays increased risk for left ventricular failure, myocardial infarction, and cerebral hemorrhage (Fox et al., 1977; Sklar et al., 1992).

Assumptions

1. The cardiovascular response in patients undergoing direct laryngoscopy and tracheal intubation is a result of sensory stimulation of the oropharynx.

2. Blockage of the sensory impulses from the oropharynx and subglottic membranes to direct laryngoscopy and tracheal intubation attenuates the increase in blood pressure and heart rate.

3. Subjects in this study population manifest the increase in blood pressure and heart rate response found in the general population.

4. The intubation skills of the data collectors are at the same skill level.

5. The oscillometric blood pressure monitor accurately measures systolic, diastolic and mean arterial pressures when calibrated and maintained in accordance with hospital standing operating procedures.

6. Oscillometric blood pressure monitors that are used in the study are calibrated and maintained in accordance with hospital standing operating procedures.

Limitations

1. Use of specific demographic and case parameters limits generalizability of the study results beyond the population represented by the sample.

2. Use of convenience sampling limits generalizability of the study results beyond patients in the study sample.

Summary

The purpose of this study was to describe the effect of nebulized lidocaine on the cardiovascular response to direct laryngoscopy and tracheal intubation in ASA I and II surgical patients. The control of this response is especially important in patients with hypertension and/or CAD because these patients are at increased risk for harmful sequelae. Using Levine's Conservation Model as a theoretical framework, the anesthesia provider's role is to intervene and assist the patient in conserving their energy for postoperative healing. The intervention being descried in this study is the pretreatment of nebulized lidocaine to attenuate the cardiovascular response to direct laryngoscopy and tracheal intubation.

CHAPTER II

Review of Related Literature

Direct laryngoscopy and tracheal intubation predictably lead to increases in blood pressure and heart rate (King et al., 1951). For the past forty years, researchers have searched for a method, an agent, or combination of agents to control or attenuate increases in blood pressure and heart rate in response to direct laryngoscopy and tracheal intubation. Calcium channel blockers, nitrates, alpha-2 agonists, opioids, beta antagonists, prostaglandins, and ganglionic antagonists have been employed with varying results. In this chapter, cardiovascular responses to direct laryngoscopy and tracheal intubation and the various agents used to attenuate these responses are discussed.

Cardiovascular Response

Direct laryngoscopy and tracheal intubation stimulate the vagus nerve that acts as the afferent pathway to the vasomotor center in the medulla. This in turn stimulates the sympathetic nervous system, which releases catecholamines manifested as both an increase in blood pressure and heart rate (King et al., 1951). This cardiovascular response to direct laryngoscopy and tracheal intubation has been well-documented over the past four decades.

King et al. (1951) documented increases in blood pressure and heart rate as a response to laryngoscopy and tracheal intubation during light planes of anesthesia. They associated direct laryngoscopy with an average rise of 53 mm Hg in systolic blood pressure and an average rise of 23 beats per minute in cardiac rate. These increases in

heart rate and blood pressure appeared to be independent of the anesthetic or neuromuscular blocking agents used.

Researchers generally concur that duration of laryngoscopy is the most important factor influencing the post-intubation cardiovascular response (Bucx, Van Geel, Scheck & Stijnen, 1992; Stoelting, 1977). Stoelting (1977) found that MAP increased progressively with the duration of laryngoscopy, with near maximal increase in heart rate and blood pressure present in all groups by 45 seconds. Compared with awake measurements, MAP was significantly increased ($p<0.05$) after 15 seconds of laryngoscopy in the control patients and after 30 seconds in the two lidocaine-treated groups (laryngotracheal and viscous lidocaine). In another study in 1978, Stoelting demonstrated that maximal increases in MAP above awake levels occurred within 5 to 15 seconds following tracheal intubation, when the duration of direct laryngoscopy is limited to 15 seconds. In a study comparing laryngotracheal (spray) and IV lidocaine, MAP remained higher than control values for 90 seconds after intubation with the laryngotracheal administration of lidocaine (Hamill et al., 1981). When IV lidocaine was used, MAP increased for less than a minute after intubation was complete. King et al. (1951) showed that with laryngoscopy and tracheal intubation, the peak pressures occurred within five seconds of the procedure and persisted for 1 to 2 minutes.

In another study, Bucx et al. (1992) demonstrated that the physical force transmitted during direct laryngoscopy contribute minimally to the stimulus for the increase in heart rate and blood pressure. These researchers also found that tracheal intubation, more than physical force, caused an increase in heart rate and blood pressure in routine

uncomplicated laryngoscopy and subsequent tracheal intubation. Data by Bucx et al. (1992) were obtained using a specially developed laryngoscope blade with which the forces applied during laryngoscopy were measured.

Attenuation

Calcium channel blockers have been shown to effectively diminish increases in blood pressure, but they also have been shown to have little effect on increases in heart rate (Kumar, Batra, Bala & Gopalan, 1993; Mikawa et al., 1992). This limited chronotropic effect restricts the use of this class of drugs because heart rate is a major factor in myocardial oxygen balance. Additional research on this class of drug needs to be conducted.

Researchers generally have concurred that nitroglycerine administration prior to direct laryngoscopy and tracheal intubation is successful in attenuating increases in systolic blood pressure, but is not successful in diminishing the associated increases in heart rate (Bijoria, Wig, Bajaj & Sapru, 1992; Mahajan, Ramachandran & Saxena, 1993; Mikawa et al., 1992). Also, researchers have demonstrated that oral alpha-2 agonists, clonidine, guanabenz and dexmedtomindine are efficacious in blunting the increases in heart rate and blood pressure due to direct laryngoscopy and tracheal intubation (Laurito, Baughman, Becker, Cunningham, Pygon, & Citron, 1993; Mikawa et al., 1993; Scheinin, Lindgren, Lindgren, Randell, Scheinin & Scheinin, 1992). However, the necessity of administrating these drugs 60 to 90 minutes prior to induction limits their clinical applicability.

Of the opioids, researchers have found alfentanil to be the most efficacious in attenuating the increases in heart rate and blood pressure during direct laryngoscopy and

tracheal intubation (Martineau, Tousignant, Miller & Hull, 1990; Miller et al., 1993; Pathak, Slater, Sum Ping, & From, 1990). Utilization of other opioid agents requires the administration of moderate to high doses in order to suppress the increases in heart rate and blood pressure due to direct laryngoscopy and tracheal intubation (Bailey & Stanley, 1990). These high doses may result in prolonged postoperative ventilatory depression following shorter surgical procedures (Bailey & Stanley, 1990).

Researchers continue to explore the effectiveness of beta antagonists such as esmolol and labetalol in attenuating the cardiovascular response to direct laryngoscopy and tracheal intubation. Research reports provide conflicting data regarding the efficacy of these agents (Chung, Sinatra, Halevy, Paige & Silverman, 1992; Helfman, Gold, DeLisser & Herrington, 1991; Vucevic, Purdy & Ellis, 1992). More research is needed to determine the possible effectiveness of these drugs.

Mikawa et al. (1990) examined the effects of prostaglandin E-1 on the cardiovascular response to direct laryngoscopy and tracheal intubation. These researchers demonstrated that at doses of 0.3 mg/kg and 0.6 mg/kg, prostaglandin E-1 inhibited the increase in blood pressure but not the increase in heart rate. Other researchers found that trimethephan, a nicotinic ganglionic antagonist, diminished the increase in blood pressure but not the increase in heart rate associated with direct laryngoscopy and tracheal intubation (Saitoh et al., 1991).

Use of Lidocaine

Numerous studies of the post-intubation attenuation effects of lidocaine have been conducted. Variations have centered on route (intravenous, topical or nebulized/aerosol),

dosage and timing of the medication delivery prior to laryngoscopy. Intravenous lidocaine has been the most extensively studied route for administration. Lidocaine 1.5 mg/kg IV administered 3 minutes or less before intubation generally has been found to be ineffective (Chraemmer-Jorgensen et al., 1986; Denlinger, Messner, D'Orazio & Balaraman, 1976; Miller & Warren, 1990; Wilson, Meiklejohn, & Smith, 1991). Hamill et al. (1981) found that using lidocaine 1.5 mg/kg IV during light nitrous-oxide-barbiturate anesthesia resulted in a 25% increase in heart rate and MAP. This increase persisted for the first minute after endotracheal intubation, but then the heart rate and mean arterial pressure began to decrease. Abou-Madi et al. (1977) found that lidocaine 0.75 mg/kg IV was effective in attenuating the rise in systolic blood pressure but that it was ineffective in preventing a statistically significant rise in diastolic blood pressure and heart rate. In the same study, lidocaine 1.5 mg/kg IV showed borderline protection against increases in blood pressure and heart rate following tracheal intubation.

A few studies found a divergence in pressure and chronotropic responses. These studies all used IV lidocaine 1.5 mg/kg; Wilson et al. (1991) and Splinter and Cervenco (1989) gave the lidocaine 4 minutes before intubation, and Stoelting (1977) gave the lidocaine 1.5 minutes before intubation. All researchers showed complete attenuation of increases in MAP, but they failed to show any effect on heart rate. In contrast, Helfman et al. (1991) found that 200 mg IV lidocaine (2.5 mg/kg in the average patient) given 2 minutes before intubation was ineffective in protecting against increases in heart rate, but was effective ($p > 0.05$) in protecting against increases in systolic blood pressure.

Wilson et al. (1991) suggested that the time interval between lidocaine delivery and intubation is too short (less than 2 minutes for a majority of the studies) to permit any action of lidocaine. He further noted that IV lidocaine given at least 4 minutes before laryngoscopy may completely attenuate the increase in blood pressure, but not the chronotropic response to laryngoscopy and tracheal intubation. Pathak et al. (1990), concluded that failure of lidocaine could be due to its centrally mediated increase in heart rate and stroke volume. That is, blocking its inhibitory mechanisms at the level of the limbic or higher cerebral centers results in an indirect stimulant effect. It should be noted that the dosage used by Pathak et al. was higher at 2 mg/kg IV lidocaine than the majority of studies using 1.5 mg/kg. Pathak et al. also concluded that lidocaine administered 3 minutes before direct laryngoscopy and intubation might have attenuated the increases in heart rate and blood pressure.

Studies of the laryngotracheal administration of lidocaine just before direct laryngoscopy and tracheal intubation also have conflicting results. Denlinger et al. (1976) reported significant increases in systolic blood pressure following laryngoscopy with tracheal spray of lidocaine. Patients with a tracheal spray of saline solution had a mean peak increase in systolic blood pressure of 39 mm Hg following intubation. However, patients with tracheal sprays of lidocaine 4% had a mean peak increase of 13 mm Hg following intubation. There were similar differences between diastolic blood pressures and heart rates in the two groups following tracheal intubation. Furthermore, Hamill et al. (1981) found that laryngoscopy and laryngotracheal spray administration of lidocaine 4%

resulted in significant heart rate and MAP increases that persisted after endotracheal intubation for at least 2 minutes.

Similar results were demonstrated by Stoelting (1977) using 25 ml of 2% viscous lidocaine as a mouthwash gargled 10 minutes before induction. Increases in blood pressure following tracheal intubation were attenuated but not prevented. Increases in MAP were shown in response to tracheal intubation. When laryngotracheal administration of the viscous lidocaine was not utilized, MAP increased an additional 22 mm Hg with placement of the endotracheal tube. Heart rate increased similarly in all groups of the study, but spontaneous reductions appeared only in groups receiving laryngotracheal viscous lidocaine. Laryngotracheal lidocaine has been shown to be effective in preventing increases in blood pressure and, to a lesser degree, increases in heart rate using a time interval of 5 to 10 minutes between delivery of lidocaine and intubation (Denlinger et al., 1976; Stoelting, 1977). In contrast, Hamill et al. (1981) found laryngeal lidocaine to be ineffective when using a time interval of 1 minute.

Nebulization of lidocaine has been used in two studies to attenuate the increases in heart rate and blood pressure in response to direct laryngoscopy and tracheal intubation (Abou-Madi, Keszler & Yacoub, 1975; Sklar et al., 1992). Sklar et al. showed that the response to IV lidocaine was not statistically significant. However, these researchers demonstrated a dose-dependent response (nebulized 120 mg versus 40 mg) in attenuating the rise in MAP following direct laryngoscopy and tracheal intubation. The attenuation of an increase in heart rate with direct laryngoscopy and tracheal intubation by lidocaine 120 mg inhalation was significant at $p < 0.05$. This was noted as the most impressive result,

because this response had never been demonstrated with other routes of lidocaine administration. A study by Abou-Madi et al. (1977) using IV lidocaine supported the use of aerosol topical lidocaine over the IV route as a better choice to minimize post-intubation increases in heart rate and blood pressure.

Systemic lidocaine absorption has been found to occur following topical administration of the local anesthetic, but plasma concentrations vary when topical or nebulized delivery is performed (Chinn, Zavala & Ambre, 1977; Patterson, Blaschke & Hunt, & Meffin, 1975; Sklar et al. 1992; Viegas & Stoelting, 1975). These researchers found that all doses used for either topical administration by direct spraying or nebulization (maximum being 400 mg) had peak plasma levels less than or equal to 2.48 mcg/ml . One exception was a study in which systemic lidocaine concentrations after topical spray exceeded 3 mcg/ml (Labedzki, Scavone, Ochs, & Greenblatt, 1990). Except in one instance, researchers have demonstrated higher plasma levels using topical spray versus nebulization despite a higher dosage of nebulized lidocaine (Chinn et al., 1977; Labedzki et al., 1990). Available research on lidocaine blood concentrations indicates that maximal plasma levels following laryngotracheal spraying are usually reached between 10 and 20 minutes after spraying (Scott, Littlewood, Covino & Drummond, 1976; Patterson et al. 1975; Viegas & Stoelting, 1975). According to Goodman & Gilman (1990), the peak effect of topical anesthesia of lidocaine is between 2 to 5 minutes. Viegas and Stoelting (1975) concluded that administration of IV lidocaine resulted in a peak lidocaine concentration within 1 minute, while laryngotracheal administration was associated with later peaks and lower but more sustained arterial blood lidocaine concentrations.

The association between increased plasma catecholamine concentrations and the cardiovascular response to tracheal intubation has been confirmed by a number of investigators (Derbyshire, Chmielewski, Fell, Vater, Achola & Smith, 1983; Russell, Morris, Frewin & Drew, 1981; Shribman, Smith & Achola, 1987). These studies showed that changes in plasma noradrenalin concentrations are linked with changes in MAP. A significant increase in diastolic blood pressure was demonstrated for groups in which only laryngoscopy was performed as well as for the group in which laryngoscopy and intubation was performed (Derbyshire et al.,1983, Russell et al., 1981, Shribman, Smith & Achola, 1987). The laryngoscopy group did not demonstrate a significant increase in heart rate like the group that had laryngoscopy with intubation. Shribman et al. (1987) interpret these results as implying that laryngoscopy produced a balanced stimulation of vagal and cardiac accelerator fibers, whereas intubation produced less vagal stimulation.

Drugs Used for Induction

Midazolam, fentanyl, thiopental, rocuronium and isoflurane are drugs commonly used as part of the induction process. Depending on the delivered dose, these agents may contribute to or totally attenuate the cardiovascular response to direct laryngoscopy and tracheal intubation. Midazolam 0.2 mg/kg administered intravenously for induction of anesthesia produces a greater increase in heart rate and decrease in blood pressure than does diazepam 0.5 mg/kg (Samuelson, Reves, Kouchoukos, Smith & Dole, 1981). These midazolam-induced hemodynamic changes are similar to changes produced by thiopental 3-4 mg/kg (Lebowitz, Cote & Daniels, 1982). Midazolam does not alter cardiac output, but it does produce transient depression of baroreceptor-mediated heart rate responses

following intravenous administration in doses appropriate for induction of anesthesia (Marty, Gauzit & Lefevre, 1986).

Fentanyl is a morphine-like synthetic opioid. It is approximately 80 times stronger than morphine with effects primarily at pain receptors. Therapeutic doses of opioids lack a major effect on blood pressure, cardiac rate and cardia rhythm; however, these doses inhibit the baroreceptor reflexes (Goodman & Gilman, 1990). The analgesic effect of fentanyl decreases stimulation caused by the intubation procedure. Kautto (1982) found that use of 2 mcg/kg of fentanyl significantly attenuated the responses (increases in blood pressure and heart rate) to direct laryngoscopy and tracheal intubation in normotensive patients. He also found that 6 mcg/kg of fentanyl given prior to intubation totally ablated the response to laryngoscopy. However, 6mcg/kg of fentanyl is not a practical dose for most surgical procedures lasting less than one hour because of resultant respiratory depression.

In normovolemic patients, thiopental 5 mg/kg administered intravenously produces a transient 10 to 20 mm Hg reduction in blood pressure that is offset by a compensatory 15 to 20 beats per minute increase in heart rate (Filner & Karliner, 1976). The mild and transient reduction in blood pressure that accompanies induction of anesthesia with barbiturates is principally due to peripheral vasodilatation reflecting depression of the medullary vasomotor center and decreased sympathetic nervous system outflow (Yamamura, Kimura & Furukawa, 1983). The resulting dilation of peripheral capacitance vessels leads to pooling of blood, decreased venous return, and the potential for decreases in cardiac output and blood pressure (Yamamura et al., 1983). In addition, thiopental and

other barbiturates are poor analgesics and may even increase sensitivity to pain when administered in inadequate amounts. In these circumstances, evidence of sympathetic response becomes manifest as an increase in heart rate, dilated pupils, tears, sweating, tachypnea, increased blood pressure, and movement or vocalization in response to surgery (Goodman & Gilman, 1990).

Rocuronium bromide is a nondepolarizing neuromuscular blocking agent with a rapid to intermediate onset depending on dosage. The ED95 during opioid/nitrous oxide/oxygen anesthesia is approximately 0.3 mg/kg. Variability near the ED95 dose suggests that 50% of patients will exhibit T1 depression of 91 - 97%. As annotated in the Zemuron package insert (1994), the initial recommended dose of 0.6 mg/kg administered over five seconds to adults 18 to 64 years of age demonstrated a time of 1 minute to reach greater than 80% neuromuscular blockade. To reach 100% blockade requires a mean of 1.8 minutes (with a range of 0.6-13 minutes) for a clinical duration of 31 minutes.

In a number of studies evaluating the neuromuscular blocking effects of rocuronium bromide, doses up to and including five times the ED90 of rocuronium showed little or no increases in heart rate, blood pressure or histamine release (Booij & Knape, 1991; Cason, Baker, Hickey, Miller, & Agoston, 1990; Cooper, Mirakhur & Maddineni, 1993; Levy, Davis, Duggan & Szlam, 1994; Muir, Houston, Green, Marshall, Bowman & Marshall, 1989; Wierda, Dewitt, Kuizenga & Agoston, 1990). In a study comparing the hemodynamic effects of rocuronium bromide 0.6 mg/kg (two times ED95) and vecuronium 0.08 mg/kg, there were no significant changes in heart rate and MAP in patients who received rocuronium (McCoy, Maddineni, Elliott, Mirakhur, Carson, &

Cooper, 1993). These also were small increases in cardiac index and stroke volume index ($p < 0.05$), with peak changes at 1 minute. Although the use of vecuronium showed a small reduction in heart rate and mean arterial pressure ($p < 0.05$), neither drug showed evidence of histamine release.

In contrast, other researchers reported using rocuronium 0.6 mg/kg 1 minute after injection, but before laryngoscopy and tracheal intubation (Booth, Marsh, Bryden, Robertson, & Baird, 1992). These researchers reported an increase in mean heart rate of 36.3% with only a 3.62% change in MAP. The difference in the percent change in heart rate between vecuronium and rocuronium was statistically significant ($p = 0.0022$). However, the researchers thought this finding was not clinically significant because the arterial pressure remained stable. It was noted that patients received preoperative intramuscular hyoscine (an anticholinergic drug) which is known to increase heart rate . Booth et al. (1992) suggested that a detailed analysis of the cardiovascular effects of rocuronium in patients at dose levels of two times the ED90 and above should be conducted.

Anesthesia is commonly maintained with an inhalational agent such as isoflurane. Isoflurane is 1-chloro-2,2,2-trifluorethyl difluoromethyl ether (an inhalational agent). The clinical properties of isoflurane allow induction of anesthesia at a 3% concentration in oxygen in less than 10 minutes, with the concentration generally reduced to 1.5% to 2.5% for maintenance of anesthesia (Goodman & Gilman, 1990). The use of additional agents such as opioids, nitrous oxide, and muscle relaxants reduces the dose of isoflurane required to achieve the conditions optimal for surgery (Goodman & Gilman, 1990).

Circulatory properties of isoflurane include as much as a 50% reduction in arterial blood pressure (of control) at 2.3% concentration (2 MAC - minimum alveolar concentration) due primarily to a decrease in systemic vascular resistance (Faust, Cucchiara, Rose, Spackman, Wedel, & Wilson, 1994). Isoflurane increases heart rate, but it does not sensitize the heart to catecholamines (Goodman & Gilman, 1990). Faust et al. (1994) reported that the heart rate increased from the preoperative value in patients under 40 years of age, but it did not change in older patients. Rogers, Tinker, Covino and Longnecker (1993) also reported that increases in heart rate appear to be more common in younger patients and may be quite pronounced (heart rate greater than 100) when isoflurane is accompanied by other drugs that also increase the heart rate.

Summary

Stimulation of the sympathetic nervous system following direct laryngoscopy and tracheal intubation with resulting increases in blood pressure and heart rate have been documented in the literature over the past forty years. Studies have demonstrated an increase in blood pressure and heart rate within five seconds following direct laryngoscopy and tracheal intubation with a maximum increase seen in 1 to 2 minutes. Calcium channel blockers, nitrates, beta antagonists and ganglionic antagonists have demonstrated inconsistent and/or only partial attenuation of the post-intubation increases in heart rate and blood pressure. Alpha-2 agonists successfully blunt the increases in heart rate and blood pressure to direct laryngoscopy and tracheal intubation, but these agents must be orally administered 60 to 90 minutes prior to induction. Alfentanil and Prostaglandin E-1 are promising candidates for attenuating post-intubation cardiovascular responses.

Studies of intravenous, spray and viscous lidocaine have led to controversy regarding their effectiveness. Most research demonstrated the ability of these forms of lidocaine to attenuate the post-intubation increase in blood pressure but not heart rate. Nebulized lidocaine has been the least documented in the literature, but it shows impressive results thus far. This study was designed to contribute to the knowledge base regarding the effectiveness of nebulized lidocaine in attenuating the cardiovascular response to direct laryngoscopy and tracheal intubation.

CHAPTER III

Methodology

This chapter begins with a brief description of the sample, setting and data collection instrument. The data collection procedure is then explained in detail. Finally, the protection of human subjects, study design and procedure for data analysis are discussed.

Population, Sample and Setting

This study took place in the operating rooms of a 430 bed Army medical facility in the southeastern United States. The convenience sample was drawn from surgical patients undergoing elective surgery requiring general endotracheal anesthesia from January 1996 through June 1996. Only patients who were cared for by one of four student registered nurse anesthetists (SRNAs) were considered for inclusion in the study. Other inclusion criteria were that subjects must have an ASA physical status classification of I or II, be 18 years of age or older, and be an English speaking patient of any ethnic origin. Excluded from the study were patients who had a history of drug allergies to agents under study, malignant hyperthermia or gastroesophageal reflux; patients with diabetes mellitus, asthma, morbid obesity, hypertension, beta blocker therapy; and patients considered to have a full stomach. Because it was assumed that pregnant patients had full stomachs and therefore required special induction considerations, they were excluded from the study.

Instrumentation

Data were recorded on the data collection worksheet (see Appendix A). Each subject's heart rate was measured by a five lead ECG. Mean arterial, systolic, and diastolic blood pressures were obtained with a non-invasive blood pressure monitor. Both heart

rate and blood pressure readings were read and displayed on a Hewlett-Packard monitor (model M1092A). All monitoring devices used had current validation by medical maintenance in accordance with hospital policy.

Procedure for Data Collection

There were four data collectors, two who were not thesis members. These data collectors were all SRNAs with similar skill levels, and they all had completed a minimum of 25 tracheal intubations prior to taking part in this study. After informed consent was obtained, subjects were randomly assigned to a lidocaine or saline group based on the next available number on a computer-generated random numbers list. The list of random numbers was used from top to bottom and left to right until completed. Even numbers were assigned to the lidocaine group, and odd numbers were assigned to the saline group.

While in the surgical holding area, intravenous access was established and lactated ringers solution was infused at the determined rate for each patient. An explanation of the current study and the use of lidocaine was explained to the patient and informed consent was obtained. Midazolam 0.03 mg/kg IV was administered to each patient (Stoelting, 1991). In accordance with the randomization procedure, either 3 ml of 4% lidocaine without epinephrine or 3 ml of 0.9% saline was administered to the patient by means of an anesthesia face mask and nebulizer utilizing O_2 as the nebulizer gas at a ten liter flow. After completion of nebulization, the subject was transported to the operating room and moved to the operating room bed. ECG leads, NIBP cuff, oxygen saturation monitor, peripheral nerve stimulator and precordial stethoscope were placed on the patient. The stimulating electrodes from the peripheral nerve stimulator were placed over

the ulnar nerve proximal to the wrist for subsequent stimulation of the adductor pollicis muscle of one of the upper extremities. Baseline blood pressure and heart rate measurements were obtained and recorded. For each subject, one of the four SRNAs administered the nebulization and all medications while another anesthesia staff member recorded vital signs during the induction and intubation sequence.

Prior to induction, subjects were denitrogenated and preoxygenated for 5 minutes with 100% oxygen. Drug dosages were based on actual body weight. Fentanyl 1.5 mcg/kg IV was given after preoxygenation. One minute after the fentanyl, an induction dose of thiopental sodium 4.0 mg/kg IV was administered. After the subject became apneic and a patent airway was established, rocuronium bromide 0.6 mg/kg IV was administered. Direct laryngoscopy and tracheal intubation were performed when the SRNA determined optimal intubating conditions (a loss of four twitches) utilizing the train-of-four ratio. A MacIntosh laryngoscope blade was used for visualization of the vocal cords. After insertion of the endotracheal tube, the SRNA verified placement using presence of end tidal carbon dioxide and auscultation of equal breath sounds.

Heart rate, systolic blood pressure, diastolic blood pressure, and MAP were measured and recorded at 30 seconds, 90 seconds and 180 seconds after tracheal intubation. These measurement intervals were chosen based on the times when peak responses in heart rate and blood pressure are expected to occur (Hamill et al., 1981; King et al., 1951; Stoelting, 1977). Use of the non-invasive blood pressure monitor permitted the first reading to be 30 seconds after intubation.

Immediately following intubation, 1% isoflurane was dialed in to maintain amnesia. No additional stimulation such as surgical prepping or repositioning occurred to the patient during this recording period. Patients were maintained for the duration of the surgery in accordance with the pre-determined patient specific anesthesia care plan.

Subjects were eliminated from the study when any of the following conditions occurred: (a) Duration of laryngoscopy exceeded 30 seconds; (b) the investigator was unable to ventilate or intubate the patient; (c) the subject experienced a decrease or increase in baseline MAP greater than 25 mm Hg; (d) the subject demonstrated a laryngospasm or bronchospasm; and (e) the time span from start of nebulization to intubation exceeded 30 minutes.

Protection of Human Subjects

The proposed study was reviewed by the Institutional Review Committee at Dwight David Eisenhower Army Medical Center, Fort Gordon, Georgia. The proposal was also reviewed by the University of Texas-Houston Health Science Center, Committee for the Protection of Human Subjects. The investigators obtained informed consent from subjects during the preanesthetic interview. Privacy and confidentiality were insured by using only a code number to identify subjects on the data collection sheet.

Study Design

An experimental study design was utilized to investigate the effectiveness of nebulized lidocaine in attenuating the cardiovascular response to direct laryngoscopy and tracheal intubation in patients receiving either 3cc of 4% nebulized lidocaine or 3cc of 0.9% nebulized saline. Sample selection was a threat to internal validity because of the

possibility that differences resulted from preexisting conditions and not as a result of manipulation of the independent variable. Also, another threat to internal validity was that laryngoscopy skills may vary among data collectors and maturation of skills may occur during the period of the study. To control this threat, no data were collected until all investigators had completed 25 intubations. Finally, a threat to generalization of study results to the general population existed because of convenience sampling performed on only non-emergent, ASA category I and II military beneficiary patients.

Procedure for Data Analysis

The effectiveness of randomization in producing comparable groups was evaluated using Chi-square analysis and ANOVA on demographic characteristics. Repeated measures ANOVA was used to compare the differences from baseline hemodynamics between the groups and between sampling intervals. Statistical significance was set at $p < 0.05$ to avoid attributing significance of results to chance; power was set at 0.80 to be able to detect a difference between the two nebulization groups. Determination of the effect size was based on the study finding of Sklar et al. (1992).

CHAPTER IV

Analysis of the Data

This chapter begins with a description of the sample characteristics. Analyses of the four hypotheses are then explained. Tables and figures are presented to help facilitate presentation of the study findings.

Description of the Sample

Of the 59 patients initiated into the research protocol, 53 subjects completed the assigned induction sequence without incident and their data were included for statistical comparison. Six patients were eliminated from the study: Two for laryngoscopy greater than 30 seconds, 2 for difficulty with ventilation, 1 for nebulization to laryngoscopy time greater than 30 minutes and 1 for uncontrolled hiccups. Three patients received an extra dose of thiopental sodium ranging from 50 to 250 mg. They were kept in the study, 2 in the lidocaine group and 1 in the normal saline group.

Of the 53 subjects in the sample, 25 (47%) were male and 28 (53%) were female. The mean age was 38.9 years with a range of 20 to 67 years of age. Thirty of the 53 patients (56.6%) were categorized as ASA I, while 23 (43.4%) were categorized as ASA II. Description of the sample characteristics according to group membership can be found in Table 1.

Analysis of variance (ANOVA) revealed no significant group differences in age, weight, duration of nebulization, or time from the end of nebulization to laryngoscopy. Chi-square analyses revealed no significant group differences in gender, ASA classification, or anesthesia provider. Furthermore, no significant differences were found

Table 1

Sample Characteristics for Lidocaine and Saline Groups

Characteristics	Groups	
	Lidocaine	Saline
	n = 27	n = 26
Gender		
Male	14	11
Female	13	15
Mean Age (years)	41	37
Age Range (years)	24 - 67	20 - 64
ASA		
I	15	15
II	12	11

in the heart rate, systolic blood pressure, diastolic blood pressure or MAP between subjects cared for by the four data collectors.

Findings

Table 2 shows mean group values for heart rate, systolic blood pressure, diastolic blood pressure and MAP at each data collection point. Figures 1 through 4 graphically depict the data for each variable at each data collection point over time. A 2 x 4 factorial analysis of variance (ANOVA) with repeated measures on one factor was performed separately on each of the four cardiovascular measures. All four hypotheses were rejected based on the presented results of the study.

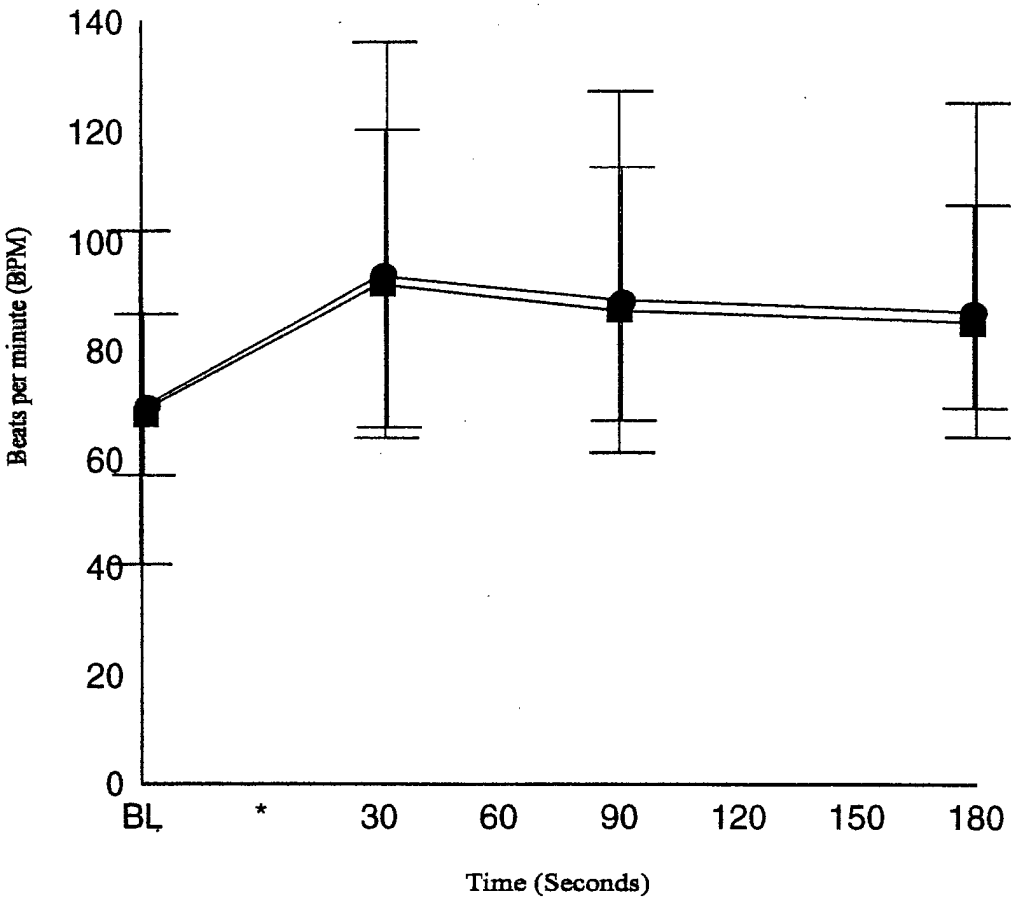
Table 2

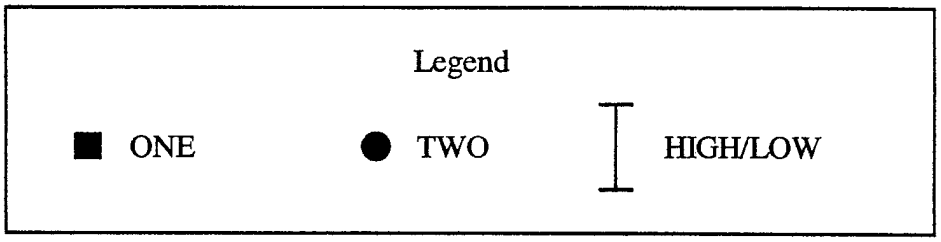
Mean Heart Rates, Systolic Blood Pressure, Diastolic Blood Pressure, and Arterial Pressure for Lidocaine and Saline Groups

	Time of Measurement			
Group	Baseline	+30 seconds	+90 seconds	+180 seconds
	Mean Heart Rate (beats per minute)			
Lidocaine	68	92	87	85
Saline	69	93	89	87
	Mean Systolic Blood Pressure (mm Hg)			
Lidocaine	128	158	140	125
Saline	124	142	133	119
	Mean Diastolic Blood Pressure (mm Hg)			
Lidocaine	68	94	79	67
Saline	66	90	75	60
	Mean Arterial Pressure (mm Hg)			
Lidocaine	89	116	99	87
Saline	85	108	94	82

Note. Time of Measurement is in seconds post-laryngoscopy/intubation.

Figure 1. Mean Heart Rates for Lidocaine and Saline Groups



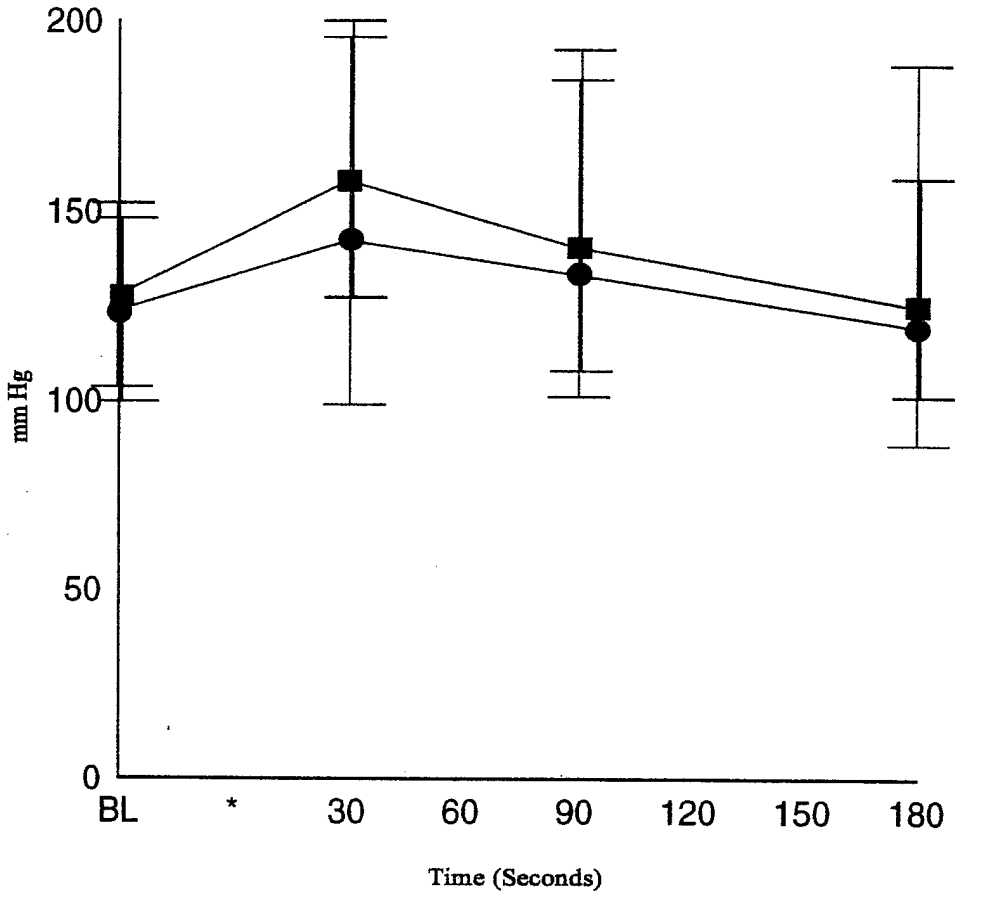


ONE = 120 mg Neubulized Lidocaine
TWO = Nebulized Saline

BL = Baseline
+ 30 = 30 sec post L/I
+ 90 = 90 sec post L/I
+ 180 = 180 sec post L/I

* The time from the BL to Laryngoscopy varied between patients

Figure 2. Mean Systolic Blood Pressure for Lidocaine and Saline Groups

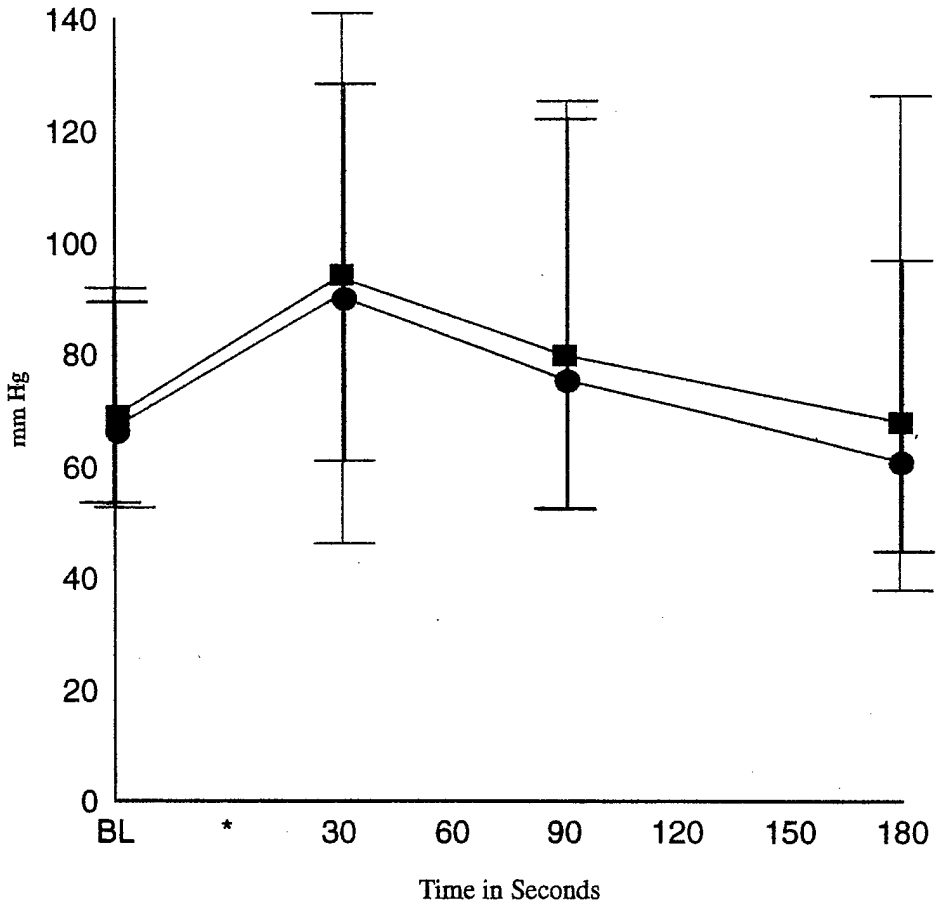


ONE = 120 mg Neubulized Lidocaine
TWO = Nebulized Saline

BL = Baseline
+ 30 = 30 sec post L/I
+ 90 = 90 sec post L/I
+ 180 = 180 sec post L/I

* The time from the BL to Laryngoscopy varied between patients

Figure 3. Mean Diastolic Blood Pressure for Lidocaine and Saline Groups



Legend

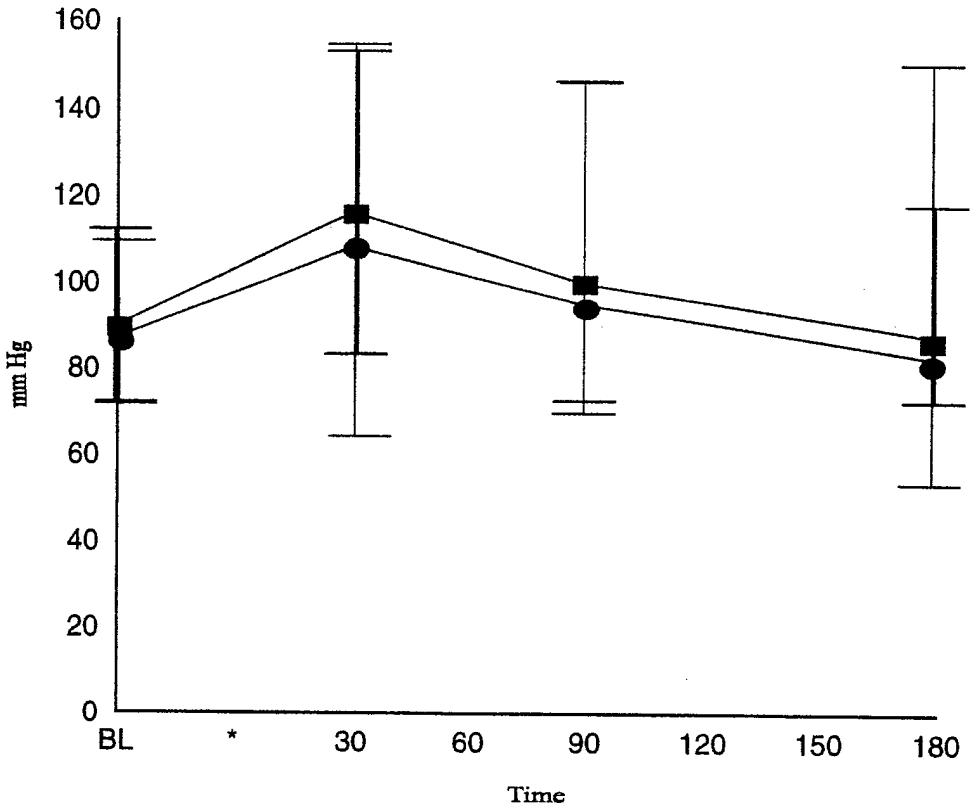
■ ONE ● TWO | HIGH/LOW

ONE = 120 mg Neubulized Lidocaine
TWO = Nebulized Saline

BL = Baseline
+ 30 = 30 sec post L/I
+ 90 = 90 sec post L/I
+ 180 = 180 sec post L/I

* The time from the BL to Laryngoscopy varied between patients

Figure 4. Mean Arterial Pressures for Lidocaine and Saline Groups



Legend

■ ONE ● TWO | HIGH/LOW

ONE = 120 mg Neubulized Lidocaine
TWO = Nebulized Saline

BL = Baseline
+ 30 = 30 sec post L/I
+ 90 = 90 sec post L/I
+ 180 = 180 sec post L/I

* The time from the BL to Laryngoscopy varied between patients

Hypothesis 1: The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in heart rate of ASA I and ASA II patients presenting for various surgical procedures.

The effect due to drug treatment (nebulized lidocaine 120 mg versus nebulized normal saline) was not statistically significant. Also, there was no significant interaction between drug treatment group and time. The data did show a significant time effect in both groups for heart rate over time ($F = 83.84$, $df = 3/153$, $p < .01$).

Hypothesis 2: The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in systolic blood pressure of ASA I and ASA II patients presenting for various surgical procedures.

The analysis showed a significant effect for time ($F = 54.31$, $df = 3/153$, $p < .01$). There was also a significant group effect ($F = 4.03$, $df = 1/51$, $p < .05$). These results suggest that systolic blood pressure was significantly greater for the nebulized lidocaine group. That is, averaged across the four time periods, systolic blood pressure was greater for the lidocaine group than for the saline group. However, because there was no significant interaction, these results indicate that the changes over time in systolic blood pressure between the two groups were similar.

Hypothesis 3: The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in diastolic blood pressure of ASA I and ASA II patients presenting for various surgical procedures.

The effect due to drug treatment (nebulized lidocaine 120 mg versus nebulized normal saline) was not statistically significant. Also, there was no significant interaction between drug treatment group and time. However, there was a statistically significant time effect ($F = 66.58$, $df = 3/153$, $p < .01$). Diastolic blood pressure for both groups changed over time.

Hypothesis 4: The administration of 120 mg nebulized lidocaine before direct laryngoscopy and tracheal intubation will attenuate the post-intubation increase in mean arterial pressure of ASA I and ASA II patients presenting for various surgical procedures.

The effect due to drug treatment (nebulized lidocaine 120 mg versus nebulized normal saline) was not statistically significant. Also, there was no interaction between drug treatment group and time. There was a statistically significant time effect ($F = 73.33$, $df = 3/153$, $p < .01$). MAP for both groups changed over time.

Summary

Fifty-three subjects were included in the study for statistical comparison. The groups were similar for all characteristics including age, weight, duration of nebulization and time from the end of nebulization to laryngoscopy. There were no significant group differences based on gender, ASA classification or data collector. The effect due to drug treatment was not statistically significant for heart rate, diastolic blood pressure or MAP although there was a significant effect in response over time for each group. There was a statistically greater systolic blood pressure found in the nebulized lidocaine group in comparison to the nebulized saline group. However, because there was no significant

interaction between the groups, the results indicate that the changes over time in systolic blood pressure between the two groups were similar.

CHAPTER V

Discussion, Conclusions, Implications, and Recommendations

In this chapter, findings related to the hypotheses are discussed and conclusions are made about the study results. Finally, implications of the findings and recommendations for future research are explained.

Discussion

The primary finding of the study was that there was no difference in the cardiovascular response to direct laryngoscopy and tracheal intubation between the group of patients receiving 120 mg nebulized lidocaine and the group receiving nebulized normal saline. These findings do not support the theoretical framework, which suggests that pretreatment of nebulized lidocaine will conserve a patient's energy and structural integrity by attenuating the cardiovascular response to direct laryngoscopy and tracheal intubation. However, it should be noted that there were no patients who experienced any adverse effects as a result of a cardiovascular response to direct laryngoscopy and tracheal intubation.

When interpreting the primary study finding, it is important to note that there was a mean time of 12.6 minutes between the end of nebulization and direct laryngoscopy and intubation in this study. According to Goodman and Gilman (1990), the peak effect of topical or surface lidocaine is 2 to 5 minutes, with the anesthesia lasting 30 to 45 minutes. Thus, laryngoscopy and intubation were performed in this study, on the average, 9 minutes after the 3 minute peak topical effect period. In contrast, Sklar et al. (1992) performed direct laryngoscopy and tracheal intubation during the 3 minute peak effect

time period, and they demonstrated an attenuation of the cardiovascular response with nebulized lidocaine. Furthermore, Hamill et al. (1981) found their nebulized lidocaine treatment to be ineffective when they intubated prior to this peak effect at 1 minute, but they found their treatment to be effective when they used a time interval of 5 minutes between lidocaine instillation and intubation. It seems apparent that both Sklar et al. (1992) and Hamill et al. (1981) had attenuation of increases in heart rate and blood pressure in response to direct laryngoscopy and tracheal intubation due to local anesthesia and blockade of vagal receptors, not due to a central effect of lidocaine based on plasma concentration.

Furthermore, there is a similarity between the changes in heart rate and blood pressure obtained in this study and the study by Hamill et al. (1981), who concluded that use of 4 ml of a 4% lidocaine laryngotracheal spray prior to intubation was ineffective in the attenuation of increases in heart rate and MAP during laryngoscopy and tracheal intubation. Hamill et al. (1981) reported that laryngotracheal lidocaine was effective in preventing increases in heart rate and blood pressure when there was a 5 minute interval between instillation of lidocaine and intubation. These researchers concluded that laryngotracheal instillation of lidocaine is only effective secondary to the resultant systemic drug absorption. In a study of plasma lidocaine concentrations after endotracheal spraying, Scott et al. (1976) found that maximal plasma concentrations were reached between 10 and 20 minutes after topical application of lidocaine and that the range for peak lidocaine levels was from 5 to 30 minutes. In a similar study, Labedzki et al. (1990)

found the time to peak serum lidocaine concentration for topical spray lidocaine and nebulized lidocaine to be 43 and 41 minutes, respectively.

Another study finding was that systolic blood pressure was significantly greater for the nebulized lidocaine group than for the saline group. However, because there was no significant interaction between group and time, the results indicated that changes over time in systolic blood pressure between the two groups were similar. Pathak et al. (1990) also experienced an increase in MAP and heart rate when using 2 mg/kg lidocaine intravenously. Because they noted this response prior to laryngoscopy and tracheal intubation, these researchers concluded that a centrally mediated response was elicited. A centrally mediated response would explain the baseline difference in systolic blood pressure between this study's lidocaine and normal saline groups. It is noted that Pathak et al. (1990) utilized a higher dosage of IV lidocaine than other studies and that this study used nebulized lidocaine. The Hawthorne effect is another possible explanation for the increased systolic blood pressure in the lidocaine group. Because lidocaine emits a strong taste as well as odor when nebulized, both the patient and the data collectors may have known when lidocaine was being used. This knowledge may have influenced the data collector-patient interactions.

Furthermore, it should be noted that at the beginning of data collection, vecuronium 0.1 mg/kg was used as the muscle relaxant. After collecting data on 8 patients, a recurrent problem of patient movement prior to complete relaxation was noted. A change in muscle relaxant was needed to maintain amnesia and avoid the use of a drug which could effect study results. Rocuronium bromide was substituted for vecuronium in the study

procedure because of its characteristically faster onset time of 1.6 minutes with 0.6 mg/kg versus vecuronium onset of 2.5 to 3.0 minutes with 0.1 mg/kg (Physicians' Desk Reference, 1996). Before changing muscle relaxants, it was noted that seven studies using rocuronium dosages of two times the ED95 (0.6 mg/kg) up to five times the ED90 showed no evidence of increases in heart rate and blood pressure or histamine release (Booij & Knape, 1991; Cason et al., 1990; Cooper et al., 1993; Levy et al., 1994; McCoy et al., 1993; Muir et al., 1989; Wierda et al., 1990). All patients, whether in the control or lidocaine groups, received the same dose of rocuronium so that any potential cardiovascular effect of rocuronium would have an equal effect on both groups.

Also, there were 3 patients who were given additional doses of thiopental (greater than 4 mg/kg) because of movement during laryngoscopy and tracheal intubation. It is believed that the patients moved secondary to inadequate anesthesia and/or problems with the peripheral nerve stimulator. The peripheral nerve stimulators may have had weakened batteries or the electrodes may have been in poor condition, leading to an inaccurate estimation of the train-of-four ratio. Because the evaluation of these 3 patients showed similar findings to those who did not receive additional thiopental, they were not excluded from the study.

It also should be noted that the duration of laryngoscopy is a variable that was not controlled in this study except that subjects with laryngoscopies lasting longer than 30 seconds were excluded from the study. Stoelting (1977) concluded that the MAP increases in response to the duration of laryngoscopy. In a study by Bucx et al. (1992), duration of laryngoscopy contributed more to the increase in heart rate and blood pressure

than the physical force transmitted during laryngoscopy. In a similar study Shribman et al. (1987) found that intubation was more stimulating than direct laryngoscopy. However, the duration of direct laryngoscopy appeared to be the primary factor involved with increases in heart rate and blood pressure.

There are four major limitations to the study. First, the results of a convenience sample of ASA I and ASA II patients cannot be generalized to the larger population of patients presenting for surgical procedures. Second, a double-blind design was not used in this study. The data collector's knowledge of which nebulization treatment was given to the patient could have influenced the patient's response to the procedure through the data collector's verbal and nonverbal interactions with the patient. Third, the duration of laryngoscopy varied for each patient. It is generally agreed that the patient's cardiovascular response to laryngoscopy increases progressively with the duration of laryngoscopy (Stoelting, 1977). Because the duration of laryngoscopy varied, the uniformity of the study is limited.

The final limitation is the number of subjects ($n = 53$) in the study. Although a power analysis of 0.80 was obtained with the inclusion of a minimum of 52 patients in the study, there still remains a 20% risk of committing a Type II error (Polit & Hungler, 1991). By increasing the sample size, the risk of committing a Type II error is progressively decreased.

Conclusions

It can be concluded that administration of 120 mg of nebulized lidocaine before direct laryngoscopy and tracheal intubation did not attenuate the cardiovascular responses

of the ASA I and ASA II surgical patients in the study. It must be noted that this conclusion is based on a mean time of 12.6 minutes between lidocaine nebulization and tracheal intubation. Because of the convenience sampling procedure that was used, this conclusion cannot be generalized to other ASA I and ASA II surgical patients.

Implications

One of the goals of anesthesia care is to prevent deleterious consequences, such as myocardial ischemia, myocardial infarction and cerebrovascular accidents, that are attributable to the effects of direct laryngoscopy and tracheal intubation in susceptible patient populations. No change in current anesthesia practice can be suggested based on the study findings. The study implications, therefore, are that anesthesia care providers should continue their current practice of using other agents such as IV lidocaine, opioids or beta blockers to attenuate post-intubation cardiovascular responses of surgical patients.

Recommendations

Based on the study findings, it is recommended that the study be replicated with the following changes in study design and data collection procedures:

1. Direct laryngoscopy and tracheal intubation should be performed during the 2 to 5 minute topical peak effect of lidocaine. This recommendation is important because of the Sklar et al. (1992) study findings noting an attenuation of post-intubation cardiovascular responses during this time interval.

2. The duration of laryngoscopy should be consistent for all patients. This would eliminate variable cardiovascular responses due to different laryngoscopy times. For

example, the duration of laryngoscopy could be limited to 30 seconds for all patients, and the duration of intubation could be limited to the last 5 seconds of laryngoscopy.

3. Glycopyrrolate should be used as a drying agent. This would create an environment for improved topicalization of the airway mucosal surface. Although glycopyrrolate exhibits a vagolytic effect, using this drug in both the lidocaine and saline groups would prevent any potentially confounding effect of this drug on the study results.

4. A double blind study design should be used so that both the patient and data collector would be blind to group membership. An anesthesia care provider other than the data collector would need to administer the nebulization to the patients and stay with them until the nebulization treatment is finished.

APPENDIX A

Data Collection Sheet

Data Collection Sheet

Code # ____ Room # _____ Investigator # _____ (1, 2, 3, or 4)
Sex M = 0, F = 1 _____ Age_____ Weight (actual)_____kg
ASA Category_____Surgical Procedure _____
Nebulization Type: (.9% NaCl 3ml) _____ (4% Lidocaine 3 ml) _____

(1) Holding Area:
a. Get consent
b. Nebulization Start Time_____
c. Give Midazolam 0.03 mg/kg____ mg
Nebulize patient at a 10 liter oxygen flow until completed
d. Nebulization Finish Time_____

(2) Operating Room:
a. Preoxygenate (100% oxygen)
b. Baseline Vital Signs SBP_____ DBP_____ MAP_____
c. Give Fentanyl 1.5 mcg/kg_____mcg
d. Give STP 4 mg/kg_____mg One Minute after fentanyl was given
e. After patient apneic, assess airway for patency
f. Give Rocuronium 0.6 mg/kg_____mg
g. Laryngoscopy and tracheal intubation After loss of four twitches in a TOF
Time of laryngoscopy_____ What your watch says!!! Not how long it took
Laryngoscopy and Intubation < 30 seconds_____(Y/N)
h. Confirm tube placement, press start mode on NIBP, turn on isoflurane 1 % Dialed

(3) Vital Signs Post Laryngoscopy:

30 Seconds	SBP_____	DBP_____	MAP_____	HR_____
90 Seconds	SBP_____	DBP_____	MAP_____	HR_____
180 Seconds	SBP_____	DBP_____	MAP_____	HR_____

a. End of Protocol Time_____
b. Total Time _____ minutes Time from the start of nebulization to the last set of vital signs

References

Abou-Madi, M. N., Keszler, H., & Yacoub, J. M. (1977). Cardiovascular reactions to laryngoscopy and tracheal intubation following small and large intravenous doses of lidocaine. Canadian Anaesthetists' Society Journal, 24(1), 12-19.

Abou-Madi, M. N., Keszler, H., & Yacoub, J. M. (1975). A method for prevention of cardiovascular reactions to laryngoscopy and intubation. Canadian Anaesthetists Society Journal, 22(3), 316-329.

Bailey, P., & Stanley, T. (1990). Narcotic intravenous anaesthesia. In R.D. Miller (Ed.), Anesthesia (Vol.1, 3rd ed., pp. 281-366). New York: Churchill Livingstone.

Bijoria, K., Wig J., Bajaj A., & Sapra R. P. (1992). Isosorbide dinitrate spray. Attenuation of cardiovascular responses to laryngoscopy and intubation. Anaesthesia, 47 (6): 523-526.

Black, T. E., Kay, B., & Healy, T. E. J. (1984). Reducing the hemodynamic responses to laryngoscopy and intubation: A comparison of alfentanil with fentanyl. Anaesthesia, 39, 883-887.

Booij, L. H., & Knape, T. A. (1991). The neuromuscular blocking effect of Org 9426. Anaesthesia, 46, 341-343.

Booth, M. G., Marsh, B., Bryden, F. M., Robertson, E. N., & Baird, L. M. (1992). A comparison of the pharmacodynamics of rocuronium and vecuronium during halothane anaesthesia. Anaesthesia, 47, 832-834.

Bucx, M., Van Geel, R., Scheck, P., & Stijnen, T. (1992). Cardiovascular effects of forces applied during laryngoscopy. Anaesthesia, 47, 1029-1033.

Cason, B., Baker, D. G., Hickey, R. F., Miller, R. D., & Agoston, S. (1990). Anesthesia Analog, 70, 382-388.

Chinn, W. M., Zavala, D. C., & Ambre, J. (1977). Plasma levels of lidocaine following nebulized aerosol administration. Chest, 71(3), 346-348.

Chraemmer-Jorgensen, B., Hoilund-Carlson, P., Marving, J., & Christensen, V. (1986). Lack of effect of intravenous lidocaine on hemodynamic responses to rapid sequence induction of general anesthesia. Anesthesia Analog, 65, 1037-1041.

Chung, K., Sinatra, R., Halevy, J., Paige, D., & Silverman, D. (1992). A comparison of fentanyl, esmolol, and their combination for blunting haemodynamic responses during rapid-sequence induction. Canadian Journal of Anaesthesia, 39(8), 774-779.

Cooper, R. A., Mirakhur, R. K., & Maddineni, V. R. (1993). Neuromuscular effects of rocuronium bromide (Org 9426) during fentanyl and halothane anaesthesia. Anaesthesia, 48, 103-105.

Crawford, D. C., Fell, D., Achola, K. J., & South, G. (1987). Effects of alfentanil on the pressor and catecholamine responses to tracheal intubation. British Journal of Anaesthesia, 59, 707-712.

Denlinger, J. K., Ellison, N., & Ominsky, A. J. (1974). Effects of lidocaine on circulatory responses to tracheal intubation. Anesthesiology, 41(4), 409-412.

Denlinger, J. K., Messner, J. T., D' Orazio, D. J., & Balaraman, G. (1976). Effect of intravenous lidocaine on the circulatory response to tracheal intubation. Anesthesiology, 3, 13-15.

Derbyshire, D., Chmielewski, A., Fell, D., Vater, M., Achola, K., & Smith, G. (1983). Plasma catecholamine responses to tracheal intubation. British Journal of Anaesthesia, 55, 855-860.

Faust, R. J., Cucchiara, R. F., Rose, S. H., Spackman, T. N., Wedel, D. J., & Wilson, P. R. (1994). Anesthesiology review (2nd Ed). New York: Churchill Livingstone.

Filner, B. F., & Karliner, J. S. (1976). Alterations of normal left ventricular performance by general anesthesia. Anesthesiology, 45, 610-620.

Forbes, A. M., & Dally, F. G. (1970). Acute hypertension during induction of anesthesia and endotracheal intubation in normotensive man. British Journal of Anaesthesia, 42, 618-624.

Fox, E. J., Sklar, G. S., Hill, C. H., Villanueva, R., & King, B. D. (1977). Complications related to the pressor response to endotracheal intubation. Anesthesiology, 47, 524-525.

Goodman, L. S., & Gilman, A., (1990). Goodman and Gilman's The pharmacological basis of therapeutics (8th Ed). New York: Pergamon Press.

Hamill, J. F., Bedford, R. F., Weaver, D. C., & Colohan, A. R. (1981). Lidocaine before endotracheal intubation: Intravenous or laryngotracheal? Anesthesiology, 55, 578-581.

Helfman, S. M., Gold, M. I., DeLisser, E. A., & Herrington, C. A. (1991). Which drug prevents tachycardia and hypertension associated with tracheal intubation: Lidocaine, fentanyl, or esmolol? Anesthesia Analog, 72, 482-486.

Hewlett-Packard Application Note, (1989). Non-invasive Pressure Monitoring: a comparison of the oscillometric, intra-arterial, and auscultatory techniques. Hewlett-Packard: Federal Republic of Germany

Hewlett-Packard Service Manual, (1993). Functional descriptions . Hewlett-Packard: United States of America.

Kautto, U. M. (1982). Attenuation of the circulatory response to laryngoscopy and intubation by fentanyl. Anesthesia of orthopedics and traumatology anesthesia in Scandinavia, 26, 217-221.

King, B. D., Harris, L. C., Greifenstein, F. E., Elder, J. D., & Dripps, R. D. (1951). Reflex circulatory responses to direct laryngoscopy and tracheal intubation performed during general anesthesia. Anesthesiology, 12, 556-566.

Kirby, I. J., Northwood, D., & Dodson, M. E. (1988). Modification by alfentanil of the hemodynamic response to tracheal intubation in elderly patients: A dose response study. British Journal of Anaesthesia, 60, 384-387.

Kumar, N., Batra, Y., Bala, I., & Gopalan, S. (1993). Nifedipine attenuates the hypertensive response to tracheal intubation in pregnancy-induced hypertension. Canadian Journal of Anaesthesia, 40(4), 329-333.

Labedzki, L., Scavone, J. M., Ochs, H. R., & Greenblatt, D. J. (1990). Reduced systemic absorption of intra bronchial lidocaine by high-frequency nebulization. Journal of Clinical Pharmacology, 30, 795-797.

Laurito, C., Baughman, V., Becker, G., Cunningham, F., Pygon, B., & Citron, G. (1993). Oral clonidine blunts the hemodynamic responses to brief but not prolonged laryngoscopy. Journal of Clinical Anesthesia, 5, 54-57.

Lebowitz, P. W., Cote, M. E., & Daniels, A. L. (1982). Comparative cardiovascular effects of midazolam and thiopental in healthy patients. Anesthesia Analogs, 61, 661-665.

Levy, J. H., Davis, G.K., Duggan, J., & Szlam, F. (1994). Determination of the hemodynamics and histamine release of rocuronium (Org 9426) when administered in increased doses under N2O/O2-sufentanil anesthesia. Anesthesia Analog, 78, 318-321.

Mahajan, R., Ramachandran, R., & Saxena, N. (1993). Topical nitroglycerine prevents the pressor response to tracheal intubation and sternotomy in patients undergoing coronary artery bypass graft surgery. Anaesthesia, 48, 297-300.

Martineau, R., Tousignant, C., Miller, D., & Hull, K. (1990). Alfentanil controls the haemodynamic response during rapid sequence induction of anaesthesia. Canadian Journal of Anaesthesia, 37(7), 755-761.

Marty J., Gauzit, R., & Lefevre, P. (1986). Effects of diazepam and midazolam on baroreflex control of heart rate and sympathetic activity in humans. Anesthesia Analogs, 65, 113-119.

McCoy, E. P., Maddineni, V. R., Elliott, P., Mirakhur, R. K., Carson, I. W., & Cooper, R. A. (1993). Haemodynamic effects of rocuronium during fentanyl anaesthesia: comparison with vecuronium. Canadian Journal of Anaesthesia, 40(8), 703-708.

Mikawa, K., Ikegaki, J., Maekawa, N., Hoshina, H., Tanaka, Y., Goto, R., & Obara, H. (1990). Effects of prostaglandin E. on the cardiovascular response to tracheal intubation. Journal of Clinical Anesthesia, 2, 420-424.

Mikawa, K., Maekawa, N., Hasegawa, M., Katesu, H., Goto, R., Yaku, H., & Obara, H. (1992). Effects of nillvadipine on the cardiovascular response to tracheal intubation. Journal of Clinical Anesthesia, 4, 292-296.

Mikawa, K., Maekawa, N., Hasegawa, M., Katesu, H., Goto, R., Yaku, H., Tanaka, Y., Nishina, K., & Obara, H. (1993). Attenuation of the cardiovascular and catecholamine responses to tracheal intubation with oral guanabenz. Anesthesia and Analgesia, 76, 585-591.

Miller, C. D., Martineau, R., O'Brian, H., Hull, K., Oliveras, L., Hindmarsh, T., & Greenway, D. (1993). Effects of alfentanil on the hemodynamic and catecholamine response to tracheal intubation. Anesthesia and Analgesia, 76, 1040-1046.

Miller, C. D., & Warren, S. J. (1990). Intravenous lidocaine fails to attenuate the cardiovascular response to laryngoscopy and tracheal intubation. British Journal of Anaesthesia, 65, 216-219.

Miller, R. D., (1994). Anesthesia (4th Ed.). New York: Churchill Livingstone.

Morgan, G. E., & Mikhail, M. S. (1992). Clinical anesthesiology. Norwalk, CT: Appleton & Lange

Muir, A. W., Houston, J., Green, K. L., Marshall, R. J., Bowman, W. C., & Marshall, I. G. (1989). Effects of a new neuromuscular blocking agent (Org 9426) in anaesthetized cats and pigs and in isolated nerve-muscle preparations. British Journal of Anaesthesia, 63, 400-410.

Pathak, D., Slater, R. M., Sum Ping, S. S. T., & From, R. P. (1990). Effects of alfentanil and lidocaine on the hemodynamic responses to laryngoscopy and tracheal intubation. Journal of Clinical Anesthesia, 2, 81-85.

Patterson, J. R., Blaschke, T. F., Hunt, Jr., K. K., & Meffin, P. J. (1975). Lidocaine blood concentrations during fiberoptic bronchoscopy. American Review of Respiratory Disease, 112, 53-57.

Physicians' Desk Reference, 50th ed., (1996). New York: Medical Economics

Polit, D. F., & Hungler, B. P. (1991). Nursing research: principles and methods (4th ed.). Philadelphia: J.B. Lippincott.

Prys-Roberts, C., Greene, L., Meloche, R., & Foex, P. (1971). Studies of anaesthesia in relation to hypertension II: Haemodynamic consequences of induction and endotracheal intubation. British Journal of Anaesthesia, 43, 531-547.

Riehl-Sisca, J. (1988). Conceptual models for nursing practice (3rd ed). East Norwalk, CT: Appleton & Lange

Rogers, M. C., Tinker, J. H., Covino, B. G., & Longnecker, D. E. (1993). Principles and practice of anesthesiology. St. Louis: Mosby-Year Book.

Russel, W. J., Morris, R. G., Frewin, D. B., & Drew, S. E. (1981). Changes in plasma catecholamine concentrations during endotracheal intubation. British Journal of Anaesthesia, 53, 837.

Saitoh, N., Mikawa, K., Kitamura, S., Maekawa, N., Goto, R., Yaku, H., Yamada, M., & Obara, H. (1991). Effects of trimethaphan on the cardiovascular response to tracheal intubation. British Journal of Anaesthesia, 66, 340-344.

Samuelson, P. N., Reves, J. G., Kouchoukos, N. T., Smith, L. R., & Dole, K. M. (1981). Hemodynamic responses to anesthetic induction with midazolam or diazepam in patients with ischemic heart disease. Anesthesia Analog, 60, 802-809.

Scheinin, B., Lindgren, L., Randell, T., Scheinin, H., & Scheinin, M. (1992). Dexmedetomidine attenuates sympathoadrenal responses to tracheal intubation and reduces the need for thiopentone and perioperative fentanyl. British Journal of Anaesthesia, 68, 126-131.

Scott, D. B., Littlewood, D. G., Covino, B. G., & Drummond, G. B. (1976). Plasma lidocaine concentrations following endotracheal spraying with an aerosol. British Journal of Anaesthesia, 48, 899-901.

Shribman, A. J., Smith, G., & Achola, K. J. (1987). Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. British Journal of Anaesthesia, 59, 295-299.

Sklar, I., Lurie, S., Ezri, T., Krichelli, D., Savir, I., & Soroker, D. (1992). Lidocaine inhalation attenuates the circulatory response to laryngoscopy and endotracheal intubation. Journal of Clinical Anesthesia, 4, 382-385.

Splinter, W., & Cervenko, F. (1989). Haemodynamic responses to laryngoscopy and tracheal intubation in geriatric patients: Effects of fentanyl, lidocaine, and thiopentone. Canadian Journal of Anaesthesia, 36, 370-376.

Stoelting, R. K. (1977). Circulatory changes during direct laryngoscopy and tracheal intubation: Influence of duration of laryngoscopy with or without prior lidocaine. Anesthesiology, 47, 381-383.

Stoelting, R. K. (1978). Blood pressure and heart rate changes during short duration laryngoscopy for tracheal intubation: Influence of viscous or intravenous lidocaine. Anesthesia Analog, 57, 197-200.

Stoelting, R. K. (1991). Pharmacology & physiology in anesthetic practice (2nd ed.). Philadelphia: J. B. Lippincott.

Stoelting, R. K., & Miller, R. D. (1994). Basics of anesthesia (3rd ed.). New York: Churchill Livingstone.

Viegas, O., & Stoelting, R. K. (1975). Lidocaine in arterial blood after laryngotracheal administration. Anesthesiology, 43(4), 491-493.

Vucevic, M., Purdy, G. M., & Ellis, F. R. (1992). Esmolol hydrochloride for management of cardiovascular stress responses to laryngoscopy and tracheal intubation. British Journal of Anaesthesia, 68, 529-530.

Wierda, J. M., DeWit, A. P., Kuizenga, K., & Agoston, S. (1990). Clinical observations on the neuromuscular blocking action of Org 9426, a new steroidal non-depolarizing agent. British Journal of Anaesthesia, 64, 521-523.

Wilson, I. G., Meiklejohn, B. H., & Smith, G. (1991). Intravenous lidocaine and sympathoadrenal responses to laryngoscopy and intubation. Anaesthesia, 40, 177-180.

Wycoff, C. C. (1960). Endotracheal intubation: Effects on blood pressure and pulse rate. Anesthesiology, 21(2), 153-158.

Yamamura, T., Kimura, T., & Furukawa, K. (1983). Effects of halothane, thiamylal, and ketamine on central sympathetic and vagal tone. Anesthesia Analog, 62, 129-134.

Yao, F. F., & Artusio, J. F. (1993). Anesthesiology: Problem-oriented patient management (3rd ed.). Philadelphia: J. B. Lippincott.

Zemuron (rocuronium bromide) injection package insert (1994). The first rapid onset nondepolarizing muscle relaxant. Organon, Inc.

VITA

Judith Bock was born in San Rafael, California on June 5, 1957. She is the only daughter of Tony and Mary Ann Martin. After graduating in 1983 with a Bachelor of Science in Nursing from San Francisco State University, she worked for five years at Kaiser Permanente Hospital as a staff nurse in various nursing units. In 1985 she began work on a graduate degree in nursing; and in the fall of 1986, she joined the Army Reserves as a Second Lieutenant. Upon completion of a Master of Science in Nursing Education degree in 1988, she decided to pursue an Army career; and she was commissioned as a First Lieutenant on active duty. During the last eight years she has been a staff nurse in a number of intensive care units; a head nurse of a telemetry unit and a medical intensive care unit, and a head nurse of a surgical intensive care unit deployed during Operation Desert Shield/Storm. In October 1994, she entered the United States Army/University of Texas - Houston Health Science Center program for nursing anesthesia. In 1983, she married her husband, Larry, who has continued to guide and support her in her many endeavors.