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VARIABILITY IN THE AMERICAN SOCIETY OF ANESTHESIOLOGISTS (ASA) PHYSICAL STATUS (PS) CLASSIFCATION SCALE

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ABSTRACT

The ASA PS classification is used world-wide by anesthesia providers to assess the preoperative PS of patients. This score is used in many areas of anesthesia including administrative policy-making, performance evaluations, resource allocation and reimbursement of anesthesia services. In addition, it is cited as a variable in virtually all research related to anesthesia and in many other areas of medical research as well. The purpose of this study was to assess inter-rater reliability among anesthesia providers in assigning ASA scores and discover possible sources of variability. A survey containing four general questions and 10 hypothetical case scenarios was given to 70 anesthesia providers asking them to assign ASA scores and provide rationale for their decisions. All subjects reported using the ASA PS classification routinely with nearly all finding it helpful in their practice. Unfortunately, most of the sample viewed the ASA PS as an anesthetic and surgical risk indicator. Findings demonstrate a lack of inter-rater reliability in assigning ASA PS scores with a range in eight of the scenarios of three to five and in only two of the scenarios a range of two. There were no statistical differences between CRNAs and anesthesiologists or between military and non-military providers. Several sources of variability were identified in this study: smoking, pregnancy, nature of the surgery, potential difficult airway, and acute injury. This classification should not be used for administrative policy determination or for reimbursement of anesthesia services until it is revised by a multidisciplinary taskforce.

Key Words: <u>ASA PS</u>, <u>preoperative PS</u>, <u>assessment</u>, <u>physical status</u>, <u>classification</u>.

VARIABILITY IN THE AMERICAN SOCIETY OF ANESTHESIOLOGISTS (ASA) PHYSICAL STATUS (PS) CLASSIFICATION SCALE

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PREFACE

This research was conducted to provide insight into the sources of variability in anesthesia providers use to the ASA PS classification. It was designed in an effort to provide information that will be helpful in the revision of this classification.

DEDICATION

I dedicate this work to the most important people in my life; my husband Andrew and two sons Jesse and Jade. Without their love and support I would not have been able to complete my masters and this research project. I dedicate this time in my life to the friends I made here who have changed me (very much for the better) and have found a place in my heart. I give God the glory for seeing me through each day and giving me the strength to press on to the finish.

I can do all things through Christ who strengthens me – Phil 4:13

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CHAPTER I: INTRODUCTION

Background

The assessment of general physical status is an integral part of the preoperative evaluation of patients. Anesthetists world wide routinely stratify patients according to the severity of their disease and overall health using the American Society of Anesthesiologists physical status (ASA PS) classification. This classification has been in wide use for over 50 years. It is one of the few prospective and widely applied descriptions of patients, with the exception of age and gender (Derrington & Smith, 1987).

The ASA PS classification was originally designed to collect and compare anesthesia statistical data. Before the development of this scale, anesthesia providers attempted to record a suspected "operative risk" (Saklad, 1941, p.281) for patients in an effort to assess patient ability to withstand surgery. This operative risk included more than physical status. To be a true indication of risk, it required inclusion of the planned surgery, the ability and skill of the team, and attention to postoperative care. While this determination was valuable in prognosis, it was seen as useless from a statistical point of view. Hence, the ASA PS classification was developed. The ASA PS scale has been shown to be useful in outcome studies due to its universal use and availability on charts (Cohen & Duncan, 1988). It has also facilitated comparison in and between medical centers (Menke, Klein, John, & Junginger, 1993).

As the ASA PS classification became widely utilized, many anesthesia providers began to associate the score with a risk assessment of anesthesia and/or surgery. There are many studies that support utilization of the ASA PS scale in this capacity, suggesting a direct correlation between ASA PS scores and morbidity and mortality. However, there are nearly as many studies with findings to the contrary.

The ASA PS classification was utilized for 31 years in practice without investigation into its reliability and validity. It was not until 1978 that the first study (Owens, Felts, & Spitznagel, 1978) looking at the ASA PS scale was conducted. Two similar studies followed several years later (Haynes & Lawler, 1995; Ranta, Hyneynen, & Tammisto, 1997). All three studies demonstrated inconsistencies between anesthesiologists in assigning ASA PS scores to patient scenarios. This raises the question of reliability and validity: Is the ASA PS classification reliably measuring what it is designed to measure?

ASA PS scores are recorded on nearly every patient. As a permanent part of the record, this score is available for audit and is being applied to performance evaluations, resource allocation, and development of institutional policies (Haynes & Lawler, 1995). In the Air Force, CRNA scope of practice is directed to a certain extent by patient ASA PS scores. Air Force Instruction (AFI) 44-102 states CRNAs may routinely administer anesthesia to children two years old and older and to ASA class II or lower risk patients. CRNAs are to consult with an anesthesiologist before providing care to children under the age of two or to ASA class III or higher patients (AFI44-102, 1998).

Some forms of insurance reimbursement for anesthesia services are based, in part, on a patient's ASA PS score. Additional reimbursement units are awarded for ASA PS III (1), IV (2), and V (3) and are added to the base units (specific to the procedure) and time units resulting in the total chargeable units. This total then determines amount of reimbursement (L.S. Broadston, personal communication, 25 November 1998). In addition, ASA PS scores are cited in most research related to anesthesia as well as many other areas of medical research. For these reasons, the use of this classification and its reliability and validity as an instrument are important to the practice of anesthesia. Accuracy in use of such an instrument that is applied to so many areas related to anesthesia and health care is essential.

Problem

Assignment of ASA PS scores to patients has been shown to be inconsistent among anesthesiologists (Haynes & Lawler, 1995; Owens et al., 1978; Ranta et al., 1997). This has presented a problem in the provision of anesthesia care because many anesthesia and health care issues use this score for performance evaluation, resource allocation, development of institutional policies, insurance reimbursement, and anesthesia and other medical research (Haynes & Lawler, 1995).

From a review of the literature, it is apparent there are several gaps in the research related to use of the ASA PS classification that need to be addressed. Nurse anesthetists have not participated in previous studies looking at anesthesia provider use of the ASA PS scale. Since nurse anesthetists comprise a large portion of the anesthesia providers in the United States and many other countries, a significant population who utilize the ASA PS classification has been ignored in the research. No study of the use of the ASA PS scale by military anesthesia providers compared to civilian providers could be found in the literature. Finally, despite the recognition of continued inconsistency in use of the ASA PS classification, no one has attempted to identify the source(s) of this variability between providers.

Purpose of the Study

The purpose of this study was to identify the source(s) of variability in application of the ASA PS classification by anesthesia providers. This data will be useful for future revisions of this instrument.

Research Questions

The following research questions were posed in this study:

1. Are assignments of ASA PS classification scores consistent among anesthesia providers, both nurse anesthetists and anesthesiologists and military and non-military?
2. What are sources of variability in anesthesia provider use of the ASA PS classification?

Conceptual Framework

The theoretical framework utilized in this study is based on the theory of reliability of health measurement instruments. Health status (or physical status) is a broad concept, complicated by many complex and abstract issues. No single variable can describe health status. Instead, its measurement depends on considering a number of variables, each representing an element of overall health. Health status cannot be measured directly – only inferences can be made about it from fallible indicators. Health measurements must be based on a specific conceptual approach. The conceptual definition of an instrument justifies its content and relates it to a broader body of theory, suggesting how the results may be interpreted in light of the theory (McDowell & Newell, 1996 ; Ware, Brook, Davies, & Lohr, 1981).

> The term 'theory' is often used to refer to a number of other types of formulations, usually abstract, including (1) vague conceptualizations or descriptions of events or things, (2) prescriptions about what are desirable social behaviors or arrangements, or (3) any untested hypothesis or idea...When theory is used to refer to an untested hypothesis or idea, it is a theory, until it is supported by empirical data, whereupon it becomes 'fact' or 'reality'(Reynolds, 1971, p.11).

The degree of acceptance of an idea as a theory with incorporation into the knowledge of a profession increases as individuals in the profession become more confident that the idea is useful to the goals of the profession and as the number of individuals considering the idea useful increases. The theory of reliability and validity has been well established in the literature and is accepted and utilized in many health care professions, including nursing.

The ASA PS classification is a subjective measurement of patient preoperative physical status. Subjective judgement is used in the health sciences because there are few objective, physical ways to measure the phenomena with which health science is concerned. Most techniques used to develop subjective measurements of health are derived from psychometrics. Psychometrics is a field of inquiry in which investigators explore the way people perceive and make judgements about physical phenomena, such as the length of a line or assignment of an ASA PS class to a patient (McDowell & Newell, 1996).

Personal biases have an impact on the subjective judgements made in health measurement instruments. Biases refer to the responses that depart systematically from the true values. "Subjective ratings of health blend an estimate of the severity of the health problem with a personal tendency to exaggerate or conceal the problem – a bias that varies among people and over time. …Such uncertainty has lead to skepticism about the accuracy of subjective health measurements" (McDowell & Newell, 1996, p. 25).

An important issue to consider when choosing a health measurement instrument is the relationship of the instrument to the phenomenon to be measured. Reliability is concerned with how consistently the instrument measures the phenomenon. Validity is the extent to which an instrument measures what it is intended to measure. The concern is how one knows if an instrument is reliably measuring what it is designed to measure. "It is important to note that even if an instrument is reliable there is no guarantee that it will produce a valid measure of the variable" (Abdellah, Levine, & Levine, 1979, p. 152). A practical example of this is a thermometer, which is off by two degrees, yet reliably measures temperature, providing the same result each time it is measured. However, the measurement is not a reflection of the actual temperature and is not a valid measurement because it is always off by two degrees.

The Theory of Reliability.

Reliability is concerned with error in measurement or the consistency of the measurement process across observers, patients, and time. Unreliability is seen as discrepancies that would arise if a measurement were made many times. The value of any measurement is a combination of two components: an underlying true score and some degree of error. Errors are described as random or systematic. Random error results from inattention, tiredness, or mechanical inadequacy, leading to an under or over estimate of the true value. Systematic error results from biases. Reliability refers to the extent to which a score is free from random error (McDowell & Newell, 1996). A measure is reliable only if it is consistently reproducible. The reliability of measures can be controlled if the sources of error are known (Abdellah, Levine, & Levine, 1979).

There are many types of reliability. Inter-rater reliability, which is of particular interest to this study, refers to whether different raters assessing the same scenario obtain the same result. Intra-rater reliability refers to whether the same result is obtained by the rater when making a second assessment of the same scenario (repeatability). Repeatability is essential to the reliability of an instrument (McDowell & Newell, 1996). Test-retest reliability is used to test the consistency of repeated measurements separated by time (Task Force for Standards of Measurement in Physical Therapy, 1991). Test-retest is used for variables whose measurements for a given individual or scenario remain stable over time (Abdellah, Levine, & Levine, 1979). In this study, as in the previous studies, inter-rater reliability of the ASA PS classification was assessed.

An additional form of reliability of interest to this study is interpretive reliability. This is an assessment of the extent to which each participant assigns the same category to a given scenario. "Category-by-category measures of reliability include the assumption that some categories are more difficult to use than others, and thus, have a lower reliability" (Burns & Grove, 1993, p. 341). Using this method, the researcher would analyze statistically the reliability category-by-category, determining the equality of distribution across categories, and examine the possibility that participants may be confusing some of the categories. Lack of interpretive reliability might account for the discrepancies found in previous studies, especially between anesthesiologists assigning ASA PS classes II and III to patients.

According to the theory of reliability, factors exist related to instruments that can lead to decreased reliability. The terms of the scale may be so general that any one of a number of specific criteria could be implied. The tool may refer to vague or poorly defined concepts, which may be viewed differently by the rater according to the context, permitting more than one possible rating for a given scenario. The scale may utilize vague judgements (mild or severe systemic disease) instead of explicit choices. In this situation, the score may actually be a reflection of the rater's opinion rather than the condition of the patient. Personal differences, both within a given rater over time and between raters can be expected to detract from the reliability of an instrument. All of these factors can potentially affect instrument reliability (Wittenborn, 1972).

The Theory of Validity.

When discussing the reliability of an instrument, one must also consider the validity, as the two theories are closely related. Validity describes the range of interpretations that can be placed on a measurement instrument. This helps answer the questions: what do the results mean and what can be concluded from the results? (Ahlban & Novell, 1984; McDowell & Newell, 1996). Validity is often described as three primary types (content, predictive, and construct) with many subtypes (face, concurrent, criteria-based, discriminal, prescriptive, etc.). These multiple types of validity can be confusing because they are interrelated. Because of this confusion, validity is often considered as a single, broad method of instrument evaluation referred to as construct validity (Burns & Grove, 1993). Two subtypes of validity of particular interest to this study are face validity and conceptual validity.

Face validity, also referred to as clinical credibility, can be said to exist for the ASA classification. Face validity is just what it says – on the face of the instrument. This type of validity is inferred from experts who review the instrument for clarity and completeness. The fact the ASA scale has been used so widely without significant revision for so many years, appears to support this form of validation. While this type of validity is desirable, it is not by itself sufficient. In order to generalize the data generated from instruments to other populations, the concepts which guided the instrument's development must be approved by the experts and clearly described. This is conceptual validity (Wittenborn, 1972). There is no apparent evidence of this validity for the ASA classification in the literature.

When the ASA PS classification was developed in 1941, no instrument existed to measure preoperative physical status. In this situation, construct validation could be utilized to assess validity because no instrument existed to which the proposed instrument could be measured against. Construct validation compares the results of several contrasting tests of validity with predictions from a theoretical model. This is similar to assembling evidence to support or refute a scientific theory and describing under what circumstances is holds true (McDowell & Newell, 1996). "When scale development is judged to be satisfactory, studies must be performed to evaluate the validity of the scale" (Burns & Grove, 1993, p. 383). "When an investigator selects an instrument, he must be familiar with…the kind of criteria that were used in establishing its validity…" (Wittenborn, 1972, p. 86). There is no evidence in the literature of construct validation of the ASA PS classification.

Validity, as well as reliability, is a matter of degree. No tool is completely valid. The degree of validity is determined rather than whether or not it exists. As measurements of the phenomenon improve, the validity of those measurements improve. Validity of an instrument can vary from sample to sample and from one situation to another, so validity should be reported for each utilization of the instrument. Validity testing supports the use of an instrument for a specific group or purpose, rather than the actual tool itself. Therefore, the validity of an instrument must be reexamined for each situation (Burns & Grove, 1993). The ideal instrument would have face validity in the sense that it looks right to the experts, conceptual validity in the sense that it is developed from generally accepted concepts, and finally, it would correlate with external criteria which have established validity (Wittenborn, 1972).

Kerber, Lawerence, and Dhanda (1993) condcuted a Medline search of the literature (1966 to 1992) in an attempt to assess the ASA PS classifications validity and reliability in predicting surgical mortality. They concluded from their review of the literature that the ASA PS classification's validity and reliability has not been adequately assessed and that because it is a "global nonspecific measure of co-morbidity" it should be compared to other co-morbidity instruments currently used to assess operative risk.

Guidelines for Measurement Development.

Decisions affecting the welfare of patients and the use of public funds are commonly based on results from health measurement tools. Guidelines have been developed by some medical disciplines in an effort to ensure instrument validity and reliability. These guidelines address three common problem areas in health measurement instruments: 1) inadequate testing and evaluation of the instrument, 2) lack of a detailed description of the instrument, and 3) lack of leadership in ensuring the continued development and promotion of the instrument (this may include responding to criticism and modification of the tool). McDowell and Newell (1996) suggest those developing instruments ascribe to a set of guidelines (see Table 1).

Table 1.

Guidelines for Developing Health Measurement Tools

1) Provide a full description of the method.
2) Make the instrument readily available.
3) Provide the rational and concepts for the design of the instrument.
4) Provide clear instructions to ensure the standard administration and scoring of the instrument.
5) Examine the internal structure of the tool by testing validity and reliability.
6) Encourage head to head comparisons of scales, providing the users with information needed to make choices.
7) The method should be tested by someone other than the authors (indicates widespread use and that it can be used successfully by others).
8) The most successful tools are those that the authors take long-term responsibility for, promoting further refinement of the method.

Documentation has become increasingly important to those who control the reimbursement of health care, and data measurement instruments are playing an increasingly important role in determining who gets paid for doing what to whom. Documentation with accurate instruments may be the only way to ensure that services will be available to the people who need them (Task Force on Standards for Measurement in Physical Therapy, 1991). Ensuring the validity and reliability of measurement instruments used in health care is imperative to promote accurate use of the data generated by these instruments.

Definitions

1. *ASA PS class* refers to the class (I through V and E) of the ASA PS classification that is assigned to an individual patient by a particular nurse anesthetist or anesthesiologist based on the current ASA PS classification guidelines (Appendix B).
2. *Providers* are either anesthesiologists or nurse anesthetists who administer anesthesia.
3. *Anesthesiologist* is a physician who has completed an anesthesia residency.
4. *Nurse Anesthetist* is a registered nurse who has completed a postgraduate nurse anesthesia program and is a certified registered nurse anesthetist (CRNA).
5. *Military* refers to those anesthesia providers employed by the federal government as a uniformed officer in the armed forces who is active duty.
6. *Non-military* refers to those anesthesia providers who are not employed by the federal government and are not active duty in the armed forces.
7. *Variability* refers to the discrepancy between individual responses to identical case information.
8. *Source(s) of variability* refers to those items presumed to be identified in this study that lead to the variability associated with anesthesia provider use of the ASA PS classification.

Assumptions

1. All nurse anesthetists and anesthesiologists are educated in the use of the ASA PS classification.
2. All nurse anesthetists and anesthesiologists use the ASA PS classification in their daily provision of anesthetics.

Limitations

1. This study is not a complete test of reliability: only inter-rater reliability was tested.
2. This was a paper and pencil survey and providers were not be able to ask further questions about the patient or examine the patient.
3. The sample size of this study is a relatively small in comparison to earlier studies in this area of anesthesia.

Summary

The ASA PS classification system is used world-wide. Data generated from this health measurement instrument is used in many ways including: performance evaluations, resource allocation, development of institutional policies, insurance reimbursement, as well as criteria in anesthesia research. Because of these, and potential future uses for data generated from utilization of the ASA PS scale, there is a need for this instrument to be reliable and valid.

Inconsistencies between anesthesiologists in assigning ASA PS scores has been demonstrated in the literature (Owens et al., 1978; Haynes & Lawler, 1995; Ranta et al., 1997). However, sources of this variability have not been identified. Because the ASA PS score of each patient contributes to a variety of health care issues, determining the reliability of the ASA PS classification as well as identifying potential sources of variability is imperative. By demonstrating sources of variability, the ASA PS classification could be refined to improve its accuracy.

CHAPTER II: LITERATURE REVIEW

Introduction

The following is a review of literature based on the information available about the American ASA PS classification. This instrument has been used worldwide for more than 50 years to indicate general physical health status, independent of the planned surgery. It has become a part of routine assessment of patients prior to surgery, and has been widely adopted because of simplicity and ease of use (Haynes & Lawler, 1995).

> A major reason for its success is that physical status is the only expression of the overall preoperative condition of a patient that has been consistently recorded before operation for a large number of patients. No one predictor, other than age, sex, and disease, is routinely available before an operation (Keats, 1978, p. 234).

Many investigators have utilized the ASA PS classification in statistical analysis (Dripps, Lamont, & Eckenhoff, 1961; Marx, Mateo, & Orkin 1973; Owens, Dykes, Gilbert, McPeek, & Ettling, 1975). Virtually all clinical research related to anesthesia for humans includes the ASA PS status of the patients being studied.

Historical Review of ASA PS Classification

In 1940, the American Society of Anesthetists, the predecessor of the ASA, formed a committee to devise a system for the "collection and tabulation of statistical data in anesthesia" (Saklad, 1941, p.281). Doctors Saklad, Rovenstine, and Talyor were the members of this committee, devising the original ASA PS classification. In the May 1941 issue of Anesthesiology, Saklad described the original classification, whose essential elements are identical to the classification in use today (Goldstein & Keats, 1970).

The scale was originally developed to standardize physical status categories for statistical studies and make uniform interpretation of hospital records possible. It was designed as a simple way to describe the patient's preoperative physical status in a reliable, reproducible manner. It was not intended to measure the specific anesthetic or surgical risk, but to improve communication by providing common terminology as well as to facilitate the collection of data for statistical analysis of patient outcomes (Haynes & Lawler, 1995). Despite the intent of its creators, the ASA PS classification has become widely utilized as an index of surgical risk.

The classification's original design included standard terms and definitions in an effort to create a common language and understanding regarding patient's preoperative physical status. Prior to its development, patients were assessed according to their ability to withstand surgery in an attempt to estimate "operative risk" (Saklad, 1941, p.281). This was a term used, not a health measurement instrument, and was deemed unsuitable because it was altered by several variables (patient condition, planned surgical procedure, experience and skill of surgeon and anesthetist, and attention to postoperative care) and was not considered a true indication of preoperative physical status. Operative risk was seen as valuable for prognosis but useless for statistical analysis.

The ASA committee felt it would be best to classify and grade patients in relation to physical status only, which would aid in the collection of statistics. They believed that fewer variables would result in clear, common definitions of the terms that would be used in such a classification. It was hoped that by employing the ASA PS classification, relationships could be identified between results, operative procedures, and the patient's operative condition (Saklad, 1941).

The different classes in the ASA PS scale were carefully defined by the committee and published by the ASA in 1941 (Appendix A). The committee proposed six categories. Five to ten example patient scenarios for each class were included in an attempt to encourage uniformity between providers. A seventh category for the moribund patient expected to die in 24 hours with or without surgery was added after publication (Owens et al., 1978). The classification was updated in 1961 after Dripps et al. proposed the elimination of classes six and seven by simply placing an E identifier in front of the other five classes to designate emergent cases. They also removed the examples provided for each class (Appendix B). These revisions, which were editorial and not conceptual, were adapted by the ASA House of Delegates in 1962 (Keats, 1978) and published in the ASA journal (ASA, 1963). This is the form of the classification in worldwide use today.

Some have criticized the removal of the patient examples from the original description of the classification. In a national conference held in Great Britain, an attempt was made to once again provide example patients for each class to aid in uniformity (Haynes & Lawler, 1995). Examples with a lengthy description of the classes are often provided in textbooks (Guarnieri & Prevoznik, 1992; Nagelhout & Zaglaniczny, 1997; and Stoelting & Miller, 1994). However, not everyone reads each text and, more importantly, not all of the examples in the texts correlate with one another (Appendix C). In addition, internet educational sources (http://www.bconnex.net/-juscah/asaclass.html -14 Nov 97 & http://www.med.virginia.edu/som-cl/anesth/education/risk.htm – 14 Nov 97) describe the ASA PS classes by providing examples, which like the texts, do not correlate with examples provided by other educators.

Clinical Studies of the ASA PS Classification

Owens et al. (1978).

The ASA PS classification was used without investigation until 1978, when it was first studied by Owens et al. They questioned if the majority of anesthesiologists would place patients in the same classes, and if not, would the use of the scale vary with identifiable factors. The participants included 235 board certified anesthesiologists practicing in the United States. They were asked to assign an ASA PS score to 10 hypothetical patients. Scenarios were designed with specific categories in mind according to the published classification rules. Demographic data about the provider's practice, years since residency training, and current use of the ASA PS scale was collected.

A wide variation in assignment of ASA PS scores between anesthesiologists was demonstrated in this study. However, the majority of participants classified the patients in similar categories to those expected by the authors. They found no significant difference between regions of the country. There was significant difference between providers from private practice and those from teaching institutions, with the latter found to be more consistent in their ratings. Those working in areas with increased medical liability did not rate patients higher, suggesting that increased costs did not influence the providers judgement. Four problem scenarios were identified with the most varied response in classification. The authors viewed these as the most important to consider as they exemplified the inherent problems with the current ASA PS classification. The differences of opinion were mainly in assigning a classification of II (moderate disease) and III (severe disease) to patients (Owens et al., 1978).

In 1978, Owens et al. proposed four characteristics that may have led to the wide variation in assigning ASA PS scores in their study: age, anemia, history of myocardial infarction, and obesity. They also suggested that if additional patient scenarios were provided, it is likely other areas of uncertainty would be identified. The issue is the difference between classes that significantly alters the provider's perception of patient health status.

The most significant finding of this study was the lack of uniformity in assigning patients to an ASA PS class. Twenty five percent of the respondents had not read a definition of the physical status classification in more than two years. Owens and associates called the ASA PS scale a workable classification that suffers from a lack of scientific precision (Owens et al., 1978). In 1979, the same authors stated

> In this era of computerization and refined statistical analysis, there is little reason not to revise the ASA PS classification. This revision should include more precise definitions of each classification. The old system has served us well and is a compliment to those who devised it years ago. Now is the time to refine (p. 181).

This variability was identified in 1978 with a call for revision of the ASA PS classification in 1979. Nineteen years later, this revision has yet to be accomplished.

Haynes and Lawler (1995).

The ASA PS classification was not studied again until 1995 by Haynes and Lawler. This study was inspired by the increasing accessibility of hospital performance data and the potential uses for that data. The authors expressed concern about the accuracy of the ASA PS data available on patient charts. In Great Britain, health care purchasers were using this data to audit and justify allocation of resources and quantify clinical performance. There was concern that inconsistency could lead to a false impression of hospital and provider performance.

This study was conducted in a similar fashion to the study done by Owens et al. in 1978. Questionnaires were randomly sent to 113 anesthesiologists working in a specific region of Great Britain. Ten hypothetical patients were presented, incorporating the "E" suffix, for the anesthesiologists to assign ASA PS classification scores to. In order to mimic real life, the researchers did not provide the participants with definitions of the ASA PS categories. They later stated it would have been helpful to know if the anesthesiologists regularly used the classification (Haynes & Lawler, 1995).

Like Owens et al. (1978), Haynes and Lawler (1995) concluded that the ASA PS classification was used inconsistently and lacked scientific precision. In none of the cases was there complete agreement as to which class the patient should be placed and with only one patient were the responses restricted to two of the five possible classes. The remaining patients were placed in at least three different categories by the anesthesiologists. In each case, there was a majority viewpoint, but always a minority who disagreed and in some cases by a wide variation. This study clearly demonstrates a lack of consistency in use of the ASA PS classification between anesthesiologists. Dixon (1995), commenting on the study by Haynes and Lawler (1995), stated a number of anesthetists do not allow for the effect of acute physiological and pathological processes on a previously healthy patient when ranking the ASA PS class. Consistency and accuracy in assigning patients to an ASA PS class may be improved if more attention is given to these acute processes at the time of anesthesia.

Haynes and Lawler (1995) concluded that with so much variation between assessments by providers when describing common clinical problems, the ASA PS score alone cannot be considered to adequately describe the physical status of a patient and should not be relied upon as the sole indicator of preoperative physical status. Yet despite this assertion, the ASA PS classification continues to be frequently used to describe the perceived surgical risk of individual patients. Haynes and Lawler suggest a multifactorial index, such as the Cardiac Risk Index (CRI), should be developed. Such an instrument would consider both the category of the surgery and the nature of a wide range of disorders. This would likely provide a more accurate assessment of preoperative risk. However, the authors recognized that such an index would be very complex and probably would not be used as widely as the ASA PS classification. One of the major advantages of the ASA PS score is its simplicity, which is also a weakness.

Ranta, Hynynen, and Tammisto (1997).

In 1997, a study was published by Ranta, Hynynen, and Tammisto looking once again at the ASA PS classification. They hypothesized that a small, culturally homogenous country such as Finland would have less variation in the assignment of ASA PS classes than large heterogenous countries such as the United States and Great Britain. The authors randomly selected 249 Finnish anesthesiologists to participate in the ASA PS scoring of the same 10 cases used by Haynes and Lawler in 1995. In addition, they researched participants attitudes about the use of the scale, compared residents to practicing physicians, and teaching to non-teaching facilities.

Similar to the earlier studies by Owens et al. (1978) and Haynes and Lawler (1995), Ranta et al. (1997) found wide variation between cases despite the similar ethnic and cultural backgrounds of the participants. They found no difference between residents and physicians in assigning ASA PS scores. Anesthesiologists from teaching hospitals consistently assigned higher ASA PS scores to patients than those from non-teaching hospitals. In their assessment of the attitudes toward the utilization of the scale, 87.7% regarded it as helpful in daily work, and 93.5% said they try to mark it on all their charts. Ranta and fellow researchers remind the reader that, although recent studies have correlated anesthetic morbidity and mortality with the ASA PS classification, it was never meant as a risk predictor and should not be used for treatment decisions (Ranta et al., 1997).

Ranta et al. (1997) recognized the need for a universal score, such as the ASA PS classification, but cautioned that the significant variation be kept in mind when using the scores for scientific and statistical purposes. It was suggested that consideration be given to discovering ways to decrease the variation inherent in the ASA PS classification. They suggested using a multi-parametric score like those used in the intensive care setting (Acute Physiology and Chronic Health Evaluation II or Multiple Organ Dysfunction Score) as a replacement for the ASA PS classification. These instruments, although cumbersome and complex, might be made feasible in the near future with computerized anesthetic records and hospital networks linking laboratory and other data.

Prause, et al. (1997).

In 1997, Prause, et al. studied the correlation between preoperative mortality for elective surgery and use of the ASA PS classification in combination with the Cardiac Risk Index (CRI). It was recognized that the ASA PS classification is not defined as a risk predictor but is often advocated as such, and therefore, Prause et al. set out to study it in that regard. The CRI is used to predict cardiac surgery complications and was developed because most postoperative deaths are due to cardiac complications (Goldman, et al., 1977).

In this study, combined ASA PS and CRI scores revealing a high correlation with mortality, suggesting both indices are good predictors of postoperative death. However, the best predictor of survival was ASA PS class II. CRI alone did not predict peri-operative mortality as well as ASA PS scores. Prause et al. (1997) postulated that assignment of patients to higher risk classes may lead to increased vigilance and better intra-opertative monitoring and post-operative care. Increasing the predictive power by applying combined ASA PS and CRI scores would enable anesthetists to provide the patient with more accurate information about their risk of death according to their physical status (ASA), age, type of surgery, and preexisting cardiac disease (CRI).

Additional Studies.

In 1982, Schwam, Gold, and Craythorne expanded on the study done by Owens et al. (1978) using the same 10 case scenarios. They noted that in the Owens study, the greatest controversy was between classes III and IV. They proposed that class III be broke down into IIIa (well compensated severe disease which is not incapacitating) and IIIb (decompensated disease with greatly limited activity). Fifty residents were given a survey with these 10 case scenarios and asked to assign ASA PS scores using both the original ASA PS classification and the modified version. The results of this study demonstrated similar results to the Owens study with use of the current ASA PS classification and an improved consistency using the modified system.

Harling (1995) also studied the ASA PS classification, providing participants with a printed table of the classification in an effort to assess interpretation of the scale rather than knowledge. Results revealed poor consistency in grading despite all the participants having the same information. The areas of inconsistency noted were systemic disease, obesity, age, acute illness, and extent of the surgery. It was suggested that these areas, as well as some of the terminology of the classification (mild, moderate, incapacitating, constant threat to life) be clarified and more clearly addressed.

Alternative Measurement Tools

A number of risk indices, in addition to the ASA PS classification, have been suggested for evaluating preoperative risk factors: Cardiac Risk Index (CRI), New York Heart Association (NYHA) index, and the Canadian Cardiovascular Society classification (CCSC) of Angina, to name a few (Kaplan, 1987). The accuracy of each is controversial. All of these indices have proven to be better predictors of mortality in specific cases, however, they are limited in scope when compared to the global index of the ASA PS classification. It is conceivable, with the technology of today, that a multi-factorial index of anesthetic risk could be developed. Variables in addition to the patient physical status (experience of the surgeon, anesthetist, and hospital personnel) could be entered into a computer program which would generate risk information. This could provide an estimate of risk of not only death and complications, but also extended hospitalizations.

The ASA PS classification is simple and provides the only currently useful predictor of overall surgical mortality (Keats, 1978). Any method of predicting the perioperative or postoperative course of patients before surgery should be applicable to a large number of patients, easy, reproducible and inexpensive. Although methods other than the ASA PS classification have been investigated (Derrington & Smith, 1987), the

ASA PS scale continues to prevail as the standard.

The following classifications are employed in special patient situations. Although, they don't apply to all patients, general principles addressed by each classification may aid in analyzing the ASA PS classification.

Cardiac Risk Index (CRI).

Perioperative cardiac arrest is more frequent in higher ASA PS classifications (III and IV) – particularly if emergent surgery is required (Stoelting & Miller, 1994). This is supported by a study done in 1985 by Keenan and Boyan, looking at perioperative cardiac arrests in one hospital over a 15-year period. They found 27 cardiac arrests among the 163,240 anesthetics given. Of these, seven cardiac arrests were classified as ASA I or II, and of the seven 2 (29%) died. In the same study, 20 patients were classified as ASA III or IV, with 12 (60%) who subsequently died. In 1978, Goldman, et al. asserted 32% of postoperative deaths are cardiac in origin.

The prediction of cardiac risk from surgery and anesthesia is important in allocating resources, evaluating risk benefit ratios, and anesthetic monitoring and management (Jeffery, Kunsman, Cullen, & Brewster 1983; Mangano, 1990). A cardiac index would be helpful if it were generally applicable and consistently accurate (Kaplan, 1987). The approach taken to evaluate cardiovascular status, though directed at cardiac problems, could provide guidelines and a model for other areas of preoperative assessment and preparation (Ascah, 1997).

In 1977, Goldman et al. set out to determine which preoperative factors might affect the development of cardiac complications for major non-cardiac surgery. By prospectively evaluating 1001 patients undergoing general anesthesia, they found nine independent variables that correlated with life-threatening or fatal cardiac complications, which if alleviated would decrease the overall risk for cardiac complications. Detsky et al. (1986b) proposed modifications to CRI to make it a more accurate predictor for different surgeries and procedures and for different patient populations. They expanded the list of nine variables and defined them more precisely.

The CRI (Appendix D & E) score is computed objectively, placing the patient into one of four risk categories. It is the most commonly referred to criteria by medical consultants, making a general understanding of it essential for the anesthesia provider (Howard, 1997). The ASA PS classification and CRI are the most frequently used and studied scales (Prause et al., 1997). CRI is more specific and objective, relying primarily on cardiovascular tests, laboratory results and history. Gerson et al., (1990) combined ASA and CRI scores, finding no difference between the two indices. The ASA PS score alone was remarkably similar to the combination score, suggesting high sensitivity but limited specificity.

Goldman et al. (1977) described the ASA PS classification as the best overall predictor of non-cardiac death and a fair predictor of cardiac death related to surgery. According to Vancanti, VanHouten, and Hill (1970) the ASA PS classification is an excellent predictor of perioperative non-cardiac complications but not of perioperative cardiac problems. With these factors in mind, Goldman et al. (1978) suggested that because the ASA PS classes are poorly defined and subjective, they could not match the CRI, which is objective and more accurate in predicting cardiac risk in high-risk patients.

Goldman et al. (1977) suggested predictive risk indices be tailored to each operation and institution in order to limit differences. This was the first multi-factorial approach to quantify the risk of cardiac events perioperatively. It was hypothesized and later validated by many researchers that this index correlated with perioperative mortality and would allow for the preoperative estimation of cardiac risk independent of surgical risk (Goldman, 1983; Mangano, 1990; Pedersen et al., 1986; Ross & Tinker, 1994; Schneider, 1983; Waters et al., 1981; White et al., 1988).

The CRI has not survived without controversy. Waters et al., (1981) studied CRI and found it to have similar predictive capabilities as the ASA PS classification but not superior to it. Jeffery et al. (1983) studied the use of CRI in patient's having a specific surgery (aortic abdominal aneurysm repair) and found it was not helpful in its present form with this particular type of surgery. Mortality rates existed that were higher than was predicted by the CRI. Similarly, Zeldin (1984) recorded patients as high risk using the CRI, predicting only half of the expected events. Detsky et al. (1986a) stated CRI had poor correlation with perioperative complications. Gerson et al. (1990) concluded that the CRI score did not add additional information beyond that provided by the ASA PS classification. Finally, Kroenke (1987) suggested the CRI not be relied upon as a sole criteria for evaluating a patients cardiac status because the outcomes predicted are life threatening or death. Most patients will develop less severe cardiac problems (angina) than are predicted by the CRI.

Acute Physiology and Chronic Health Evaluation II (APACHE II).

APACHE II is used to provide a general measure of the severity of disease in intensive care units. It is based on 12 routine physiological measurements, age, and previous health status. This scale is designed to stratify the acutely ill and assists researchers in comparing new therapies. High APACHE II scores have been shown to correlate with mortality. It requires a very precise description of the disease and is a fairly complex tool. Although it is only an estimate of disease state, clinical decisions are based on the score (Knaus, Draper, Wagner, & Zimmerman 1985). Wolters, Wolf, Stutzer, and Schroder (1996) declared this instrument, although internationally known and utilized, not applicable to all patients undergoing anesthesia. It does, however, serve as a guide to a multi-factorial index, which is being explored to assess anesthetic risk.

Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM).

This tool was developed to aid surgical audits and is based on a point score derived from 12 physiological and six operative factors. Because it was designed for retrospective assistance with audits, the method does not give the full score and numerical risk of mortality and morbidity until the outcome is known (Wolters et al., 1996). Copeland & Walter (1991) studied it and found it to provide an indication of the risk of mortality and morbidity in the general surgical patient. These researchers are currently studying a comparison of POSSUM with other assessment systems to determine if it might be useful in the preoperative assessment of patients.

Risk Visual Analogue Scale (RISK-VAS).

In 1996, Arvidsson, Ouchterlony, Sjostedt, and Svardsudd described RISK-VAS as a way to incorporate the providers subjective beliefs based on all factors contributing to risk, making it a global assessment associated with the planned surgery. These researchers tested this scale using ASA PS class, age, and procedure factors as references. They found that all four classifications correlated with the occurrence of postoperative adverse events. The ASA PS classification appeared to be a better predictor of severe adverse events than of milder events (classes III, IV or V identified 68% of the events). RISK-VAS was the most successful at predicting severe outcomes. The researchers concluded that all four systems performed fairly equally and that none were ideal for counseling the patient. The RISK-VAS demonstrated only modest sensitivity and specificity and too low of a predictive value. It was suggested that the ASA PS classification, age, procedure factors, and the RISK-VAS would be better applied to populations for use in practice issues (production surveillance, quality assessment, and resource allocation), rather than individual patient risk assessment.

Graded Anesthesia Score (GAS).

Lake and Williams (1997) in their search for a method to determine anesthetic risk, expressed the need for an improved scoring system which would include both physical status and operative risk while remaining reproducible and simple. In a recent pilot study, the GAS scale, which combines a slightly modified version of the ASA PS classification with indications of relative anesthetic risk was studied (Appendix F). Lake and Williams described anesthetic risk as multi-factorial, thus attempts to incorporate it into a physical status score such as the ASA PS classification, create difficulties and inconsistencies, particularly with trauma or severe acute illnesses (sepsis). Lake and Williams suggest grading anesthetic risk separately, concentrating on chronic health concerns. In the GAS scale, a small modification was made to the ASA PS classification by adding a class between II (mild systemic disease) and III (severe systemic disease) for moderate systemic disease, which frequently presents.

According to Lake and Williams (1997), the GAS provides a double-digit score with improved risk assessment. Additional risk factors identified include: acute exacerbation of chronic disease, the condition requiring the surgery, proposed surgery and it's urgency, trauma, physiological disturbances, and anesthesia influencing conditions (upper respiratory infection, pseudocholinesterase abnormalities, aspiration risk, etc…). The simplicity and ease of use of GAS scale was confirmed in a pilot study and is soon to be analyzed in a larger, national study.

Risk Factors.

Robinson (1979) suggested simply using a written summary of risk factors, concerns and the anesthetic plan in place of the ASA PS classification. He claimed this is more accurate and targets all health care professionals (nurse anesthetists and anesthesiologists, nurses, surgeons, administrative, and legal). "I feel this would be better than obscuring the (risk) assessment with a numerical code which, though devised to communicate within our specialty, often to the exclusion of other health professionals, confuses even anesthesiologists who use it regularly" (p. 180).

Goldstein and Keats (1970) identified risk factors specific to anesthesia: physical status, extremes of age and being male. They suggested that with a sufficient number of risk factors identified, the mortality of individual patients could be predicted with greater precision than is currently possible. "If risk factors for anesthesia mortality could be identified and their sensitivity tested, it would seem possible to weight and combine them to provide an index which would be meaningful for predictions of outcomes in individual patients" (p. 140).

ASA PS Classification as a Risk Assessment Tool?

Many providers are unable to separate anesthetic risk from physical status and refer to the ASA PS scale as a risk classification (Owens et al., 1978). "Trough use during more than three decades, this vague and subjective classification independently developed into an excellent expression of 'operative risk', exactly which was not intended" (Keats, 1978, p. 234). Saklad (1941) anticipated this confusion, stating "It may be difficult, at first, for the anesthetist to classify patients with reference to their physical status alone. Subconsciously he is apt to allow his knowledge of the contemplated surgical procedure to influence him in his grading of patients. With care, diligence and attention to detail, he very soon will limit himself to the consideration of the patient's condition in his classification"(p. 284).

Determination of risk is important because the indication for surgery itself is formulated on the basis of a risk-benefit ratio (Waugama, Foster, & Rigor, 1992). "Quality perioperative care mandates accurate preoperative risk assessment to predict complications and facilitate clinical decision making" (Kerber, Lawrence, & Dhanda, 1993, p. 520). Risk of any surgery is determined not only by patient related factors (physical status, age, adequacy of preoperative preparation, nature and duration of the illness, nutritional status, and other concurrent illnesses), but also by risk inherent to the specific surgery. Surgical risks include experience of the surgical team, the medical institution, elective versus emergent, availability of advanced monitoring and critical care nursing, and to a degree the choice of anesthetics and techniques (Goldstein & Keats, 1970; Traber, 1997). A way to look objectively at the impact of these factors is lacking, leaving the assessment of anesthetic and surgical risk largely to intuition (Feigal & Blaisdell, 1979). To further complicate the issue of risk, it is very difficult to dissect out anesthetic related death from death due to surgical or combined problems (http://www.med.virginia.edu/som-cl/anesth/education/risk2.htm – 14 Nov 97).

There is a recognized need to know the risks of anesthesia apart from the risk of surgery. Knowledge of risk applied to groups would serve as a monitor of the practice of anesthesia while the risk applied to individuals would provide important statistical information needed by providers and their patients to make decisions (Goldstein & Keats, 1970; Klotz, Platz, Horvath, Dindo, Schlumpf, & Largiader, 1996). Kronlund and Phillips (1985) demonstrated that the initial counseling of patients regarding their risk of surgery by surgeons was greatly underestimated (surgeons underestimated the risk in 57% of patients by at least 100 fold). It has been suggested if the physician, institution, and other perioperative variables are known, the experienced anesthesia provider can predict the outcome (Brown, 1992). Institutional differences, largely attributable to age distribution of patients and frequency of high-risk surgeries, have been shown to affect postoperative mortality. According to Moses and Mosteller (1968), validity of subjective risk estimation is limited to the institution and the team.

Some have pointed out that the ASA PS classification does not consider special anesthetic hazards such as morbid obesity, malignant hyperthermia, difficult airway, or other inadvertent anesthesia problems that may develop during surgery (Goldstein & Keats, 1970; Keats, 1978). In addition, the ASA PS classification does not take into account age of the patient or complexity of the surgery. There is also no differentiation made between systemic disease leading to the surgery or incidental disease (Wolters et al., 1996). Finally, the ASA PS scale does not consider other factors such as human error or equipment failure which still accounts for a large number of adverse patient outcomes (Zambricki, 1992).

The subjective evaluation of risk allows for inclusion of real but unspoken risk factors such as skill, experience, and judgement of the treatment team including surgeons and anesthesia providers. "Any anesthesiologist who has experience in a particular field of surgery and who has accurate knowledge of the postoperative outcome can formulate a reasonable estimation of risk and train himself to improve its quantitative accuracy" (Urzua et al., 1981, p. 628). Many providers have a perception of risk but don't communicate or record it. To improve this intuitive assessment of anesthetic risk, more detailed information is needed on the risk from preoperative conditions associated with specific surgeries and how that risk varies with patient age, sex, and physical status. This information would aid the anesthesia provider and surgeon in deciding whether to operate or not (Fowkes, Lunn, Farrow, Robertson, & Samuel, 1982).

In 1986, Tiret and Hatton reported the rate of perioperative complications to be closely related to physical status (ASA class I = .4:1000, class IV & V = 9.6:1000), with emergency surgeries having even greater correlation (1:1000 in class I increasing to 26.5:1000 in class IV and V). In a recent study of death associated with anesthesia, the majority of deaths were found to occur in ASA PS class IV and V, with the main contributing factor to death being preoperative disease. Risk for anesthetic complications rises as preoperative condition deteriorates. If a patient classified as ASA I dies, there is reason to believe the anesthesia or surgery had something to do with it (Tikkanen & Hovi-Viander, 1995). An additional pilot study by Munoz-Ramon (1995) suggested a correlation between ASA PS scores and adverse events (ASA I = 20.1%, II = 27.8%, III = 46.9%, and IV/V = 74.2%). A common language of perioperative complications is needed to communicate anesthetic risks and outcomes. This would also improve communication between investigators (Brown, 1992).

Although it was not designed to classify individual risk, some clinical studies in the field of anesthesia suggest the ASA PS classification correlates with the morbidity and mortality attributable to anesthesia and surgery, suggesting it may be useful in predicting patient outcomes (Cohen & Duncan, 1988; Cullen, Nemeskal, Cooper, Zaslavsky, & Swyer 1992; Cullen, Giovanni, Greenfield, Guadagnoli, & Cleary, 1994; Derrington & Smith, 1987; Djokovic & Healey-Whyte, 1979; Dripps et al., 1961; Farrow, Fowkes, Lunn, Robertson, & Samuel, 1982; Feigal & Blaisdell, 1979; Forrest, Rehder, Cahalan, & Goldsmith, 1992; Hovi-Viander, 1980; Lee, Lum, O'Regan & Hillman, 1998; Marx et al., 1973; Menke et al., 1993; Munoz-Ramon, 1995; Pedersen et al. 1986; Schneider, 1983; Tikkamen & Hovi-Viander, 1995; Tiret, Hatton, Desmonts, & Vourc'h, 1988; Vacanti et al., 1970; Wolter et al., 1996;). One study even suggest that ASA PS classification may predict PACU complications (Hines et al., 1992).

Wolters et al. (1996) recognized the ASA PS classification as the most widely used patient risk assessment tool in anesthesia despite being developed for statistical data management. In their study, it was suggested that the risk of complications are influenced mainly by ASA PS class III and IV and that the ASA PS score is indeed a predictor of postoperative outcome. The ASA PS score also correlated with mortality rates; less than 1% of class II, 4% of class III, and 25% of class IV died. In addition, they found intraoperative and postoperative variables (blood loss, duration of postoperative ventilatory support, ICU admission, pulmonary and cardiac complications) correlated with the ASA PS score, increasing as the ASA PS score increased.

In 1986, Pedersen et al. studied the importance of individual risk factors in the development of life threatening perioperative complications. The following variables were identified in decreasing order of strength: ASA PS classification, CRI, abnormalities in chest films, electrocardiogram abnormalities, history of pulmonary disease, and emergency surgery. They also compared patients assigned to ASA PS class I through III with those assigned to classes IV and V. A 35 times increase in risk of mechanical ventilation (which is associated with increased mortality) and 19 times greater chance of dying was demonstrated in patients assigned to ASA PS class IV or V compared to those in classes I to III.

Some researchers place the physical status of patients and type of surgery among the most important factors contributing to operative mortality (Hovi-Viander, 1980). Tiret et al. (1988) describe the ASA PS score as the most significant factor in predicting the outcome of anesthesia, demonstrating that despite it's simplicity, the ASA PS classification is multivariate and "… intuitively integrates most of the information considered relevant by anaesthetists in the evaluation of operative risk" (p. 953). "ASA Classification is one of the most important factors used to assess the overall perioperative risk" (http://anesthesiology.mc.vanderbilt.edu/vpecguide/predictor.htm – 14 Nov 97). It is likely that deaths in healthy patients are attributed to anesthesia while deaths in sicker patients are attributed to the surgery or to the patients preexisting disease (Ross & Tinker, 1994).

A study by Menke et al. (1993) demonstrated a correlation between ASA PS classification and the following factors: postoperative complications (an increase of 10 fold from ASA PS class I to IV), length of stay in the Intensive Care Unit (.1 days in ASA I to 3.8 days in ASA IV), and mortality (none in class I to 7.2% in class IV). These researchers proposed that use of objective findings, subjective impressions, and final clinical judgement, enables the ASA PS classification to distinguish between the five grades of preoperative physical status. They went on to suggest the ASA PS classification, when utilized as a prospective evaluation of operative risk, could influence the type of anesthesia and to some extent the type of surgery.

A significant amount of research has resulted in data contrary to the above studies (Gagner, 1991; Goldman et al., 1977; Lewin, Lerner, Green, Del Guercio, & Siegel, 1971). Goldstein and Keats (1970) stated the ASA PS classification was not a sensitive predictor of anesthetic mortality because 41% of anesthetic related deaths occurred in patients assigned to ASA PS class II or III. They proposed precision is possible in predicting postoperative events for patient populations but not for individual patients. Arvidsson et al. (1996) agreed, suggesting that while the ASA PS classification has value due to its simplicity, it is too crude for individual patient risk assessment. Davies and Stunin (1984) said the ASA PS classification cannot assess anesthetic or surgical risk or postoperative outcome because the ASA PS class can be assigned without knowing the proposed surgery, age or weight of the patient.

Little (1995) conducted a study similar to the Haynes and Lawler study (1995). Results suggested the ASA PS classification may work well when applied to populations (grading tends to be smoothed out with large numbers of patients), however, it is unreliable when applied to individual patients. Fowkes et al. (1982) looked at a large number of surgeries (>100,000) retrospectively, concluding the numbers were still too small to analyze the risk of preoperative condition for specific surgeries. "Even when given lists of risk factors and associated mortality, it is usually impossible to calculate risk for a given patient, since the patient does not usually fit exactly the classification of the study" (Schneider, 1983, p. 1114). In 1971, Lewin, et al., demonstrated that the ASA

PS classification alone did not provide sufficient data on which to base a prediction of peri-operative mortality in high-risk patients (those who would fall into ASA PS class III and IV). In lower risk patients (those who would be classified as ASA II) no correlation between physical status and cardio-respiratory function was found. These findings question the use of the ASA PS classification as an indicator of anesthetic or surgical risk.

In stratifying risk, an organ systems approach would be more useful, enabling identification and management of specific problems (Kroenke, 1987). Waugaman et al. (1992) states the ASA PS classification is an objective system and is "...one of the most commonly used systems to estimate patient risk" (p. 146). However, subjective evaluation of anesthetic risk is not only based on the ASA PS classification, but also the experience of the anesthetist, patient history, physical exam, lab results, skill of the surgeon, and institutional characteristics. Despite these findings in the literature, the controversy surrounding use of the ASA PS classification as an assessment of anesthetic or surgical risk continues.

Problems with preoperative assessment of risk become more evident when considering young healthy patients with minor problems that have serious consequences for anesthesia, such as a family history of malignant hyperthermia. According to the ASA PS classification (which does not take into account risks specific to anesthesia), these patients would be classified as ASA PS class I, yet there is a high risk for a life threatening complication to occur with these patients during surgery (Healy & Cohen, 1995).

It is important to recognize that the ASA PS classification was not intended to represent an estimate of anesthetic risk but rather to serve as a common language among different institutions for subsequent examination of anesthetic morbidity and mortality (Stoelting & Miller, 1994). "Research has failed to produce clear evidence that patient classification systems are, in fact, predictive of patient outcome" (Zambricki, 1992, p. 189). Schwam and Gold (1982) remind colleagues that the ASA PS classification is only one facet of the concept of risk. Goldstein and Keats (1970) see the estimation of anesthesia risk for individual patients as almost entirely intuitive.

Summary

Since its inception in 1940, the ASA PS classification has been surrounded with controversy. It is seen by some as a direct indication of anesthetic or surgical risk and by others as only one piece of a multi-factorial puzzle of risks.

> Despite the many objective scoring systems devised to estimate patient risk, the Dripps system (ASA PS classification) has prevailed as the standard in anesthesia practice. Other systems such as CRI, may be employed in special situations. The ASA PS classification is entered on the patient's record before anesthesia, thereby providing a baseline for anesthesia planning and management decisions and as a later reference in guiding postoperative care (Zambricki, 1992, p. 189).

Perhaps more information can be gained from this score than was intended by its creators. While these issues are interesting, the issue of most concern is the inherent inconsistency between providers in assigning patients an ASA PS classification preoperatively.

Three studies have been conducted looking directly at the assignment of ASA PS classes to patients (Haynes & Lawler, 1995; Owens et al, 1978; Ranta et al., 1997). All three agree the classification is applied inconsistently between anesthesiologists. This not only has implications in patient care (development of the operative plan of care), but also in the collection of statistics, allocations of resources, assessment of the clinical performance, development of policies, and insurance reimbursement. In addition, ASA PS scores are reported in nearly all research related to human anesthesia, as well as research in allied health professions. It is for these reasons the ASA PS classification needs to be further evaluated and perhaps revised to provide a more accurate assessment of physical status. The risk assessment tools in use in other areas of medicine may provide direction and guidance to this revision.

CHAPTER III: METHODOLOGY

Research Design

This was a descriptive study of the application of the ASA PS classification to 10 hypothetical case scenarios. Demographic data about participants (nurse anesthetists and anesthesiologists), their assignment of an ASA PS score to 10 scenarios, and their rational for choosing each score were collected, tabulated and analyzed.

Sample Population

Nurse anesthetists and anesthesiologists at four hospitals in the Washington DC area and one hospital in a northern mid-western state participated in this study. The investigator personally attended departmental meetings, distributing and collecting the survey forms. The sample size for this study was determined by the method described by Kraemer and Thiemann (1987). To achieve 80% power using a two-tailed test and an alpha of 0.05, 83 subjects would be needed for an expected critical effect size of 0.30. After the collection of 70 surveys, statistical significance was demonstrated and the sample size was considered adequate. Of the 70 providers surveyed, 39 (56%) were CRNAs and 31 (44%) were anesthesiologists. Forty-one (59%) of the providers were military while 28 (41%) were non-military (one participant did not disclose their military status). Years practicing anesthesia ranged from 0.25 years to 30 years (mean 8.1, SD 6.97, mode 1).

Measurement

The tool used in this investigation (Appendix F) was adapted from a study conducted by Haynes and Lawler in 1995. Demographic data was collected to facilitate comparisons between different providers and facilities. Ten patient scenarios were presented, eight of which are similar to those employed by Haynes and Lawler. Two of the scenarios were altered to reflect two current health care issues (pregnancy and smoking).

The hypothetical scenarios were designed to address two specific issues related to anesthesia. First, consistency between anesthesia providers in their use of the ASA PS classificatioin. Second, whether anticipated anesthetic difficulties (difficult airway) would cause providers to alter the assigned ASA PS score. The scores assigned by the participants were recorded with a space provided for the participants to provide rational for the selected ASA PS scores. From the comments provided several sources of variability in use of the ASA PS classification were identified.

Protection of Human Rights

The anonymity and privacy of each participant and institution was protected as the questionnaires were not coded in any way preventing linking surveys to individuals or to their institution.

Data Analysis

The demographic data and responses to case scenarios with comments obtained from participants were summarized and tabulated. Frequency, distributions, means, and standard deviations were stratified according to nurse anesthetist/anesthesiologist and military/non-military anesthesia providers. Tabular data is presented in a similar manner of the Haynes and Lawler (1995) study (Appendix G).

CHAPTER IV: DATA ANALYSIS

Introduction

This chapter includes a description of the method of data tabulation and information about the study sample. In addition, the scenarios used in this study as well as the quantitative and qualitative data are presented in narrative and table format.

Data Tabulation

All data collected from the surveys (Appendix F) were entered into the statistical program SPSS, version 8.0. ASA PS scores were summarized according to the 10 scenarios, type of anesthesia provider and whether military or non-military.

Sample Population

A total of 70 participants in this study included certified registered nurse anesthetists (CRNAs) and anesthesiologists employed at two civilian and two military hospitals in the greater Washington DC area, and one military hospital in a northern mid-west state. Anesthesia providers were approached at their departmental meetings to participate in this study. Volunteers completed surveys in approximately 10-20 minutes, returning them to the researcher before leaving the meeting.

Of the 70 anesthesia providers surveyed, 39 (56%) were CRNAs and 31 (44%) were anesthesiologists. Forty-one (59%) of the providers were military and 28 (41%) were non-military (one participant did not disclose their military status). The number of years participants practiced anesthesia ranged from 0.25 years to 30 years (mean 8.1, SD 6.97, mode 1).

Data Analysis

Data collected from the four general questions presented in the survey (appendix F) regarding the ASA PS classification is presented below. This data is followed by the quantitative and qualitative results obtained from the 10 case scenarios.

Routine Use of ASA PS Scores.

All anesthesia providers participating in this study reported they routinely record ASA PS scores for their patients.

ASA PS Scores Helpful.

The majority of the providers surveyed (51.4%) reported that ASA PS scores are helpful to somewhat helpful (44.3%) in their daily practice of anesthesia (see Table 2 and 3). A small number (4.3%) reported that ASA PS scores are not helpful in their practice. There were no significant differences noted between CRNAs and anesthesiologists or between military and non-military providers with respect to this item. One participant commented the ASA PS classification is useful when doing research, but is not clinically useful in day to day practice.

Table 2.

ASA PS Scores Helpful in Daily Practice (Anesthesiologist/Nurse Anesthetist)

		ASA PS Scores Helpful in Daily Practice			Total
		Helpful	Somewhat Helpful	Not Helpful	
Type of Anesthesia Provider	Anesthesiologist	19	11	1	31
	Nurse Anesthetist	17	20	2	39
Total		36	31	3	70

Table 3.

ASA PS Scores Helpful in Daily Practice (Military/Non-Military)

		ASA PS scores Helpful in Daily Practice			Total
		Helpful	Somewhat Helpful	Not Helpful	
Type of Anesthesia Provider	Military	23	17	1	41
	Non-Military	13	13	2	28
Total		36	30	3	69

ASA PS Score as Anesthetic Risk Indicator.

Of the 70 providers surveyed, 62 (88.6%) of CRNAs and anesthesiologists reported that the ASA PS classification is an anesthetic risk indicator, 8 (11.4%) reported it is not (this is depicted in Table 4). Results were similar for military and non-military provider groups with 61 (87.4%) providers reporting the ASA PS classification is an anesthetic risk indicator and 8 (11.6%) reporting that it is not (see Table 5). One participant commented "…many consider it a risk scale, when actually it just parallels risk."

Table 4.

ASA PS Score as Anesthetic Risk Indicator (Anesthesiologist/Nurse Anesthetist)

		ASA PS Score as Anesthetic Risk Indicator		Total
		Yes	No	
Type of Anesthesia Provider	Anesthesiologist	26	5	31
	Nurse Anesthetist	36	3	39
Total		62	8	70

Table 5.

<u>ASA PS Score as Anesthetic Risk Indicator (Military/Non-Military)</u>

		ASA PS Score as Anesthetic Risk Indicator		Total
		Yes	No	
Type of Anesthesia Provider	Military	35	6	41
	Non-Military	26	2	28
Total		61	8	69

<u>ASA PS Score as Surgical Risk Indicator.</u>

Of the 69 CRNAs and anesthesiologists who answered this question, 34 (49.3%) reported that the ASA PS classification is a surgical risk indicator while 36 (52.2%) reported that it is not (see Table 6). Thirty four (49%) military and non-military provider groups reported that the ASA PS score indicates surgical risk while 35 (51%) reported that it does not (see Table 7). No significant difference was noted between CRNAs and anesthesiologists or between military and non-military providers with respect to this item. One participant commented “Physical status classification is not intended to represent an estimate of risk to the patient but is used to examine morbidity and mortality amongst various patients at various institutions.”

Table 6.

ASA PS Score as Surgical Risk Indicator (Anesthesiologist/Nurse Anesthetist)

		ASA PS Score as Surgical Risk Indicator		Total
		Yes	No	
Type of Anesthesia Provider	Anesthesiologist	14	17	31
	Nurse Anesthetist	20	19	39
Total		34	36	70

Table 7.

ASA PS Score as Surgical Risk Indicator (Military/Non-Military)

		ASA PS Score as Surgical Risk Indicator		Total
		Yes	No	
Type of Anesthesia Provider	Military	15	26	41
	Non-Military	19	9	28
Total		34	35	69

Case Scenarios.

Comments from participants about their rational in assignment of ASA PS scores are presented with each case scenario in table format. The reported ASA PS classification is followed by the number of participants who provided specific comments. Each comment was tallied separately. Forty five participants provided rational for their assignment of ASA PS class to each patient (62% CRNAs, 38% anesthesiologists, 75% military, and 24% non-military). See Appendix H for raw data for each case scernario.

Scenario One

A 19-year-old man was involved in a motor vehicle accident 10 hours ago. He now requires fixation of a compound fracture of the tibia. He was unconscious at the accident site. On arrival to the emergency room, he responded to pain, making incomprehensible sounds. Computerized tomography revealed a large frontal contusion, but no signs of intracranial hypertension. He now obeys commands and opens his eyes when spoken to.

The range of responses to this scenario as to the ASA PS class was five, with participants assigning scores from I to VE. The most common response, IIE, was recorded by 24 (34%) of CRNAs and anesthesiologists and 24 (35%) of military and non-military participants. There was less variation among nurse anesthetists than among anesthesiologists with little difference between the groups of providers. Of the providers surveyed, 61 (87 %) viewed this patient as emergent (E). It is interesting to note that three conditions (head injury, change in level of consciousness, and full stomach) were reported by the participants as reasons for selecting both ASA II and III categories. Also, two comments that are unrelated to the ASA PS score (possible neck injury and risk of doing poorly postoperatively) were cited as contributing factors in assigning this patient an ASA PS score. Comments provided by participants about ASA PS scoring of this scenario are listed in Table 8.

Table 8.

Provider Comments - Scenario One

ASA PS Class	Total Number Providers	Provider Comments
IE	3	No systemic disease/Healthy
II or IIE	9	Head injury
	6	Change in level of consciousness
	4	Full stomach
	4	Blood loss/Dehydration
	1	Hypothermia
	1	Mildly limited functional status
	12	Emergent
III or IIIE	3	Head Injury
	2	Full stomach
	1	Decreased level of consciousness
	1	Life threatening injury
	1	Not enough information
	1	Pathology
	1	Possible neck injury
	1	Possibility of decompensation
	1	Possible significant physical consequences
	1	Risk of doing poorly postoperatively
	8	Emergent
IVE	1	Not enough data to assure accurate ASA score

Scenario Two

A 66-year-old man presents for anterior resection of the rectum for carcinoma. He has smoked 20-30 cigarettes per day for the last 50 years, and has had a productive cough for the last 15 years. He had two courses of antibiotics from his general practitioner within the last 6 months for a "chest infection", but is now producing clear sputum. He is breathless on climbing one flight of stairs, but plays golf twice a week, usually managing to complete a full round. On examination his chest is clear but is slightly hyper-inflated. He has no cardiovascular symptoms or signs, and does not take regular medication. Additional data: Hb = 13.6g/dL, BUN and electrolytes within laboratory reference range, chest x-ray shows slightly hyper-inflated lung fields, ECG is unremarkable, FEV1 is 2.31 and FVC is 3.51.

The range of ASA PS scores for this case was two (ASA II or III) with no significant difference between scores provided by CRNAs and anesthesiologists or military and non-military participants. It is interesting to note that three conditions (COPD, smoking and decreased activity) were provided as rationale for the selection of two different ASA PS categories, and that the type of surgery was also reported as a factor contributing to the ASA PS score. Comments made by the participants regarding the ASA PS scoring of this scenario are listed in Table 9.

Table 9.

Provider Comments - Scenario Two

ASA PS Class	Total Number Providers	Provider Comments
II	9	Bronchitis (COPD)
	6	Smoker
	5	Systemic disease but functional status normal (ADL's)
	1	Decreased activity
	1	Lower abdominal procedure
	1	Not enough information
	1	Recent chest infection
III	9	COPD
	5	Decreased activity
	2	Smoker
	1	Multiple medical problems
	1	Not enough information
	1	Surgery (large fluid shifts)

Scenario Three

A 72-year-old man presents for elective repair of an abdominal aortic aneurysm. He had a myocardial infarction 2 years ago with no further complications. He has had stable angina for the last 5 years for which he takes nifedipine and nitroglycerin sub-lingual spray, which he uses about once per week. Examination reveals a systolic murmur loudest over the aortic area. His blood pressure is 170/80 mmHg. Additional data: ECG reveals Q waves in leads II, III, and aVF, with borderline left ventricular hypertrophy. Chest x-ray and full blood count are unremarkable. BUN is 30 mg/dL, creatinine is 2.0 mg/dL, and electrolytes are normal.

The range of ASA PS scores for this scenario was three. Great consistency was noted between CRNAs and anesthesiologists in this case with the majority (79% and 87% respectively) assigning an ASA PS score of III. The same consistency was noted between military and non-military providers (88% and 78% respectively). It is interesting to note that five conditions (hypertension, history of myocardial infarction, abdominal aortic aneurysm, nature of the surgery, and arotic stenosis) were reported by participants as rationale for the assignment of both ASA PS II and III. Comments provided by participants about the ASA PS scoring of this scenario are listed in Table 10.

Table 10.

Provider Comments - Scenario Three

ASA PS Class	Total Number Providers	Provider Comments
II	1	Heart Disease
III	24	Cardiovascular Disease/angina
	8	Hypertension
	8	History of myocardial infarction
	8	Renal insufficiency
	3	Abdominal aortic aneurysm
	3	Systolic mumur
	2	Abnormal electrocardiogram
	2	Not enough information
	2	Nature of the surgery
	1	Aortic stenosis
	1	Exercise intolerance
	1	Physical exam
	1	Severe systemic changes
IV	2	Nature of the surgery
	1	Abdominal aortic aneurysm
	1	Abnormal electrocardiogram
	1	Angina
	1	Aortic stenosis
	1	Constant threat to life
	1	Increased morbidity and mortality
	1	History of myocardial infarction
	1	Hypertension
	1	Renal insufficiency

Scenario Four

A 69-year-old man, weighing 80 kg, is admitted for transurethral prostatectomy. He has smoked all his adult life but states that he enjoys good health. Closer questioning reveals decreasing exercise tolerance over the last few years and shortness of breath when walking on an incline. He is given symptomatic relief of this by using an atrovent inhaler and he uses a beconase inhaler prophylactically. He produces a small amount of clear sputum daily. Physical exam reveals slight intercostal retractions, with scattered expiratory rhonchi. His FEV1 is 2.21, and FVC is 3.91. CBC, BUN, electrolytes, ECG and chest x-ray are all unremarkable.

The range for this scenario was three (ASA II, III and IV). CRNAs and anesthesiologists were nearly equally split between ASA II and III (51.4% and 45.7%

respectively). A small percentage of providers (2.9%) classified this patient as ASA IV. There were no significant differences between military and non-military participants (ASA II 52.2%, ASA III 44.9%, and ASA IV 2.9%). It is interesting to note that two conditions (pulmonary disease and smoking) were reported by participants as contributing to both ASA II and III classes. Provider comments regarding the ASA PS scoring of this scenario are listed in Table 11.

Table 11.

Provider Comments - Scenario Four

ASA PS Class	Total Number Providers	Provider Comments
II	9	Pulmonary Disease (COPD/ RAD)
	5	Smoker
	5	Systemic disease without effect on lifestyle
	1	Moderate size operation
	1	Non-cardiac
	1	Not enough information
	1	Respiratory risk
III	8	Decreased activity level
	7	Pulmonary disease (COPD)
	4	Physical Exam
	3	Smoker
	1	Coronary Artery Disease
	1	Not enough information

Scenario Five

A 61-year-old woman has carcinoma of the middle third of the esophagus with diet restricted to liquids. She is scheduled for esophagectomy (involving an upper abdominal incision and a right-sided thoracotomy). She began to experience angina one year ago, but had no further episodes after daily atenolol was started. Recently, when she became unable to swallow the tablets, her anginal symptoms returned whenever exercising. ECG, chest x-ray, liver function tests, BUN and electrolytes are normal. Her Hb is 10.1 g/dL, with a microcytic picture. FEV1 and FVC are approximately 90% of predicted for age and weight (before the onset of the dysphagia).

The range in this scenario was three (ASA II to IV) with more variation noted between providers. The majority of participants assigned a score of III (67% CRNAs and anesthesiologist, and 68% military and non-military). Once again, no significant differences were noted between CRNAs and anesthesiologists or between military and non-military providers. It is interesting to note that some of the conditions (angina, coronary artery disease, and esophageal cancer) reported by the participants were common to all three ASA PS classes. There is also a condition unrelated to the ASA PS score (major surgery) reported by three providers as contributing to the ASA PS score of this patient. Participant comments regarding the ASA scoring of this scenario are listed in Table 12.

Table 12.

Provider Comments - Scenario Five

ASA PS Class	Total Number Providers	Provider Comments
II	4	Angina
	1	Coronary artery disease
	1	Mild debilitating disease
	1	Moderate systemic changes
III	7	Coronary artery disease
	7	Esophageal cancer
	5	Anemia
	5	Angina
	5	Decreased activity
	3	Major surgery
	2	Nutritional status
	1	Hypertension
	1	Not enough information
	1	Potential anesthetic problems
	1	Risk for aspiration
IV	3	Angina
	1	Esophageal cancer
	1	Malnutrition

Scenario Six

A 42-year-old woman suffered a subarachnoid hemorrhage 36 hours ago. She still has a severe headache, but her level of consciousness is not impaired. The only abnormality on neurological examination is a right sided oculomotor nerve palsy. Previously she has enjoyed good health. Cerebral angiography identified an anterior communicating artery aneurysm, with little evidence of arterial spasm. She now presents for craniotomy and clipping of the aneurysm.

In this scenario, as in case scenario one, a range of four scores was recorded by participants (ASA I to IVE). Most assigned an ASA PS score of II, III, or IV (24%, 27%, and 18% respectively) with no significant differences between CRNAs and anesthesiologists or between military and non-military providers. Once again, there was a common condition cited by providers (aneurysm) who assigned different ASA PS scores. There was one unrelated factor (risk of doing poorly) cited as rationale. Provider comments regarding ASA PS scoring of this scenario are listed in Table 13.

Table 13.

<u>Provider Comments - Scenario Six</u>

ASA PS Class	Total Number Providers	Provider Comments
I	5	Healthy
II	6	Subarchnoid hemmorage
	2	Change in level of consciousness
	1	Possible physiological compromise
	1	Single disease
III	3	Aneurysm
	2	Life threatening surgery
	1	End organ manifestations
	1	Neurological changes
	1	Risk of doing poorly
IV	5	Aneurysm/Subarchnoid hemorrage
	4	Constant threat to life
	2	Increased morbidity and mortality
	2	Risk of cerebral vasospasm
	1	Extent of surgery
	1	Unstable neurological condition

<u>Scenario Seven</u>

A 57-year-old male insulin-dependent diabetic is to have a right knee joint replacement because of osteoarthritis. This knee was injured playing football 20 years previously. There is no significant arthritis in any other joint. He is otherwise healthy and monitors his blood glucose regularly, which is rarely more than 150 mg/dL. History and physical examination are unremarkable. There are no cardiovascular or opthalmic abnormalities noted. Apart from a creatinine of 2.0 mg/dL, all routine pre-operative labs and tests are normal.

In this scenario, the least variability in assignment of ASA PS scores was demonstrated with nearly 86% agreement (ASA II), however, the range of scores was three (ASA I, II, and III). There was no statistical difference in responses from nurse anesthetists and anesthesiologists or military and non-military providers. Provider comments regarding ASA scoring of this scenario are listed in Table 14.

Table 14.

Provider Comments - Scenario Seven

ASA PS Class	Total Number Providers	Provider Comments
II	17	Diabetes mellitus
	3	No effect on lifestyle
	2	Mild renal insufficiency
	1	Not enough information
	1	Osteoarthritis
III	5	Renal disease (end organ manifestations)
	4	Diabetes Mellitus

Scenario Eight

A 23-year-old female, weighing 60 kg, presents for a left knee arthroscopy. She has smoked 1 pack per day for the past 3 years. She denies any health problems other than injury to the left knee in a skiing accident approximately 2 months ago. Before the accident, she was running approximately 3 miles 3 times per week. Physical exam is unremarkable. Hcg is negative.

The above case scenario was developed for this study in an effort to understand the impact of smoking on provider's assignment of ASA PS classification. The range of ASA PS scores was two (ASA I and II). There was no statistical difference between CRNAs and anesthesiologists or between military and non-military providers. The majority of providers assigned an ASA II (70% CRNA/anesthesiologist and 72% military/non-military). It is interesting to note that five providers cited a smoking history as rationale for assigning ASA I while 17 cited it as rationale for assigning ASA II. Provider comments regarding the ASA PS scoring of this scenario are listed in Table 15.

Table 15.

Provider Comments - Scenario Eight

ASA PS Class	Total Number Providers	Provider Comments
I	5	No effect of smoking on physical status yet
	3	Healthy
II	17	History of smoking

Scenario Nine

A 25-year-old female, gravida 1 para 0, presents in active labor. She is dilated to 5cm and is is requesting a labor epidural. Height is 65 inches and weight is 80 kg. Her pregnancy course has been uneventful. Hct is 38%, Hb is 12.4g/dL, electrolytes are within normal limits. She has no significant history and physical exam is normal for full term pregnancy.

This scenario was developed for this study in an attempt to understand what impact pregnancy has on provider assignment of ASA PS classification. The range of scores for this scenario was two (ASA I/IE and II/IIE). A bimodal distribution was apparent with peaks at ASA scores II and IIE. Twendy six providers (37%) classified this patient as emergent. No statistical difference in ASA PS scoring was noted between CRNAs and anesthesiologists or between military and non-military participants. Alterations in physiology was reported by providers as rationale for assigning both an ASA I and II. Provider comments for this scenario are listed in Table 16.

Table 16.

Provider Comments - Scenario Nine

ASA PS Class	Total Number Providers	Provider Comments
I or IE	5	Healthy
	2	Normal physiological changes of pregnancy
	1	Physiological stress of pregnancy
	2	Emergent
II or IIE	15	Pregnancy
	7	Alteration in normal physiology
	4	Full stomach
	5	Emergent

Scenario Ten

A 26-year-old woman presents for a bilateral tubal reanastamosis. She is in excellent health. History, physical and review of systems are unremarkable. During your pre-operative visit you notice she has a small mouth with protruding upper incisors, and a small chin. Mouth opening is restricted. She was seen by a maxillo-facial surgeon 3 years ago after being hit in the face by her boyfriend. No bony injury was found, but it was felt by her physician that she may be left with some temporo-mandibular joint dysfunction. She has never previously had a general anesthetic.

The range of scores in this scenario was two (ASA I and II). Of the 70 providers surveyed, 55 (78%) of CRNAs and anesthesiologist and 54 (78%) of military and non-military providers assigned this patient an ASA I. No significant differences in ASA PS scoring was noted between the groups of participants. The possibility of a difficult airway, which is unrelated to the ASA PS classification, was reported by some providers as rationale for assigning both ASA I and II. Provider comments regarding the ASA PS scoring of this scenario are listed in Table 17.

Table 17.

Provider Comments - Scenario Ten

ASA PS Class	Total Number Providers	Provider Comments
I	12	Possible difficult airway (not related to ASA)
	11	Healthy
II	2	Possible difficult airway
	1	Physical exam
	1	TMJ dysfunction

Summary

The data collected and presented in this study supports findings from previous studies regarding variability among anesthesiologists in their assignment of ASA PS scores to patients. The qualitative data collected provides insight into possible sources of this variability. In no case were significant differences found between the groups of providers (CRNAs, anesthesiologists, military and non-military) and their assignment of

ASA PS classes. There was similar variability among providers within each group of providers, with a range of scores of four on a scale of one through five.

CHAPTER V: SUMMARY

Introduction

The assessment of general physical status is an important aspect of the preoperative evaluation of patients. Anesthesia providers have been using the ASA PS classification since 1941. Its world wide application influences many aspects of anesthesia including administration and public policy determination, resource allocation, reimbursement, performance evaluations, and research. This study was designed to test the reliability of the ASA PS classification. The purpose was to identify anesthesia providers assessment of the meaning of the measure, to assess inter-rater reliability in assigning ASA PS scores, and to attempt to identify sources of variability.

The ASA PS classification was originally designed to collect and compare anesthesia statistical data (Saklad, 1941). As the ASA PS became widely utilized, many anesthesia providers began to incorrectly associate the score with a risk assessment of anesthesia or surgery. No studies to date have found direct statistically significant correlation between ASA PS and any aspect of surgical or anesthetic risk. However, numerous studies have described a possible correlation between higher ASA PS scores and increased morbidity and mortality (Cohen & Duncan, 1988; Derrington & Smith, 1987; Djokovic & Healey-Whyte, 1979; Dripps et al., 1961; Hovi-Viander, 1980; Farrow et al., 1982; Feigal & Blaisdell, 1979; Forrest, Rehder, cahalan, & Goldsmith, 1992; Marx et al., 1973; Menke et al., 1993; Pedersen et al. 1986; Schneider, 1983; Tikkamen & Hovi-Viander, 1995; Tiret & Hatton, 1986; Tiret et al., 1988; Vacanti et al., 1970). These studies suggest the ASA PS classification may be useful in predicting patient outcomes, however, other studies have demonstrated the assignment of ASA PS scores is inconsistent among anesthesiologists (Haynes & Lawler, 1995; Owens et al., 1978; Ranta et al., 1997). This poses the following question; how can an instrument be useful in predicting outcomes if it has not been demonstrated to be valid or reliable?

In this study, a survey containing questions about use of the ASA PS classification was presented to 70 anesthesia providers at two civilian and three military hospitals. Subjects were asked to assign ASA PS scores to patients in 10 hypothetical cases and to identify factors in the scenarios that influenced their decisions.

The range of scores in the scenarios was five. There were no significant differences between the groups of providers (CRNAs and anesthesiologists or military and non-military). In several of the case scenarios, the same rationale was provided for the assignment of different ASA PS classification. Multiple conditions unrelated to the ASA PS classification (risk of surgery, major surgery, risk of doing poorly, possible difficult airway) were also reported as rationale for provider assignment of ASA PS classification.

In the following discussion about the 10 scenarios, results from this study are compared to the findings of Haynes and Lawler (1995).

Case Scenarios

Scenario One.

> **A 19-year-old man was involved in a motor vehicle accident 10 hours ago. He now requires fixation of a compound fracture of the tibia. He was unconscious at the accident site. On arrival to the emergency room, he responded to pain, making incomprehensible sounds. Computerized tomography revealed a large frontal contusion, but no signs of intracranial hypertension. He now obeys commands and opens his eyes when spoken to.**

The range of scores for this patient was five, from I to VE. The most commonly sited ASA PS score was IIE (34%). Those providers who assigned an ASA IE cited "no systemic disease/healthy" as their rationale (see Table 8). The most common reasons cited in assigning ASA II or IIE were "head injury and change in level of consciousness." However, those who assigned an ASA III or IIIE also cited "head injury and full stomach" most frequently. Those who assigned ASA IV and V did not provide rationale. ASA PS class definitions are broad in nature which may have contributed to this variability. Providers may also be considering the acute physical status of the patient as well as the planned surgical interventions when assigning ASA PS scores.

Using the ASA PS classification guidelines (ASA, 1961), this patient should probably be assigned an ASA IIIE. The definition of an ASA III is "A patient with severe systemic disease that limits activity, but is not incapacitating." From the data available, it is questionable if this patient's injuries are incapacitating and a constant threat to life, which would make him an ASA IV. However, due to the extent of his injuries and his initial presentation, his disease should be probably viewed as severe rather than mild (ASA II). Some providers in this study disagreed with this rational, suggesting the patient should be classified as an ASA 1E as his physical status was healthy prior to the accident. Other providers assigned this patient a classification of ASA VE (a moribund patient not expected to survive 24 hours with or without operation).

This scenario presents a dilemma. Should acute physical injury be considered a disease state and influence preoperative assignment of ASA PS scores? Some providers believe it should because the physical status of a patient can be changed by the injury. Others argue that ASA PS refers to the disease state of the patient and is unrelated to the injury.

Dixon (1995) noted that some anaesthetists do not consider acute physiological or pathological processes in their assessment of a previously healthy patient when assigning an ASA PS score. For example, consider assigning an ASAPS score to Princess Diana after her accident. She presented for surgery as a healthy young person except for her ruptured pulmonary artery and other injures sustained in a motor vehicle accident. Some anesthesia providers would argue that she should be classified as ASA IE as her physical status prior to the accident was healthy. Other providers argue that her injuries, which were life threatening, would place her in the ASA PS class IVE or VE. This dilemma illustrates an inherent problem with the ASA PS classification. Dixon suggests that the inconsistency apparent in the assignment of ASA PS classification might be lessened if more attention was given to acute disease at the time of anesthesia.

This scenario and scenario six were developed by Haynes and Lawler (1995) to evaluate the influence of experience level in assigning ASA PS scores. The majority of anesthesiologists who participated in their study (54%) assigned this patient an ASA III. It was noted by these researchers that nearly a quarter (22.7%) of the anesthesiologists surveyed did not perceive this patient as having a severe systemic disease, assigning him an ASA II.

Scenario Two.

A 66-year-old man presents for anterior resection of the rectum for carcinoma. He has smoked 20-30 cigarettes per day for the last 50 years, and has had a productive cough for the last 15 years. He had two courses of antibiotics from his general practitioner within the last 6 months for a "chest infection", but is now producing clear sputum. He is breathless on climbing one flight of stairs, but plays golf twice a week, usually managing to complete a full round. On examination his chest is clear but is slightly hyper-inflated. He has no cardiovascular symptoms or signs, and does not take regular medication. Additional data: Hb = 13.6g/dL, BUN and electrolytes within laboratory reference range, chest x-ray shows slightly hyper-inflated lung fields, ECG is unremarkable, FEV1 is 2.31 and FVC is 3.51.

This patient has severe systemic disease which limits his activity (unable to climb stairs). The question is whether it should be considered incapacitating. In the ASA PS classification guidelines (ASA, 1961), "incapacitating" is not clearly defined and thus is subject to individual interpretation. This patient could, therefore, be classified as an ASA II or III depending on one's interpretation of the scale.

The range of classes assigned by the participants for this patient was two which was more narrow than in the previous scenario. Of the providers surveyed, 50% assigned an ASA II and 50% assigned an ASA III. It's interesting to note that all the participants who provided rationale commented that COPD, smoking, and decreased activity were factors which lead to their decisions (see Table 9), suggesting these variables are not good discriminators for assigning ASA PS scores. Several providers cited "systemic disease but normal activity level", while others cited "decreased activity." Thus there is a lack of agreement in this patient's activity level from the information provided. The lack of clear guidelines about the variable "decreased activity" leads to variability in interpretation.

Haynes and Lawler (1995) viewed this patient as one with chronic respiratory disease with a moderate effect on lifestyle (ASA III). The anesthesiologists surveyed in their study assigned the following ASA PS scores: 37.1% ASA II, 60.8% ASA III, and 2.1% ASA IV.

<u>Scenario Three.</u>

> **A 72-year-old man presents for elective repair of an abdominal aortic aneurysm. He had a myocardial infarction 2 years ago with no further complications. He has had stable angina for the last 5 years for which he takes nifedipine and nitroglycerin sub-lingual spray, which he uses about once per week. Examination reveals a systolic murmur loudest over the aortic area. His blood pressure is 170/80 mmHg. Additional data: ECG reveals Q waves in leads II, III, and aVF, with borderline left ventricular hypertrophy. Chest x-ray and full blood count are unremarkable. BUN is 30 mg/dL, creatinine is 2.0 mg/dL, and electrolytes are normal.**

Greater consistency in assignment of ASA PS scores was noted in this scenario than in the others, with the majority (83%) of providers assigning an ASA III. This is consistent with the definition of ASA III in the classification guidelines (severe systemic disease that limits activity but is not incapacitating). This patient has severe systemic disease (heart disease, abdominal aortic aneurysm, and questionable aortic stenosis). It may be inferred that this disease limits his activity by his use of sublingual nitroglycerin.

The range of classes assigned to this patient was three, from ASA II to ASA IV. Providers who assigned an ASA II as well as III cited cardiovascular disease (heart disease, angina, hypertension, abdominal aortic aneurysm, and aortic stenosis) most frequently as their rationale (see Table 10). Similar variables were identified by those who assigned this patient an ASA IV. Once again, the same factors were used as rationale by participants who assigned different ASA PS scores. An unrelated variable (nature of the surgery) was also provided as rationale for assignment of ASA PS scores. This scenario is a good example of how some providers incorrectly consider the "nature of the surgery" when assigning an ASA PS score.

Haynes and Lawler (1995) developed this scenario to explore the distinction between an ASA PS score of III and IV. They point out that this operation is performed because "...untreated, an aortic aneurysm is a constant threat to life" (p.49). If this is considered in the assignment of a ASA PS score, the patient should be classified as an ASA IV. Of the anesthesiologists surveyed in their study, 14% categorized the patient as ASA II, 63.9% ASA III, and 21.6% ASA IV. Haynes and Lawler suggested that this patient is typical of those who present for this surgery and that the nature of the procedure may be influencing the anesthesiologists assignment of ASA PS class.

Scenario Four.

> **A 69-year-old man, weighing 80 kg, is admitted for transurethral prostatectomy. He has smoked all his adult life but states that he enjoys good health. Closer questioning reveals decreasing exercise tolerance over the last few years and shortness of breath when walking on an incline. He is given symptomatic relief of this by using an atrovent inhaler and he uses a beconase inhaler prophylactically. He produces a small amount of clear sputum daily. Physical exam reveals slight intercostal retractions, with scattered expiratory rhonchi. His FEV1 is 2.21, and FVC is 3.91. CBC, BUN, electrolytes, ECG and chest x-ray are all unremarkable.**

The range of ASA PS scores assigned by providers in this scenario was three (ASA II, III and IV). The groups of providers (CRNAs/anesthesiologist and military/non-military) were almost evenly split between ASA II (51%) and III (46%). Only two providers (2.9%) assigned this patient an ASA IV, however, they did not provide any rationale for their selection.

Providers who assigned an ASA II cited COPD, smoking and disease without significant effect on lifestyle most frequently as rationale for their choice (see Table 11). Similarly, those who chose ASA III cited COPD and smoking as factors which influenced their decision which makes these variables poor discriminators. The variable separating those assigning ASA III from those assigning ASA II appears to be activity level.

According to ASA PS guidelines (ASA, 1961), an ASA III patient would demonstrate severe systemic disease with activity that is limited but they are not incapacitated. Only eight providers recognized this patient's potential limited activity level which is evidenced by shortness of breath when walking on an incline. This would move the patient from an ASA II to an ASA III. It is unclear why this patient would be considered an ASA IV as he is not incapacitated by his illness, and it does not appear to be a constant threat to his life.

This scenario was created by Haynes and Lawler in 1995 to explore the interface between ASA PS II and III by presenting a patient with chronic respiratory disease that only modestly affects his lifestyle. Of the anesthesiologists in that study, 32% assigned ASA II, 64.9% assigned ASA III and 3.1% assigned ASA IV, findings similar to those in our study. The researchers designed this case along with case two to present similar patients (chronic respiratory disease with modest effect on lifestyle) with different operative procedures in an effort to explore if the nature of the surgery would be considered by providers when assigning an ASA PS class. They found no such Correlation in their study.

Scenario Five.

> **A 61-year-old woman has carcinoma of the middle third of the esophagus with diet restricted to liquids. She is scheduled for esophagectomy (involving an upper abdominal incision and a right-sided thoracotomy). She began to experience angina one year ago, but had no further episodes after daily atenolol was started. Recently, when she became unable to swallow the tablets, her anginal symptoms returned whenever exercising. ECG, chest x-ray, liver function tests, BUN and electrolytes are normal. Her Hb is 10.1 g/dL, with a microcytic picture. FEV1 and FVC are approximately 90% of predicted for age and weight (before the onset of the dysphagia).**

The range of ASA PS classifications for this patient was three (ASA II, III, and IV). Of the providers surveyed, 19% assigned ASA II, 67% ASA III, and 14% ASA IV. No statistical differences were noted between the provider groups. Heart disease was the primary variable used by providers assigning this patient to all three classes (see Table 12). Other reported variables include: cancer, anemia, decreased activity level, and nutritional status.

According to the ASA PS guidelines, this patient would most likely be classified as an ASA III. She has severe systemic disease (heart disease that is not well controlled) which limits her activity (increased anginal symptoms) without necessarily being incapacitating.

This scenario, like scenario three, was designed to explore the interface between ASA III and IV (Haynes & Lawler, 1995). The Haynes and Lawler findings were similar to the current study with a slightly greater percentage of the participants assigning an ASA IV (23.7%) to this patient.

Scenario Six.

> **A 42-year-old woman suffered a subarachnoid hemorrhage 36 hours ago. She still has a severe headache, but her level of consciousness is not impaired. The only abnormality on neurological examination is a right sided oculomotor nerve palsy. Previously she has enjoyed good health. Cerebral angiography identified an anterior communicating artery aneurysm, with little evidence of arterial spasm. She now presents for craniotomy and clipping of the aneurysm.**

This scenario, like scenario one, had the greatest range of responses from the participants (ASA I to IV). The most common responses were ASA II, III and IV. Five providers assigned an ASA I, commenting that this patient was "healthy" (see Table 13). The most frequently cited variable for assigning an ASA II, III or IV was aneurysm/subarachnoid hemorrhage. Other variables considered by the participants included: change in level of consciousness, life threatening surgery, and increased morbidity and mortality, none of which are relevant in the ASA PS classification guidelines.

This case has a similar point of controversy as in case one. Should acute injury/disease be considered when assessing preoperative physical status? Some providers argue that because this patient no longer has an altered level of consciousness and is only presenting with a head ache and oculomotor palsy, that this disease state is mild and thus should warrant an ASA score of II. Others argue that a cerebral aneurysm, like an aortic aneurysm, is a constant threat to life, and these patients should be assigned an ASA IV. Still others view this disease as activity limiting but not incapacitating (ASA

III). The variability of provider responses to this scenario demonstrate the lack of objective and clear guidelines associated with the ASA PS classification scale.

Haynes and Lawler (1995) presented this case, as with case one, in an attempt to assess the effect of provider experience level. They compared those with recent neuroanesthesia experience to those without, and found no significant difference. Their findings ranged from ASA I to IV with 71.1% of the anesthesiologists classifying the patient as an ASA II, III, or IV. They found this spread of scores surprising, suggesting ASA PS grading in this type of patient is highly variable.

Scenario Seven.

> **A 57-year-old male insulin-dependent diabetic is to have a right knee joint replacement because of osteoarthritis. This knee was injured playing football 20 years previously. There is no significant arthritis in any other joint. He is otherwise healthy and monitors his blood glucose regularly, which is rarely more than 150 mg/dL. History and physical examination are unremarkable. There are no cardiovascular or opthalmic abnormalities noted. Apart from a creatinine of 2.0 mg/dL, all routine pre-operative labs and tests are normal.**

This scenario generated the greatest agreement in ASA PS scoring among providers; 85.7% of CRNAs and anesthesiologists and 85.5% of military and non-military providers assigned this patient an ASA II. The range for this case was three with one provider (1.4%) choosing ASA I and nine (12.9%) providers assigning ASA III. Those who assigned ASA II and III to this patient agreed that diabetes mellitus and renal insufficiency were the primary factors contributing to their decision (see Table 14).

This patient has systemic disease (diabetes mellitus) that is well controlled (consistently near normal blood sugar). With the exception of possible renal insufficiency, he has no other systemic manifestations of the disease and is otherwise in good health. There is no apparent limitations in this patients activity level. This patient should be assigned an ASA II due to the presence of mild systemic disease that does not affect activity level.

As in scenario two and four, Haynes and Lawler (1995) wanted to examine the boundaries between ASA II and III. Their findings were similar to ours with 82.5% of the participants assigning an ASA II, 1.0% an ASA I, and 16.5% an ASA III.

Scenario Eight.

> **A 23-year-old female, weighing 60 kg, presents for a left knee arthroscopy. She has smoked 1 pack per day for the past 3 years. She denies any health problems other than injury to the left knee in a skiing accident approximately 2 months ago. Before the accident, she was running approximately 3 miles 3 times per week. Physical exam is unremarkable. Hcg is negative.**

The above scenario was developed for this study to explore how patient smoking affects provider assignments of ASA PS scores. The range of classes assigned was two with all providers assigning either an ASA I or II. The majority of participants (72%) assigned this patient as ASA II, siting a history of smoking as the only contributing factor (see Table 15). Those providers who chose ASA I remarked that her short smoking history (three pack years) had not affected her physical status (she runs three miles three times per week), and that she was otherwise healthy.

The influence of smoking and provider assignment of ASA PS classification has been described in the literature (Bayes, 1982). Some providers assign an ASA I for asymptomatic smokers, arguing that smoking is not a disease despite the fact that it has been linked to physiological changes in nearly every body system, and to certain diseases.

Asymptomatic smokers have increased closing volumes consistent with small airway disease (McCarthy, Spencer, Greene, & Milic-Emili, 1972), and abnormalities in mucociliary transport (Lourenco, Klimek, & Borowski, 1971). Even passive exposure to smoking is associated with a decline in the forced expiratory volume in the first second (FEV1) (Kerstjens, Rijcken, Schouten, & Postma, 1997). Smoking is the leading cause of chronic bronchitis and emphysema (COPD), causing bronchial wall thickening, mucous gland hyperplasia, muscle hypertrophy, and chronic inflammation (McCance & Huether, 1994).

In addition to the pulmonary sequelae, patients exposed to both active and passive smoking, have accelerated coronary atherosclerosis and coronary artery disease, increased incidence of coronary vasoconstriction and vasospasm, increased heart rate, blood pressure and cardiac output due to sympathetic stimulation and release of catecholamines, and an altered response to many medications due to down regulation of alpha and beta receptors (Zhu, Williams, & Parmley, 1995; Bo-quing & Parmley, 1995). In addition, the peripheral vasculature assumes an abnormal structure and tone, contributing to an increase in vascular resistance (McVeigh, 1997). One study suggests that 30% of the annual mortality rates related to coronary artery disease are traceable to cigarette smoking (Hancock, 1993). Smoking at any age doubles the risk of hypertension and other cardiovascular diseases at any age (McCance & Huether, 1994).

An association between smoking and cancer has also been demonstrated. Epidemiological and experimental data support the conclusion that smoking is carcinogenic and remains the most important cause of cancer linked to laryngeal, lung, esophageal, renal, and bladder cancer (Henderson, Ross, & Pike, 1991).

The endocrine system can also be affected by smoking. Smoking acutely impairs glucose tolerance and causes insulin insenstivity which has been linked with an increased incidence of non-insulin dependent diabetes mellitus (NIDDM) and when chronic, to vascular changes and arthrogenesis (Frati, Iniestra, & Ariza, 1996). Smoking has recently been linked with Grave's disease and may worsen hypothyroidism (Utiger, 1995). Finally, there is an increase in postoperative morbidity in smokers (Laszlo, Archer, Darrell, Dawson, & Fletcher, 1973). When considering these factors, it appears that even asymptomatic smoking should be considered a mild to moderate systemic disease, justifying an ASA score of II, yet 28% of the providers surveyed assigned this patient an ASA score of I.

Scenario Nine.

> **A 25-year-old female, gravida 1 para 0, presents in active labor. She is dilated to 5cm and is is requesting a labor epidural. Height is 65 inches and weight is 80 kg. Her pregnancy course has been uneventful. Hct is 38%, Hb is 12.4g/dL, electrolytes are within normal limits. She has no significant history and physical exam is normal for full term pregnancy.**

This scenario was created to assess how pregnancy influences provider assignment of ASA PS scores. The range of classes assigned to this patient was two with a bimodal distribution demonstrated by peaks at ASA II and IIE. Approximately 44% of participants assigned an ASA II and 28% an ASA IIE. In addition to an alteration in physiology, several of these providers also mentioned full stomach as a contributing factor (see Table 16). Approximately one third of the providers considered this patient to be emergent.

A recent discussion on the internet focused on the ASA PS scoring of the pregnant patient (anesthesiology@groucho.med.yale.edu – 5-12 October 1998). Some of the providers favored ASA II for pregnant patients due to the physiological changes of pregnancy. Others argued that pregnancy is not a disease state and these patients, who are otherwise healthy should be classified as ASA I. There was also disagreement as to whether pregnant patients should be considered emergent (E) in their ASA PS score.

Physiological changes during pregnancy are well documented (Morgan & Mikail, 1996). Nearly all body systems are affected by pregnancy (respiratory, cardiovascular, renal, hepatic, gastrointestinal, and hematological). There is an increase in oxygen consumption and minute ventilation with a decrease in functional residual capacity (FRC) which places the partuient at greater risk for rapid desaturation. In addition, closing volumes exceed FRC, making the pregnant patient prone to atelectasis and hypoxemia. There is also capillary engorgement of the respiratory mucosa, predisposing the patient to trauma, bleeding and obstruction. Blood volume increases by one third with an increase in cardiac output of 40% and greater. The renal system demonstrates increased perfusion and glomerular filtration with a decreased threshold for glucose and amino acid filtration. Liver enzymes increase while there is a dilutional decrease in albumin and pseudocholinesterases. The increase in progesterone inhibits the release of cholecystokinin (CCK) which decreases emptying of the gall bladder and alters bile metabolism, placing the partuient at risk for gall stones. The pregnant patient demonstrates a state of hypercoagulability (increased fibrinogen and factors VII, VIII, and X) and dilutional thrombocytopenia. Metabolism is also affected as evidenced by a relative insulin resistance and hyperactive thyroid.

When these physiological changes are considered, the argument that pregnancy can be considered a "mild systemic disease" is logical, justifying an ASA score of II. However, no all providers agree with this argument as 19 (27%) of them classified this patient as an ASA I or IE.

Scenario Ten.

> **A 26-year-old woman presents for a bilateral tubal reanastamosis. She is in excellent health. History, physical and review of systems are unremarkable. During your pre-operative visit you notice she has a small mouth with protruding upper incisors, and a small chin. Mouth opening is restricted. She was seen by a maxillo-facial surgeon 3 years ago after being hit in the face by her boyfriend. No bony injury was found, but it was felt by her physician that she may be left with some temporo-mandibular joint dysfunction. She has never previously had a general anesthetic.**

This scenario was adapted from one created by Haynes and Lawler (1995) to depict a healthy patient with a potential difficult airway. The range of ASA PS classes assigned to this patient was three (ASA I to III) with the majority of participants (78%) assigning an ASA I. Twelve of the providers who assigned an ASA I identified the potential difficult airway but did not consider it contributory to the ASA PS score (see Table 17). Fourteen percent of the participants assigning an ASA II identified the potential difficult airway as a factor in their ASA scoring. It is clear from the ASA PS classification guidelines (ASA, 1961) that physical status should be assessed without regard to potential anesthetic risks such as a difficult airway. Therefore, this patient should be assigned an ASA I. This scenario demonstrates that some providers may still be utilizing the ASA PS classification incorrectly as an assessment of anesthetic risk.

Haynes and Lawler (1995) reported similar results: 87.6% of the anesthesiologists assigned an ASA I, 7.2% an ASA II, and 5.2% an ASA III. They also noted that a small number considered airway assessment in their assignment of ASA PS scores to patients.

Conclusion

In this study there were no scenarios that demonstrated satisfactory inter-rater reliability in the assignment of ASA PS scores. The overall range of ASA PS scores assigned was four. There were no statistically significant difference in assigning ASA PS scores among groups of providers (nurse anesthetists and anesthesiologists, military and non-military). Scoring of those cases adapted from the Haynes and Lawler (1995) study were similar to their findings. However, unlike the former study, we did not find that greater than 50% of respondents agreed in all cases. In only six of the scenarios did we find more than 50% agreement on ASA PS class. The ASA PS classes assigned by the providers to the various patients had a range of three to five in eight of the scenarios, and in two of the scenarios there was a range of two. In the Haynes and Lawler study, nine of the scenarios had a range of three to five and only one scenario had a range of two. These findings demonstrate a lack of inter-rater reliability in the assignment of ASA PS scores which is consistent with previously reported studies (Haynes & Lawler, 1995; Owens et al., 1978; Ranta et al., 1997).

The results of this study suggest that the ASA PS classification is subjective in nature and unreliable when applied to individual patients. Sources of variability in assigning ASA PS scores include; nature of the surgery, potential difficult airway, history of smoking, and pregnancy. In addition to using similar rationale in assigning different scores (smoking, pregnancy, heart disease, lung disease, etc…) we found that some (88%) anesthesia providers are not using this instrument as it was intended, but rather as an indicator of anesthetic and surgical risk. This data raises several questions. What are providers perceptions about the meaning of this measurement, and how might this influence their assigning of ASA PS scores? Do planned surgical interventions influence provider assignments of scores? Do economic or political considerations for which this score is used influence decision making? Some forms of insurance reimbursement for anesthesia services are based, in part, on a patient's ASA PS score. Additional reimbursement units are awarded for ASA III (1), IV (2), and V (3). These additional units are added to the base units (specific to the procedure) and to the time units resulting in the total chargeable units. This total then determines the amount of reimbursement for anesthesia services (L.S. Broadston, personal communication, 25 November, 1998).

It is apparent from this study there are many sources of variability in the anesthesia providers use of the current ASA PS classification including; smoking, pregnancy, nature of the surgery, potential difficult airway, acute injury, and others.

Recommendations

These findings demonstrate there is much variance among anesthesia providers when assessing patient physical status, and that the ASA PS classification is very subjective in nature. We must ask; why do we need such a score in the practice of anesthesia? What is the purpose? The intended purpose, as the ASA PS classification was designed, is to collect and compare anesthesia statistical data within and among institutions. If it is being used to provide an assessment of anesthetic and/or surgical risk to individual patients or groups of patients, validity has not been established. If the anesthesia community needs such a risk indicator, a new objective classification scale should be developed, which would include surgical and anesthetic risk factors and the interactions among these.

The ASA PS classification lacks reliability and should not be used for administrative or public policy determination, for reimbursement, or for any other purpose as long as inter-rater reliability can not be demonstrated. A multidisciplinary taskforce should be formed to revise the ASA PS classification into an objective and reliable instrument. Anesthesia providers should then be appropriately educated to its actual meaning and relationship to other factors having a potential influence on patient outcomes.

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APPENDICES

Appendix A
Original ASA Physical Status Classification

Appendix A
Original ASA Physical Status Classification (1941)

Class 1. No organic pathology or patients in whom the pathological process is localized and does not cause any systemic disturbance or abnormality.

Examples: This includes patients suffering with fractures unless shock, blood loss, emboli, or systemic signs of injury are present in an individual who would otherwise fall in class 1. It includes congenital deformities unless they are causing systemic disturbance. Infections that are localized and do not cause fever, many osseous deformities, and uncomplicated hernias are included. Any type of operation may fall in this class since only the patient's physical condition is considered.

Class 2. A moderate but definite systemic disturbance, caused either by the condition that is to be treated by surgical intervention or which is caused by other existing processes, forms this group.

Examples:
Mild diabetes
Functional capacity I or IIa
Psychotic patients unable to care for themselves
Mild acidosis
Anemia moderate
Septic or acute pharyngitis
Chronic sinusitis with postnasal discharge
Acute sinusitis
Minor or superficial infections that cause a systemic reaction (if there is no systemic reaction, fever, malaise, leukocytosis, etc., aid in classifying)
Nontoxic adenoma of thyroid that causes but partial respiratory obstruction
Mild thryrotoxicosis
Acute osteomyelitis (early)
Chronic osteomyelitis
Pulmonary tuberculosis with involvement of pulmonary tissue insufficient to embarrass activity and without other symptoms

Class 3. Severe systemic disturbance from any cause or causes. It is not possible to state an absolute measure of severity, as this is a matter of clinical judgement. The following examples are given as suggestions to help demonstrate the difference between this class and class 2.

Examples:
Complicated or severe diabetes
Functional capacity IIb
Combinations of heart disease and respiratory disease or others that impair normal functions severely
Complete intestinal obstruction that has existed long enough to cause serious physiological disturbance
Pulmonary tuberculosis that, because of the extent of the lesion or treatment, has

reduced vital capacity sufficiently to cause tachycardia or dyspnea
Patients debilitated by prolonged illness with weakness of all or several systems
Pulmonary abscess

Class 4. Extreme systemic disorders which have already become an eminent threat to life regardless of the type of treatment. Because of their duration or nature there has already been damage to the organism that is irreversible. This class is intended to include only patients that are in an extremely poor physical state. There may not be much occasion to use this classification, but it should serve a purpose in separating the patient in very poor condition from others.

Examples:
Functional capacity III – (Cardiac Decompensation)
Severe trauma with irreparable damage
Complete intestinal obstruction of long duration with marked renal impairment
Patients who must have anesthesia to arrest a secondary hemorrhage where the patient is in poor condition associated with marked loss of blood.

Class 5. Emergencies that would otherwise be graded in Class 1 or Class 2.

Class 6. Emergencies that would otherwise be graded as Class 3 or Class 4.

Adapted from: Saklad, M. (1941). Grading of patients for surgical procedures. Anesthesiology, 2, 281-284.

Appendix B
Revised ASA Physical Status Classfication (1961)

Appendix B
Revised ASA Physical Status Classification (1961)

1 A normal healthy patient

2 A patient with mild systemic disease

3 A patient with a severe systemic disease that limits activity, but is not incapacitating

4 A patient with an incapacitating systemic disease that is a constant threat to life

5 A moribund patient not expected to survive 24 hours with or without operation

In the event of an emergency operation, precede the number with an E.

Adapted from: American Society of Anesthesiologists, (1961). New Classification of Physical Status. Anesthesiology, 24(1), 111.

Appendix C
Modified Physical Status Classification (1997)

Appendix C
Modified Physical Status Classification (1997)

1. The patient has no systemic disease, including the pathologic process for which the operation is needed, which is localized. *Example:* A healthy young man requires inguinal hernia repair.

2. The patient suffers mild to moderate systemic disease due either to the surgical condition or to a concomitant disease. *Example:* The patient describes taking oral medication for diabetes but has no end-organ damage and has never suffered severe ketoacidosis.

3. Severe systemic disease limits the patient's activity. *Example:* The patient above had a myocardial infarction last year and now has angina usually controlled by medical treatment.

4. Severe life-threatening disease markedly limits the patient. *Example:* The patient has congestive heart failure and can walk less than half a block.

5. The moribund patient has a 50 percent 24 hour mortality, regardless of the planned operation. *Example:* Our patient has infarcted bowel and is anuric, comatose, and has a blood pressure of 70/40 with a dopamine infusion.

6. The patient is declared dead and will undergo operation for organ donation. *Example:* 72 hours after a motorcycle accident, a PS 1 patient comes to the OR for liver and kidney donation.

E. When the patient requires emergency operation, an E is appended to the PS number. *Example:* The diabetic patient described suffered a strangulated hernia during the years before he developed coronary occlusion, and sought attention promptly; he was rated PS 2E.

Adapted from: Traber, K. (1997). Preparing to administer anesthesia (chapter 3). Introduction to Anesthesia (9th ed.). Longnecker, D.E. & Murphy, F.L. W.B. Saunders Company: Philadelphia

Appendix D
Cardiac Risk Index (1978 and 1986)

Appendix D
Cardiac Risk Index (1978)

1. S3 gallop or jugular-vein distention on preoperative examination
2. Myocardial infarction in preceding 6 months
3. Rhythm other than sinus, or premature atrial contractions on preoperative electrocardiogram
4. >5 premature ventricular contractions/min documented at any time before an operation
5. Intraperitoneal, intrathoracic or aortic operation
6. Age > 70 years
7. Important valvular aortic stenosis
8. Emergency operation
9. Poor general medical condition

Adapted from: Goldman, L., Caldera, D.L., Southwick, F.S., Nussbaurm, S.R., Murray, B., O'Malley, T.A., et al. (1978). Cardiac risk factors and complications in non-cardiac surgery. Medicine, 57(4), 357-370.

Appendix E
Cardiac Risk Index (Modified Multifactorial Index) (1986)

Appendix E
Cardiac Risk Index
(Modified Multifactorial Index)
(1986)

	Points
Coronary Artery Disease	
Myocardial infarction within 6 months	10
Myocardial infarction more than 6 months	5
Canadian Cardiovascular Society angina	
Class III	10
Class IV	20
Unstable angina within 6 months	10
Alveolar Pulmonary Edema	
Within 1 week	10
Ever	5
Valvular disease	
Suspected critical aortic stenosis	20
Arrythmias	
Rhythm other than sinus or sinus APB's* on last preoperative electrocardiogram	5
More than five premature ventricular contractions at any time prior to surgery	5
Poor general medical status	5
Age over 70	5
Emergency operation	10

Adapted from: Detsky, A.S., Abrams, H.B., McLaughlin, J.R., Drucker, D.J., Sasson, Z., Johnston, N., Scott, J.G., Forbath, N., & Hilliard, J.R. (1986). Predicting cardiac complications in patients undergoing non-cardiac surgery. Journal of General Internal Medicine, 1, 211-219.

Appendix F
Graded Anesthesia Score

Appendix F
Graded Anesthesia Score

Chronic health/physical status	Additional anaesthetic risk
1. A normal healthy patient	1. No additional risk
2. A patient with mild systemic disease	2. Minor
2.5 A patient with moderate systemic disease	2.5 Moderate
3. A patient with severe systemic disease that limits activity but is not incapacitating	3. Major
4. A patient with an incapacitating systemic disease that is a constant threat to life	4. Life threatening

5. A moribund patient who is not expected to survive for 24 hours with or without an operation

Adapted from: Lake, A.P. & Williams, E.G. (1997). ASA classification and perioperative variables: Graded anaesthesia score? British Journal of Anaesthesia, 78,(2), 228-229.

Appendix G
Variability in the ASA PS Classification Survey (1998-1999)

Appendix G

Variability in the ASA Physical Status Classification Capt Wendy Aronson (1998-1999)

Thank you for participating in this study. The anonymity of all participating providers will be protected with no coding of the data that would link surveys to individuals or hospitals. Below is a list of demographic and opinion questions followed by 10 case scenarios. Please assign an ASA classification to the patients in each scenario and use the space provided to record comments about your decision. Possible sources of variability are the main focus of this study, so it is important for you to provide some rationale for your difficult choices. There is space at the end of the survey for any additional comments or suggestions you would like to make regarding this study. Thank you again for your input. The results of this study will be forwarded to your department upon completion of the study.

Demographics & Opinion Questions (please circle your answer):

1. What type of anesthesia provider are you? **(circle one)** Anesthesiologist Nurse Anesthetist
2. Military status? **(circle one)** Military Non-military
3. How long have you been practicing anesthesia? Years_________
4. Do you routinely record ASA scores on your patients? **(circle one)** YES NO
5. Do you find the ASA scores of patients helpful in your daily practice? **(circle one)** Helpful Somewhat Helpful Not Helpful
6. Do you see the ASA classification as an anesthetic "risk indicator"? **(circle one)** YES NO
7. Do you see the ASA classification as a surgical "risk indicator"? **(circle one)** YES NO

Case Scenarios:

1. A 19-year-old man was involved in a motor vehicle accident 10 hours ago. He now requires fixation of a compound fracture of the tibia. He was unconscious at the accident site. On arrival to the emergency room, he responded to pain, making incomprehensible sounds. Computerized tomography revealed a large frontal contusion, but no signs of intracranial hypertension. He now obeys commands and opens his eyes when spoken to.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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2. A 66-year-old man presents for anterior resection of the rectum for carcinoma. He has smoked 20-30 cigarettes per day for the last 50 years, and has had a productive cough for the last 15 years. He had two courses of antibiotics from his general practitioner within the last 6 months for a "chest infection", but is now producing clear sputum. He is breathless on climbing one flight of stairs, but plays golf twice a week, usually managing to complete a full round. On examination his chest is clear but is slightly hyper-inflated. He has no cardiovascular symptoms or signs, and does not take regular medication. Additional data: Hb = 13.6g/dL, BUN and electrolytes within laboratory reference range, chest x-ray shows slightly hyper-inflated lung fields, ECG is unremarkable, FEV1 is 2.31 and FVC is 3.51.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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3. A 72-year-old man presents for elective repair of an abdominal aortic aneurysm. He had a myocardial infarction 2 years ago with no further complications. He has had stable angina for the last 5 years for which he takes nifedipine and nitroglycerin sub lingual spray, which he uses about once per week. Examination reveals a systolic murmur loudest over the aortic area. His blood pressure is 170/80 mmHg. Additional data: ECG reveals Q waves in leads II, III, and aVF, with borderline left ventricular hypertrophy. Chest x-ray and full blood count are unremarkable. BUN is 30 mg/dL, creatinine is 2.0 mg/dL, and electrolytes are normal.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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4. A 69-year-old man, weighing 80 kg, is admitted for transurethral prostatectomy. He has smoked all his adult life but states that he enjoys good health. Closer questioning reveals decreasing exercise tolerance over the last few years and shortness of breath when walking on an incline. He is given symptomatic relief of this by using an atrovent inhaler and he uses a beconase inhaler prophylactically. He produces a small amount of clear sputum daily. Physical exam reveals slight intercostal retractions, with scattered expiratory rhonchi. His FEV1 is 2.21, and FVC is 3.91. CBC, BUN, electrolytes, ECG and chest x-ray are all unremarkable.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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5. A 61-year-old woman has carcinoma of the middle third of the esophagus with diet restricted to liquids. She is scheduled for esophagectomy (involving an upper abdominal incision and a right-sided thoracotomy). She began to experience angina one year ago, but had no further episodes after daily atenolol was started. Recently, when she became unable to swallow the tablets, her anginal symptoms returned whenever exercising. ECG, chest x-ray, liver function tests, BUN and electrolytes are normal. Her Hb is 10.1 g/dL, with a microcytic picture. FEV1 and FVC are approximately 90% of predicted for age and weight (before the onset of the dysphagia).

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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6. A 42-year-old woman suffered a subarachnoid hemorrhage 36 hours ago. She still has a severe headache, but her level of consciousness is not impaired. The only abnormality on neurological examination is a right sided oculomotor nerve palsy. Previously she has enjoyed good health. Cerebral angiography identified an anterior communicating artery aneurysm, with little evidence of arterial spasm. She now presents for craniotomy and clipping of the aneurysm.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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7. A 57-year-old male insulin-dependent diabetic is to have a right knee joint replacement because of osteoarthritis. This knee was injured playing football 20 years previously. There is no significant arthritis in any other joint. He is otherwise healthy and monitors his blood glucose regularly, which is rarely more than 150 mg/dL. History and physical examination are unremarkable. There are no cardiovascular or opthalmic abnormalities noted. Apart from a creatinine of 2.0 mg/dL, all routine pre-operative labs and tests are normal.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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8. A 23-year-old female, weighing 60 kg, presents for a left knee arthroscopy. She has smoked 1 pack per day for the past 3 years. She denies any health problems other than injury to the left knee in a skiing accident approximately 2 months ago. Before the accident, she was running approximately 3 miles 3 times per week. Physical exam is unremarkable. Hcg is negative.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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9. A 25-year-old female, gravida 1 para 0, presents in active labor. She is dilated to 5cm and is requesting a labor epidural. Height is 65 inches and weight is 80 kg. Her pregnancy course has been uneventful. Hct is 38%, Hb is 12.4g/dL, electrolytes are within normal limits. She has no significant history and physical exam is normal for full term pregnancy.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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10. A 26-year-old woman presents for a bilateral tubal reanastamosis. She is in excellent health. History, physical and review of systems are unremarkable. During your pre-operative visit you notice she has a small mouth with protruding upper incisors, and a small chin. Mouth opening is restricted. She was seen by a maxillo-facial surgeon 3 years ago after being hit in the face by her boyfriend. No bony injury was found, but it was felt by her physician that she may be left with some temporo-mandibular joint dysfunction. She has never previously had a general anesthetic.

ASA SCORE: **1 2 3 4 5 6 (E)**
Comments:

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Additional Comments & Suggestions:

The scenarios in this survey were adapted with several modifications from: Haynes & Lawler, (1995). An assessment of the consistency of ASA physical status classification allocation. Anesthesia, 50, 195-199.

Appendix H
Data Analysis from the Haynes & Lawler (1995) Study

Appendix H
Data Analysis from the Haynes & Lawler (1995) Study

Data from this study was reported in the following fashion for total ASA scores:

ASA Grades

	1	2	3	4	5
Case 1 Total	4 (4.1%)	93 (95.9%)	0	0	0
Case 2 Total	17 (17.5%)	5 (5.2%)	52 (53.6%)	23(23.7%)	0
Case 3 Total	0	36 (37.1%)	59 (60.8%)	23 (40.2%)	0
Case 4 Total	15 (15.4%)	11 (11.3%)	29 (29.9%)	39 (40.2%)	1 (1.0%)
Case 5 Total	0	0	4 (4.1%)	44 (45.4%)	59 (60.8%)
Case 6 Total	0	14 (14.4%)	62 (63.9%)	21 (21.6%)	0
Case 7 Total	0	31 (32.0%)	63 (64.9%)	3 (3.1%)	0
Case 8 Total	0	16 (16.5%)	57 (58.8%)	23 (23.7%)	1 (1.0%)
Case 9 Total	85 (87.6%)	7 (7.2%)	5 (5.2%)	0	0
Case 10 Total	1 (1.0%)	80 (82.5%)	16 (16.5%)	0	0

Adapted from: Haynes & Lawler. (1995). An assessment of the consistency of ASA physical status classification allocation. Anesthesia, 50, 195-199.

Appendix I
Data Analysis of Case Scenarios

Variability in the ASA Physical Status Classification
Data Table of Scenario Results

	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
Scenario 1												
CRNA	0	7(10%)	3(4.3%)	13(18%)	3(4.3%)	12(17.1%)	0	1(1.4%)	0	0	0	0
MDA	1(1.4%)	6(8.5%)	1(1.4%)	11(16%)	1(1.4%)	5(7.1%)	0	5(7.1%)	0	1(1.4%)	0	0
Combined	1(1.4%)	13(18.6%)	4(5.7%)	24(34.3%)	4(5.7%)	17(24.3%)	0	6(8.6%)	0	1(1.4%)	0	0
Military	0	11(16%)	1(1.4%)	16(23%)	1(1.4%)	9(13%)	0	2(2.9%)	0	1(1.4%)	0	0
Non-military	1(1.4%)	1(1.4%)	3(4.3%0	8(11.6)	3(4.3%)	8(11.4%)	0	4(5.8%)	0	0	0	0
Combined	1(1.4%)	12(17.4%)	4(5.8%)	24(34.8%)	0	17(24.6%)	0	6(8.7%)	0	1(1.4%)	0	0
Haynes & Lawler (Case 2)	**17(17.5%)**	*	**5(5.2%)**	*	**52(53.6%)**	*	**23(23.7%)**	*	**0**	*	*	*
Scenario 2												
CRNA	0	0	19(27.1%)	0	20(28.6%)	0	0	0	0	0	0	0
MDA	0	0	16(22.8%)	0	15(21.4%)	0	0	0	0	0	0	0
Combined	0	0	35(50%)	0	35(50%)	0	0	0	0	0	0	0
Military	0	0	22(31.9%)	0	19(27.1%)	0	0	0	0	0	0	0
Non-Military	0	0	13(18.8%)	0	15(21.4%)	0	0	0	0	0	0	0
Combined	0	0	35(50.7%)	0	34(49.3%)	0	0	0	0	0	0	0
Haynes & Lawler (Case 3)	**0**	*	**36(37.1%)**	*	**59(60.8%)**	*	**2(2.1%)**	*	**0**	*	*	*
Scenario 3												
CRNA	0	0	0	0	31(44.3%)	0	8(11.6%)	0	0	0	0	0
MDA	0	0	1(1.4%)	0	27(39.1%)	1(1.4%)	2(2.9%)	0	0	0	0	0
Combined	0	0	1(1.4%)	0	58(82.9%)	1(1.4%)	10(14.3%)	0	0	0	0	0
Military	0	0	1(1.4%)	0	36(51.4%)	0	4(5.8%)	0	0	0	0	0
Non-military	0	0	0	0	22(31.9%)	1(1.4%)	5(7.1%)	0	0	0	0	0
Combined	0	0	1(1.4%)	0	58(84%)	1(1.4%)	9(13%)	0	0	0	0	0
Haynes & Lawler (Case 6)	0	*	14(14.4%)	*	62(63.9%)	*	21(21.6%)	*	0	*	*	*

Variability in the ASA Physical Status Classification
Data Table of Scenario Results

	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
Scenario 4												
CRNA	0	0	20(28.6%)	0	18(25.7%)	0	1(1.4%)	0	0	0	0	0
MDA	0	0	16(22.8%)	0	14(20.3%)	0	1(1.4%)	0	0	0	0	0
Combined	0	0	36(51.4%)	0	32(45.7%)	0	2(2.9%)	0	0	0	0	0
Military	0	0	22(31.9%)	0	18(26.1%)	0	1(1.4%)	0	0	0	0	0
Non-Military	0	0	14(20.3%)	0	13(18.8%)	0	1(1.4%)	0	0	0	0	0
Combined	0	0	36(52.2%)		31(44.9%)	0	2(2.9%)	0	0	0	0	0
Haynes & Lawler (Case 7)	0	*	31(32.0%)	*	63(64.9%)	*	3(3.1%)	*	0	*	*	*
Scenario 5												
CRNA	0	0	8(11.4%)	0	27(39.1%)	0	4(5.8%)	0	0	0	0	0
MDA	0	0	5(7.1%)	0	20(28.6%)	0	6(8.5%)	0	0	0	0	0
Combined	0	0	13(18.6%)	0	47(67.1%)	0	10(14.3%)	0	0	0	0	0
Military	0	0	7(10%)	0	29(42%)	0	5(7.1%)	0	0	0	0	0
Non-Military	0	0	6(8.5%)	0	18(26.1%)	0	4(5.8%)	0	0	0	0	0
Combined	0	0	13(18.8%)	0	47(68.1%)	0	9(13.0%)	0	0	0	0	0
Haynes & Lawler (Case 8)	0	*	16(16.5%)	*	57(58.8%)	*	23(23.7%)	*	1(1.0%)	*	*	*
Scenario 6												
CRNA	4(5.8%)	1(1.4%)	10(14.3%)	2(2.8%)	11(15.7%)	1(1.4%)	7(10%)	3(4.3%)	0	0	0	0
MDA	1(1.4%)	1(1.4%)	7(10%)	3(4.3%)	8(11.4%)	1(1.4%)	6(8.6%)	4(5.8%)	0	0	0	0
Combined	5(7.1%)	2(2.9%)	17(24.3)	5(7.1%)	19(27.1%)	2(2.9%)	13(18.6%)	7(10.0%)	0	0	0	0
Military	4(5.8%)	2(2.8%)	8(11.4%)	4(5.8%)	12(17.1%)	0	6(8.6%)	5(7.1%)	0	0	0	0
Non-Military	1(1.4%)	0	9(12.9%)	1(1.4%)	7(10%)	1(1.4%)	7(10%)	2(2.8%)	0	0	0	0
Combined	5(7.1%)	2(2.9%)	17(24.3%)	5(7.1%)	19(27.1%)	1(1.4%	13(18.6%)	7(10.0%)	0	0	0	0
Haynes & Lawler (Case 4)	15(15.4%)	*	11(11.3%)	*	29(29.9%)	*	39(40.2%)	*	1(1.0%)	*	*	*

Variability in the ASA Physical Status Classification
Data Table of Scenario Results

	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
Scenario 7												
CRNA	0	0	34(48.6%)	0	5(7.1%)	0	0	0	0	0	0	0
MDA	1(1.4%)	0	26(37.1%)	0	4(5.8%)	0	0	0	0	0	0	0
Combined	1(1.4%)	0	60(85.7%)	0	9(12.9%)	0	0	0	0	0	0	0
Military	0	0	34(48.6%)	0	7(10%)	0	0	0	0	0	0	0
Non-Military	1(1.4%)	0	25(36.2%)	0	2(2.8%)	0	0	0	0	0	0	0
Combined	1(1.4%)	0	59(85.5%)	0	9(13.0%)	0	0	0	0	0	0	0
Haynes & Lawler (Case 10)	1(1.0%)	*	80(82.5%)	*	16(16.5%)	*	0	*	0	*	*	*
Scenario 8												
CRNA	9(12.8%)	0	30(42.8%)	0	0	0	0	0	0	0	0	0
MDA	11(15.7%)	0	20(28.6%)	0	0	0	0	0	0	0	0	0
Combined	20(28.6%)	0	50(71.4%)	0	0	0	0	0	0	0	0	0
Military	8(11.4%)	0	33(47.1%)	0	0	0	0	0	0	0	0	0
Non-Military	11(15.7%)	0	17(24.3%)	0	0	0	0	0	0	0	0	0
Combined	19(27.5%)	0	50(72.5%)	0	0	0	0	0	0	0	0	0
Haynes & Lawler	*	*	*	*	*	*	*	*	*	*	*	*
Scenario 9												
CRNA	8(11.4%)	3(4.3%)	19(27.1%)	9(12.8%)	0	0	0	0	0	0	0	0
MDA	5(7.1%)	3(4.3%)	12(17.1%)	11(15.7%)	0	0	0	0	0	0	0	0
Combined	13(18.6%)	6(8.6%)	31(44.3%)	20(28.6%)	0	0	0	0	0	0	0	0
Military	7(10%)	4(5.8%)	16(23.2%)	14(20%)	0	0	0	0	0	0	0	0
Non-Military	6(8.6%)	2(2.8%)	15(21.7%)	5(7.1%)	0	0	0	0	0	0	0	0
Combined	13(18.8%)	6(8.7%)	31(44.9%)	19(27.5%)	0	0	0	0	0	0	0	0
Haynes & Lawler	*	*	*	*	*	*	*	*	*	*	*	*

Variability in the ASA Physical Status Classification
Data Table of Scenario Results

	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
Scenario 10												
CRNA	30(42.8%)	0	8(11.4%)	0	1(1.4%)	0	0	0	0	0	0	0
MDA	25(36.2%)	0	6(8.6%)	0	0	0	0	0	0	0	0	0
Combined	55(78.6%)	0	14(20.0%)	0	1(1.4%)	0	0	0	0	0	0	0
Military	33(47.8%)	0	7(10%)	0	1(1.4%)	0	0	0	0	0	0	0
Non-Military	21(30.4%)	0	7(10%)	0	0	0	0	0	0	0	0	0
Combined	54(78.3%)	0	14(20.3%)	0	1(1.4%)	0	0	0	0	0	0	0
Haynes & Lawler (Case 9)	85(87.6%)	*	7(7.2%)	*	5(5.2%)	*	*	*	*	*	*	*