NURSES’ PERCEPTIONS ON THE USE AND EFFECTIVENESS OF CAPNOGRAPHY IN THE EMERGENCY DEPARTMENT

A Thesis
Presented
to the Faculty of
California State University, Chico

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
in
Nursing

by
Catherine E. Payne
Fall 2010
NURSES’ PERCEPTIONS ON THE USE AND EFFECTIVENESS OF CAPNOGRAPHY IN THE EMERGENCY DEPARTMENT

A Thesis

by

Catherine E. Payne

Fall 2010

APPROVED BY THE DEAN OF GRADUATE STUDIES AND VICE PROVOST FOR RESEARCH:

__________________________
Katie Milo, Ed.D.

APPROVED BY THE GRADUATE ADVISORY COMMITTEE:

__________________________
Irene S. Morgan, Ph.D.
Graduate Coordinator

__________________________
Jennifer Lillibridge, Ph.D., Chair

__________________________
Irene S. Morgan, Ph.D.
ACKNOWLEDGEMENTS

I am thankful to my Graduate Coordinator, Irene Morgan, whose encouragement and support from the initial draft to the final thesis allowed me to gain a greater understanding of nursing research.

I would like to express my sincerest thanks to my thesis advisor Jennifer Lillibridge, for her helpful advice, support and dedication during the process of writing this thesis. I would like to thank her for her enormous patience and encouragement. You have been a great mentor for which I will forever be grateful!

I would like to thank Professor Nancy Carter for her valuable input, for which I am most appreciated.

Lastly, I want to thank my family for their support, especially my husband, Bill Payne, you are the greatest!
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>iii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>vi</td>
</tr>
<tr>
<td>Abstract</td>
<td>vii</td>
</tr>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Background</td>
<td>2</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>3</td>
</tr>
<tr>
<td>Purpose</td>
<td>5</td>
</tr>
<tr>
<td>Relevance of the Study to Nursing</td>
<td>6</td>
</tr>
<tr>
<td>Theoretical Framework</td>
<td>6</td>
</tr>
<tr>
<td>Research Questions</td>
<td>8</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>9</td>
</tr>
<tr>
<td>Qualifications of the Researcher</td>
<td>9</td>
</tr>
<tr>
<td>Transitional Statements</td>
<td>10</td>
</tr>
<tr>
<td>II. Review of the Literature</td>
<td>11</td>
</tr>
<tr>
<td>Review of Literature</td>
<td>11</td>
</tr>
<tr>
<td>Critical Care</td>
<td>12</td>
</tr>
<tr>
<td>Availability</td>
<td>14</td>
</tr>
<tr>
<td>Pre-Hospital and Inter-Hospital Transport</td>
<td>15</td>
</tr>
<tr>
<td>Emergency Department</td>
<td>18</td>
</tr>
<tr>
<td>Traditional Statements</td>
<td>21</td>
</tr>
<tr>
<td>III. Research Methodology</td>
<td>23</td>
</tr>
<tr>
<td>Research Methodology</td>
<td>23</td>
</tr>
<tr>
<td>Theoretical/Philosophical Underpinnings</td>
<td>24</td>
</tr>
<tr>
<td>Setting/Population</td>
<td>24</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>25</td>
</tr>
<tr>
<td>Data Collection</td>
<td>26</td>
</tr>
</tbody>
</table>
## CHAPTER PAGE

<table>
<thead>
<tr>
<th>Data Collection Procedure</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative Analysis</td>
<td>28</td>
</tr>
<tr>
<td>Transitional Statements</td>
<td>29</td>
</tr>
</tbody>
</table>

### IV. Results

<table>
<thead>
<tr>
<th>Results</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Findings</td>
<td>32</td>
</tr>
<tr>
<td>Transitional Statements</td>
<td>34</td>
</tr>
</tbody>
</table>

### V. Discussion

<table>
<thead>
<tr>
<th>Discussion</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td>30</td>
</tr>
<tr>
<td>Rational for Use</td>
<td>36</td>
</tr>
<tr>
<td>Limitations</td>
<td>37</td>
</tr>
<tr>
<td>Accuracy</td>
<td>38</td>
</tr>
<tr>
<td>Safety</td>
<td>39</td>
</tr>
<tr>
<td>Availability</td>
<td>39</td>
</tr>
<tr>
<td>Transport</td>
<td>40</td>
</tr>
<tr>
<td>Ease of Set Up and Tolerated Device</td>
<td>41</td>
</tr>
<tr>
<td>Interference</td>
<td>42</td>
</tr>
<tr>
<td>Quality and Recommendation</td>
<td>42</td>
</tr>
<tr>
<td>Theoretical Framework</td>
<td>43</td>
</tr>
<tr>
<td>Limitations of Study</td>
<td>44</td>
</tr>
<tr>
<td>Implication for Practice</td>
<td>44</td>
</tr>
<tr>
<td>Implications for Research</td>
<td>45</td>
</tr>
<tr>
<td>Implications for Education</td>
<td>45</td>
</tr>
<tr>
<td>Implications for Emergency Nurses</td>
<td>46</td>
</tr>
<tr>
<td>Conclusions</td>
<td>46</td>
</tr>
</tbody>
</table>

References ............................................................................................................. 47

## Appendices

<table>
<thead>
<tr>
<th>A. Informed Consent Form</th>
<th>53</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Survey</td>
<td>57</td>
</tr>
<tr>
<td>C. Letter of Introduction to Emergency Department Nurses</td>
<td>61</td>
</tr>
<tr>
<td>D. Reminder Letter</td>
<td>63</td>
</tr>
<tr>
<td>E. Human Subjects Clearance / Post Data Collection Forms</td>
<td>65</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demographic Characteristics of Respondents</td>
<td>31</td>
</tr>
</tbody>
</table>
ABSTRACT

NURSES’ PERCEPTIONS ON THE USE AND EFFECTIVENESS OF CAPNOGRAPHY IN THE EMERGENCY DEPARTMENT

by

Catherine E. Payne

Master of Science in Nursing

California State University, Chico

Fall 2010

The purpose of this study was to determine the effectiveness of capnography monitoring in providing safe and effective nursing care in the emergency department (ED). Study participants were surveyed regarding both the ease of use of capnography as well as the effectiveness of capnography as a nursing assessment instrument in the ED.

Care of patients in the ED is challenging in the immediate resuscitation period. Intubated patients pose an increased challenge to ED nurses because of the array of potential or actual complications associated with mechanical ventilation. One adjunct recommended for use in the ED, though not widely available or consistently used, is capnography.

A quantitative, descriptive design was chosen to explore nurses’ perceptions on the use and effectiveness of capnography. The research setting was a Northern California ED because it had implemented a standard of care in which all intubated
patients are required to have capnography. A survey was distributed to all ED nurses who frequently provided nursing care to intubated patients.

Eighty-nine nurses (95%) agreed capnography contributes to improving the safety of patient care. Ninety-five percent confirmed capnography contributes to quality patient care. Survey results demonstrated capnography was viewed as assisting in patient assessment and recommended for use in other EDs.

This study provides evidence that suggests capnography is an effective assessment instrument that is well received by the ED nurses participating in this study. Further studies are indicated to clearly define the role of capnography during nursing assessment in the ED.
CHAPTER I
INTRODUCTION

Care of patients in the emergency department is challenging in the immediate resuscitation period. Vital signs and patients’ symptoms may change quickly requiring emergency department nurses to rapidly identify patients’ needs and intervene to reduce risks to patients’ stability. Early in the resuscitation, aggressive interventions have been found to improve patient outcomes; monitoring is critical in this effort (Andrews & Nolan, 2005). Endotracheal intubated patients pose an increased challenge to emergency department nurses because of the array of potential or actual complications associated with mechanical ventilation. The artificial airway poses a risk for obstruction, displacement or dislodgment requiring nurses to rapidly identify life-threatening situations that require immediate interventions (McCorstin, Cottrell, Rose, & Dwyer, 2008). One adjunct recommended for use in the emergency department, though not widely available or consistently used, is capnography (Delorio, 2005).

Capnography is a non-invasive monitoring system measuring carbon dioxide (CO2) during inhalation and exhalation. Capnography provides information about airway patency and physiologic information such as a patient’s ventilation and perfusion status. Nagler and Krauss (2009) assert that capnography in the confirmation of endotracheal tube placement is considered a standard of care offering more proven accuracy than “traditional confirmation methods, including auscultation, chest rise, and tube
condensation, and more rapid than oximetry in identifying esophageal intubations” (p. 85). Additionally, capnography can be utilized in patients’ early resuscitation period along with conventional monitoring such as blood pressure, heart rate, respiratory rate and body temperature to help determine treatment.

Background

Capnography was first developed in 1942 and since 1986 has become a standard of care during anesthesia (Gilboy, & Hawkins, 2006). Capnography is a noninvasive monitoring of end-tidal CO2 (ETCO2) offering information on patients’ oxygenation, ventilation, and acid base balance and assists in assessing the integrity of the ventilator circuit. Capnography is currently being utilized in the operating room, intensive care units and is valuable during continuous monitoring of tube position during transport of critically ill patients (Nagler, & Krauss, 2009).

During mechanical ventilation CO2 is exhaled and is measured through a device called a capnometer. The measurement is a quantitative estimation of the partial pressure of expired carbon dioxide (PCO2) and provides the benefit of confirmation of tracheal intubation (Cheifetz, & Myers, 2007). The continuous reading provides an assessment of mechanical ventilation that is utilized throughout the intubation period. However, Cheifetz and Myers caution there are factors that can cause inaccuracy of CO2 values such as inadequate perfusion, patients with abnormal pulmonary function and conditions that increase dead space. Therefore, interpretation of CO2 values always requires patient assessment consideration.
The capnogram is the waveform produced during the respiratory cycle that provides useful information on the patient’s ventilator status (Zwerneman, 2006). Similar to the interpretation of electrocardiogram (EKG) patterns, the capnogram waveform shape can assist in determining confirmation of endotracheal tube placement or the presence of obstruction and other abnormal patterns that assist in planning intervention in patient care. A normal capnogram waveform has a flattening before the end of exhalation. A continued rise in waveform can indicate the patient may have a kinked endotracheal tube or bronchospasm. The interpretation of a capnogram can also provide useful clinical information in managing respiratory illnesses (Nagler & Krauss, 2009). For example, increasing ETCO2 in a patient with obstructive lung disease rapidly alerts care provider with feedback for clinical management.

Statement of the Problem

Critically ill patients are requiring longer stays in the emergency department because intensive care units are impacted. The standard of intensive patient care should be provided consistently throughout hospitalization regardless of the patient care arena. Standards of care, utilized in the intensive care unit for monitoring critically ill patients, are therefore required in the emergency department environment to optimize patient care. This fast paced constantly changing environment necessitates requirements for adjuncts to assist in monitoring patients to prevent potential complications. Capnography is one example of such an adjunct therapy that may assist in eliminating these general and global health care concerns.
Some emergency departments have implemented a capnography policy mandating its use after recognizing “methods of monitoring mechanically ventilated patients were not providing them with the data needed to achieve optimal outcomes” (Anderson, 2006, p. 152). Capnography has been shown to offer valuable information for the clinical management of intubated patients such as how the patient’s cells use oxygen and how well they are eliminating CO2 from the body. Further, “End-tidal CO2 monitoring can reflect changes in CO2 levels within 10 seconds, whereas, pulse oximetry takes several minutes to reflect a change” (Evans, Lavorato, & Lord, 2008, p. 30). Capnography has also been endorsed by national position statements and guidelines for measuring a patient’s ventilator status (Delorio, 2005). However, capnography may not accurately reflect PaCO2 in patients with inadequate perfusion (Lee et al., 2009).

Capnography is new to the emergency department setting and information is lacking regarding the use and effectiveness of this technology by emergency department nurses in improving the quality of their patient care.

Nursing assessment is an important aspect of patient monitoring. Capnography is one monitoring device that is readily available and not frequently utilized in the emergency department. While research has shown its usefulness in clinical settings, it is uncertain how nurses view this tool. The literature is unclear if intubated patients would benefit from capnography in the emergency department. Emergency department nurses are at the forefront of patient care and it is essential to determine if nurses value capnography as effective and useful in nurses’ delivery of care. Research is needed to provide evidence to determine if capnography is viewed by nurses as a necessary adjunct during nursing assessment.
Purpose

Capnography is new to the emergency department setting and emergency department nurses are the best source to determine if capnography is an effective and efficient adjunct in meeting demands in the management of intubated patients. The purpose of this study was to determine if emergency department nurses consider capnography an effective monitoring adjunct in the provision of safe and effective nursing care for intubated patients. The implementation of technology requires evaluation to assess its usefulness and impact on improving patient care. Although capnography is not a new technology, the technology is new to emergency department nurses. This means the implementation of capnography requires critical thinking and technical knowledge to support accurate patient care decision making. Surveying emergency nurses to determine their perceptions concerning the use and effectiveness of this technology in practice, the impact on the care processes and patient outcomes is invaluable.

A Level 1 Adult and Pediatric Trauma Center located in Northern California implemented in September 2008, a nursing practice change in which all intubated patients in the emergency department were to be monitored by capnography (C. Williams, personal communication, January 5, 2010). The purpose of implementing the change in clinical practice was to promote clinical decision making to improve patient safety and promote quality care. To this date the effectiveness of the use of capnography in this emergency department has not been evaluated. The feasibility of the change in practice should be evaluated to validate the evidence-based practice change. A clinical practice protocol based on research has the potential to improve patient care. In addition,
obtaining nurses’ perceptions about the use of capnography during assessment, planning and intervention of critically ill and/or injured patients will provide insight into whether capnography is an important adjunct in improving patient outcomes in the emergency department. Emergency department nurses’ perceptions are an important factor to determine if the practice change was warranted.

Relevance of the Study to Nursing

This study will aid in understanding more about one nursing intervention in which nurses work to gain knowledge to bring about positive changes for their patients. Despite recommendations from several medical societies in support of the use of end-tidal CO2 monitoring, end-tidal CO2 monitoring is not frequently used or applied by emergency physicians. This will be the first known study to explore emergency department nurses’ current perceptions about the use and effectiveness of this new technology in the emergency department setting. Nurses are a valuable source of information to determine if the use of this technology will assist in caring for patients in meeting their self-care demands. It is anticipated the results will contribute to the body of nursing knowledge towards the provision of improving the quality and safety of patient care through the use of technology.

Theoretical Framework

Dorothea E. Orem’s Self-Care Deficit Theory of Nursing was used as a theoretical framework for this study. The theory postulates individuals perform daily activities of self care toward the maintenance of human regulatory function (Orem, 2001). Activities include conscious behaviors such as eating, sleeping, and maintenance
of general hygiene as well as non-cognitive processes such as breathing and maintenance of blood pressure. The materials necessary for activities of self care are air, water, and food, which are considered essential for life. In a clinical setting, disease processes often limit the ability of patients to maintain the quality and quantity of these materials known to be compatible with human life. Orem’s Theory proposes when individuals are unable to meet their self care needs, self deficits arise and some intervention will be required (Orem, 2001).

The self care deficit theory is a combination of three theories: theory of self care, theory of self care deficit and the theory of nursing system (Orem, 2001). In the theory of self care, individuals perform activities to maintain their own health. Self care deficit theory, individuals are unable to perform these activities and a self care deficit arises. Individuals are in need of self care that can be helped by nursing. The nursing system theory proposes once a need is identified, the nurse is required to provide care based on the degree of self care deficit. The care provided is then evaluated to determine if planned goals were met.

Orem’s theory explains that self-care deficit is the reason nursing is required. Nurses perform actions to relieve deficits and work towards promoting individuals own self care. An intubated patient’s inability to maintain a sufficient intake of air is an example of a self care deficit. Nurses are required to have knowledge and skills to meet individuals self care demands and to perform actions to meet those requirements. Capnography is a technology that can provide valuable information about an individual’s ventilator status as it relates to inadequate air intake. However, does capnography assist nurses in assessing patient’s self care deficit and aid in performing actions to meet
individual’s needs? Orem’s theory was used as a framework to determine if nurses view capnography supportive in patient care decision making in order to meet the needs of patients and to identify and limit patients’ self care deficits.

Research Questions

“Nursing science as a process begins with investigations of what, why, or how questions in a search for understanding of nursing practice” (Orem, 2001, p. 161). Care of intubated patients in the emergency department is challenging and monitoring devices that can aid aggressive intervention to improve patient outcomes are essential. The use of technology requires evaluation to determine its usefulness and impact on improving the quality of patient care. Despite the proven clinical/research benefits of capnography and its subsequent implementation in various hospital settings, it is still unclear if the medical management team, especially nurses, who are at forefront of care, find this technology useful in their day to day practice. The research questions were:

What are emergency department nurses’ perceptions about the use of capnography in the emergency department setting?

What are emergency department nurses’ perceptions about the effectiveness of capnography in the emergency department setting?

These questions served to determine whether from a nursing standpoint, capnography has a valuable function in the emergency department setting, and if it does, this technology may be implemented in other emergency departments in the future.
Definition of Terms

Definitions of terms used in this research have been provided to give a clearer understanding of the variables involved in this study.

- **Capnography**- A graphic display of instantaneous CO2 concentration (FCO2) versus time or expired volume during a respiratory cycle (CO2 waveform or capnogram) (Kodali, 2008).

- **End-tidal CO2**- The level of carbon dioxide in the air exhaled from the body (The Free Dictionary, 2010).

- **Endotracheal intubation**- The placement of a tube into the trachea in order to maintain an open airway in patients who are unconscious or unable to breathe on their own (Encyclopedia of Surgery, 2010).

- **PaCO2**- Partial pressure of CO2 in arterial blood (Kodali, 2008).

Qualifications of the Researcher

The researcher is a nursing graduate student at California State University, Chico with 19 years of critical care nursing experience. The researcher is a Critical Care Registered Nurse with experience in the intensive care unit, emergency department and pre-hospital settings. In the pre-hospital setting the researcher had 9 years of experience using capnography on critically ill intubated patients. The researcher was actively involved in a research project comparing end-tidal carbon dioxide during helicopter transport and outcome of trauma patients. Further, the researcher has completed graduate level course work in research and theory.
Transitional Statements

Capnography is a valuable non-invasive monitoring tool endorsed by national endorsement papers and implemented as a nursing practice change in some intuitions. Technology usefulness and impact on improving the quality of patient care requires evaluation. The next chapter will review available literature to examine the current use of capnography in different patient care settings to identify best-evidence based practices for airway management of intubated patients.
CHAPTER II

REVIEW OF THE LITERATURE

Caring for intubated patients in the emergency department is challenging for nurses. The early resuscitation period demands frequent assessment and interventions of the critically ill and injured to optimize and improve patient outcomes. Capnography is a non-invasive monitoring device that is not frequently used in the emergency department setting, but provides valuable assessment information. Examining emergency nurses’ perceptions about capnography will validate if this technology is an important adjunct needed in the emergency department setting. This chapter will provide a review of the literature specific to capnography use to provide a context for this current study.

Review of Literature

Intubated patients are at increased risk of morbidity and mortality in which monitoring tools are valuable in minimizing risks and maximizing interventions to optimize patient care. A review of literature was conducted to examine the current use of capnography, a non-invasive airway monitoring tool. Capnography use and effectiveness in different patient care settings was examined to identify best-evidence based practices for airway management of intubated patients.

An online search was conducted using the Academic Search option of CINAHL research database of the Meriam Library. PubMed and GoogleScholar.com
were also utilized. Search terms used: Capnography, End-Tidal Carbon Dioxide (ETCO2), monitoring, emergency department, intubated, transport, and evidence-based. Articles and studies published between the years 2005 and 2010 were considered. The literature search produced 222 articles, which were narrowed further to produce literature examining application of capnography on intubated patients. Studies were selected examining the availability and usages of capnography outside of the operating room.

Studies were evaluated in a structured format according to critical care, availability, pre-hospital and inter-hospital transport and emergency department.

**Critical Care**

Nursing care of intubated patients in the intensive care unit requires continuous observation and monitoring. Couchman, Wetzig, Coyer, and Wheeler (2007) reviewed available literature on the nursing care of mechanically ventilated patients addressing assessment and safety. Articles published between 1995 and 2006 were reviewed, identifying evidence and expert comments on common practice of care for mechanically ventilated patients. Common management practices utilized in the intensive care units were not all found to be supported by evidence, suggesting lack of evidence to support one monitoring method as better-quality. The literature review found the utilization of two or more monitoring techniques, “one of which is able to be measured regularly or continuously, to assess tube placement” would seem sensible (p. 8).

Capnography was one monitoring device determined to be a reliable method for assessing correct tube placement and an effective tool for monitoring ventilation. Further, arterial blood gas (ABG), considered the “gold standard” for frequent analysis of arterial carbon
dioxide, is associated with complications and costs from repeated ABG analysis, supporting the use of non-invasive monitoring techniques.

The artificial airway poses a risk for obstruction, displacement or dislodgment requiring detection of life-threatening situations that require immediate interventions. Monitoring devices can reduce “risks of incidents and accidents both by detecting the consequences of errors, and by giving early warning that the condition of a patient is deteriorating for some other reason” (Young, & Griffiths, 2006. p. 39). A review of incidents on airway devices in the critical care area was examined by Thomas and McGrath (2009). The purpose of this study was to identify themes associated with these incidents and to recommend practice for safe airway management. A convenience sample of patient safety incidents reported to the UK National Patient Safety Agency in a two year period was examined. Identified were 1085 incidents in which 893 were identified as post-placement problems, e.g. displacement and partial dislodgement of the tube into the pharynx. Capnography was not described as a method used to diagnose these incidents; in fact capnography was only described three times in 1085 incidents. Partial dislodgment of tubes was found to be several times more dangerous to patients than complete removal of the tube. The results demonstrated displacement may pose a problem due to the difficulty in diagnosing prior to severe hypoxia without the use of capnography. Thomas and McGrath recommended the use of capnography in intensive care units to aid in the early recognition and intervention of tube displacement.

Delay in the recognition of airway incidents in intensive care units (ICUs) has the potential for causing serious harm to patients. Capnography, a standard of care for anesthetic monitoring, is not a standard for monitoring in intensive care units. Harvey and
Thomas (2010) conducted a survey on the use of capnography in intensive care units in the UK. One hundred sixty nine clinicians from adult ICUs responded; 89 units had CO2 monitoring abilities. A Likert scale was used examining attitude and opinions about the effect of capnography on patient safety. The study found 36% of respondents strongly agreed capnography improved patient safety and 31% felt capnography was an essential standard. The survey found some respondents viewed capnography as an inadequate substitute for arterial CO2 monitoring, difficult to train staff to reliably use, and not 100% sensitive and specific in the diagnosis of airway misplacement. Further, available information on airway mishaps may be lacking, therefore risks in critical care may go unrecognized. Harvey and Thomas believed capnography was warranted for all confirmation of airway placement in the ICU to improve airway safety. “Capnography is neither 100% sensitive nor specific for diagnosing correct airway placement, but it is superior to reliance on clinical signs alone, hence its potential to improve airway safety” (p. 35).

Availability

Capnography is not widely used or available in emergency departments for the care of the critically ill/injured patients. A study examining the availability of ETCO2 and its use in the emergency department was performed through a survey sent by mail (Delorio, 2005). A multiple-choice formatted survey was sent to a random sample of emergency physicians that were members of the American College of Emergency Physicians (ACEP). The survey inquired if ETCO2 monitoring was available at their respective emergency departments and the frequency of use. Of the 1,000 surveys sent,
550 surveys were voluntarily returned with 25% confirming that their facility had continuous ETCO2 monitoring capability and of those that had the capnography available; the device was used 14% of the time for non-arrest patients. Academic settings were more apt to have the monitoring device. ACEP recommends that “End-tidal CO2 detection, either qualitative, quantitative, or continuous, is the most accurate and easily available method to monitor correct endotracheal tube position” (p. 492). Despite this endorsement, emergency departments are not universally utilizing this monitoring device.

ETCO2 monitoring is underutilized in pediatric emergency department settings (Langhan & Chen, 2008). Directors of accredited pediatric emergency medicine fellowship programs in the United States and Canada were sent a survey to determine their opinions in regards to strengths and weakness of capnography and its application. Eighty-one percent of the surveys were completed and of those, 88% had ETCO2 monitoring capabilities. However, only 69% of the time the capabilities were used for endotracheal tube confirmation and only 8% of the time for trauma patients. All institutions that had the monitoring capabilities found the device easy to use. This study found ETCO2 monitoring was widely available to this patient population; however, it was underutilized in certain settings.

Pre-Hospital and Inter-Hospital Transport

Low ETCO2 readings have been correlated with poor patient outcomes and having this information available can alert care providers to adjust their resuscitation attempts to possibly alter this outcome (Galante, Jacoby, Clark, Payne & Anderson, 2004). A retrospective chart review was conducted of all intubated trauma patients
transported by a university’s helicopter transport program over a 4-year period examining ETCO2 values and patient outcomes. ETCO2 were recorded by flight nurses from time of intubation or arrival on scene and until the patient was transferred to trauma surgeons in the emergency department. There were 91 trauma patients with established airways that met inclusion criteria that were divided into two groups, 68 survivors (70%) and 23 non-survivors (30%). The two groups comprising mostly of males involving blunt trauma with similar Glasgow Coma Scales (GCS) and Revised Trauma Scores (RTS). Systolic blood pressure and heart rate appeared physiologically similar in both groups. ETCO2 values were similar in both groups at the beginning of transport, but ETCO2 in non-survivors dropped significantly as the flight progressed. The study identified low values of carbon dioxide as indicators in the pre-hospital setting as a predictor of outcome that can aid in aggressive therapeutic interventions.

Pre-hospital providers not recognizing an esophageal intubation or misplacing the endotracheal tube during transport to the hospital can lead to serious complications for the critically ill and intubated patient (Silvestri et al., 2005). A prospective, observational study conducted by Silvestri et al. at a Level 1 trauma center that receives pediatric and adult patients from numerous Emergency Medical Services (EMS) agencies investigated the use of ETCO2 monitoring and unrecognized misplaced intubation. The researchers were aware that the EMS agencies studied varied on their protocols and equipment because of the different medical authority used by each agency. In this study 153 pre-hospital patients met inclusion criteria of oral tracheal intubation. Confirmation of correct endotracheal placement was confirmed by the receiving emergency department physicians. Researchers found that all 93 patients transported by continuous ETCO2 had
confirmation of correct endotracheal placement. There were 14 patients with misplaced endotracheal tubes identified by emergency department physicians in which ETCO2 monitoring was not used during transport to the hospital. The limitations of this study included many variables involved during transport that could have contributed with the success rate of ETCO2 monitoring. This study did find continuous ETCO2 monitoring a beneficial tool in confirming tracheal tube placement.

Confirmation of correct endotracheal tube placement during transport is paramount for critically ill children. In fact, the American Heart Association (AHA) currently recommends use of colorimetric detector or capnography during intra and inter-hospital transport of all infants and children (AHA, 2005). Singh, Allen, Venkataraman, and Bhende (2006) studied the use of a portable capnometer during transport of children by ground and rotor wing. During a six month period, intubated patients were attached to a capnometer with ETCO2 recorded every 15 minutes. Immediately after transport Respiratory Therapists (RTs) responded to a questionnaire regarding the capnometer application during transport. The RTs participating in this study had previous experience working with capnographs in the intensive care unit settings. The RTs found the device easy to secure in 46 patients, and helpful in all 50 transports. The capnometer detected correct placement of endotracheal tubes in all patients (n=50). The capnometer was helpful in detecting a low respiratory rate in an infant in which the pulse oximetry did not register a signal. Also, the ETCO2 waveform detected two patients with endotracheal air leaks.

A study conducted by Price, Wilson, and Fee (2007) further validated the feasibility of using ETCO2 monitoring during transport of critically ill patients. A
prospective, observation study primarily of adult trauma patients evaluated the use of sidestream ETCO2 monitoring during helicopter transport (Price et al.). Twenty eight intubated and 72 non-intubated patients transported by helicopter were evaluated by flight nurses using a 5-point Likert scale. Nurses’ opinions on ease of set up, use during patient care, and patient toleration of equipment produced a mean score of 0.5, indicating minor problems. The study concluded the monitoring device was easy to use during helicopter transport. The study’s limitations were the population sample size and demographics.

Emergency Department

ETCO2 closely correlates with arterial PCO2 in hemodynamically stable patients, which can aid in the rapid evaluation of the respiratory status of patients arriving to the emergency department in respiratory distress (Yosefy, Hay, Nasri, Magen, & Reisin, 2004). Yosefy et al. conducted a prospective semi-blind study over a six month period, enrolling 73 patients that met inclusion criteria. The patients presented in respiratory distress to the emergency department requiring an ABG for determination of treatment. ABGs and ETCO2 measurements were recorded along with other parameters such as medical diagnosis, age and vital signs. The results showed a good correlation between arterial PCO2 and the non-invasive sidestream, with a correlation coefficient of 0.792. The researchers found the device suitable for the emergency department setting because of its immediate use in rapidly identifying ETCO2 estimates.

The immediate resuscitation period of emergency department patients can benefit from the use of ETCO2 in determining severity of acidosis (Nagler, Wright, &
Krauss, 2006). Low serum bicarbonate (HCO3) levels are commonly seen in children with gastroenteritis. A children’s hospital emergency department examined the relationship between serum HCO3 and ETCO2 values to determine if capnography could aid in detecting patients with acidosis. A convenience sample of pediatric patients presenting to the emergency department during a one year period complaining of vomiting and/or diarrhea was enrolled. There were 135 patients meeting inclusion criteria with a median age of 2.9 years. ETCO2 readings were recorded from a portable handheld capnography connected to oral/nasal cannula. The Pearson’s correlation coefficient of 0.80 between ETCO2 values and HCO3 demonstrated non-invasive ETCO2 could aid in the assessment and management of children with acidosis. A limitation of this study was the convenience sample used, which may not represent the larger pediatric population. Also, other abnormal laboratory values will not be detected by capnography and thus drawing serum electrolyte panels will still be needed. The benefit of the immediate use of ETCO2 for initial patient assessment and recognition for need of further serum testing to reaffirm decision making in patient care was demonstrated.

ETCO2 monitoring can be useful in assessing the severity of asthma in children presenting to the emergency department. A prospective observation study was performed at a pediatric emergency department using a convenience sample of asthma patients presenting with symptoms associated with asthma exacerbation (Langhan, Zonfrillo, & Spiro, 2008). Control subjects were children without asthma or respiratory disturbances. Enrolled in the study were 104 asthma and 89 control subjects ages ranging from 1 to 21 years. The subjects were attached to a non-invasive capnography/pulse oximetry and measurements were recorded by an investigator. The treating physicians
were blinded to the results so that clinical decisions were not based on ETCO2 results. The results showed a significantly lower ETCO2 in asthma patients compared with the control group. The researchers found the device suitable for the emergency department setting because of its immediate use in rapidly identifying ETCO2 estimates in severely asthmatic patients. Further, the device was tolerated by all except one child making the device adaptable to children as well as the adult population.

Capnography is useful to rapidly assess ventilation in severe TBI patients in the emergency department (Lee, et al., 2009). A prospective observation study was conducted in a 40-bed emergency department examining the relationship between PaCO2 and ETCO2 of severe TBI patients. Normal differences between PaCO2 and ETCO2 are defined as -5 mm Hg to 5 mm Hg (Corbo, Bijur, Lahn, & Gallagher, 2005). Sixty six patients met inclusion criteria for Glasgow Coma Scale (GCS) <9, endotracheal intubation and a brain lesion by evidence of a radiographic study (Lee, et al., 2009). Variables recorded within 30 minutes of mechanical ventilation were Injury Severity Score, Abbreviated Injury Scale of head and chest, vital signs, ABGs, lactate level, ETCO2 and mode of ventilation. The Pearson’s correlation test and Bland-Altman plot were used to analyze the PaCO2 and ETCO2. The study found ETCO2 correlated 73% with PaCO2 in severe TBI patients. Chest trauma and poor tissue perfusion resulted in an increase in differences between PaCO2 and ETCO2. The immediate use and continuous monitoring of ETCO2 for the population of severe TBI patients in the emergency department is valuable, however, the population of patients with chest trauma and poor tissue perfusion needs special consideration.
Another study examining ETCO2 correlation with PaCO2 in trauma patients found capnography use as a guide for ventilation was valuable in a limited subset of patients. A prospective observational study of intubated trauma patients treated in an emergency department found a lower correlation between ETCO2 and PaCO2 values for a majority intubated trauma patients (Warner, et al., 2009). One hundred eighty adult intubated patients suffering from a traumatic injury met inclusion criteria, 19% patients with isolated TBI. ABG and ETCO2 readings were recorded simultaneously, along with a full set of vital signs and ventilator settings. Ventilator setting adjustments were made based on ABG values only. Linear regression was used to determine the correlation between ETCO2 and PaCO2 values. The study demonstrated the subgroup of TBI patients with severe abdominal injury had the worse correlation ($R^2=0.19$). The subgroup of patients with isolated TBI had the best correlation ($R^2=0.52$). Trauma patients with physiologic signs of inadequate perfusion status will not accurately reflect PaCO2 and the use of ETCO2 for determining ventilation may be misleading.

Transitional Statements

Management of the critically ill intubated patient in the emergency department requires critical nursing care. The literature review demonstrated that capnography is a valuable tool that can aid in critically assessing, planning and intervening in the care of patients. The ETCO2 monitor aids in the confirmation of tracheal tube placement and offers valuable information about airway patency in the pre-hospital setting during transport. The use of ETCO2 in the emergency department can alert care providers to low values of CO2, which may indicate the need for more aggressive therapeutic
interventions. The use of ETCO2 is helpful during the first 24 hours after a brain injury to avoid hyperventilation and compromising cerebral perfusion. However, capnography use as a guide for ventilation in some trauma patients may be limited.

There is a lack of evidence from current scientific research to support the use of capnography in practice guidelines and protocols for emergency department use. There are no randomized controlled trial studies to date that have determined if every intubated patient should have continuous ETCO2 monitoring. This descriptive study will build on prior research conducted by Delorio (2005) and Langhan et al. (2008) by exploring the utilization of continuous ETCO2 by emergency department personnel. This will be the first study to investigate if nurses consider ETCO2 monitoring to be efficient and effective in improving quality and safety of care for critically ill and/or injured patients in the fast paced environment of the emergency department. The findings from this research may contribute to improving quality and safety of patient care through the use of technology. The next chapter will describe the research methodology chosen in order to provide a clearer understanding of the current nursing practice in regards to capnography feasibility and usefulness in the emergency department setting.
CHAPTER III

RESEARCH METHODOLOGY

Nursing research is essential for developing evidence-based practice and in the planning of future research. The aim of descriptive research is to “discover new meaning, describe what exists, determine the frequency with which something occurs and categorize information” (Walker, 2005, p. 572). This chapter describes the chosen research methodology examining capnography use in the emergency department.

Research Methodology

A quantitative, descriptive design was chosen to determine emergency department nurses’ perceptions regarding the implementation, use and effectiveness of capnography in the emergency department. A descriptive study is valuable in gaining more information about justifying current nursing practice; especially in areas where little research has been conducted (Burns & Grove, 2005). The descriptive research process was chosen because it is helpful in gaining more information to provide a clearer understanding of the current nursing practice regarding the use and effectiveness of capnography in the emergency department. Further, descriptive research is valuable in generating questions and hypotheses that can be used to develop further research.
Theoretical/Philosophical Underpinnings

This study will aid in understanding more about one nursing intervention in which nurses work to gain knowledge to bring about positive changes for their patients. Concepts of Orem’s Self Care Theory were used in the analysis phase in interpreting the results to explore nurses’ views of capnography in supporting nurses’ actions in the care of intubated patients.

Setting/Population

A 613 bed Level I Adult and Pediatric Trauma Hospital and Research Center serving northern California and eastern Nevada treating approximately 60,000 patients each year in their emergency department was used for this study (UC Davis Health System, 2010). The emergency department has 42 beds and is the location for the resuscitation and stabilization of critically ill patients in which the most advanced technology is utilized. This emergency department was chosen as the research setting because a clinical practice change was implemented in 2008 requiring all intubated patients to have ETCO2 monitoring.

As of November 2009, there were 120 emergency department nurses that frequently provide nursing care to the critically ill and/or injured intubated patients arriving to this institution (C. Williams, personal communication, Oct. 29, 2009). The nurses caring for these patients have on average seven years of nursing experience. All the nurses caring for intubated patients have been trained on the use of capnography by a select group of emergency department clinical resource nurses. Purposive sampling was chosen because it is the best way to find participants that will provide information about
the phenomenon under investigation. The sampling procedure targeted registered emergency department nurses with direct patient care, who have been trained on the use of capnography and have used capnography on intubated patients in this emergency department. It was anticipated, based on personal communication with C. Williams, an administrative nurse in the emergency department, that 100 nurses would meet inclusion criteria.

Ethical Considerations

The study was implemented after the approval of the Human Subjects Research Committee (HSRC) of the California State University, Chico and Institutional Review Board (IRB) University of California, Davis to protect the interest of the people involved in this research study. The risks associated with this study were identified and minimized to assure adequate protection of these subjects. An expedited review was requested as there were no foreseeable risks involved in this study. The subjects were given a written consent and a description of the purpose of the study and anticipated risks and/or benefits of this study. The subjects were informed participation was strictly voluntary and they could withdraw at any time without penalty or any affect related to their employment. Written consent was obtained from the subjects (Appendix A). The study data were coded so that it was not linked to the subject’s name. Upon completion of the survey, the subjects sealed the completed survey in a manila envelope and returned it to the locked collection box in the emergency department staff break room. The data will be retained for a minimum of five years and has been stored in such a way that access is limited to only the primary investigator.
Data Collection

A list of all emergency department nurses names and e-mail addresses meeting inclusion criteria were requested from the emergency department nurse manager. An e-mail was sent to these nurses two weeks prior to the distribution of survey to introduce the researcher and to provide information about the purpose and process of this research study. A survey was then distributed to nurses’ confidential intra-hospital mail box asking about their perceptions about the use and effectiveness of capnography in the emergency department setting using a Likert scale (Appendix B). A Likert scale was chosen because it is a valuable instrument that is frequently used in research when determining opinions about a subject (Burns, & Grove, 2005). The scale was used to assess the participant’s perceptions about capnography use in the emergency department setting. The rating scale used was “strongly disagree,” “disagree,” “agree,” “strongly agree” (Burns, & Grove, 2005). Items in the survey were included based on two previous research studies conducted examining physicians utilization of continuous ETCO2 monitoring in emergency department settings (Langhan, & Chen, 2008; Delorio, 2005). Data collection included demographic information on age, gender, years of experience as a registered nurse, years worked in this emergency department, length of experience with capnography, experience with capnography on intubated patients in this emergency department, and any experience of capnography outside of this emergency department. A codebook was developed incorporating the demographic information for data collection.
Data Collection Procedure

The survey was reviewed prior to distribution by three nursing educators experienced in quantitative research to establish content validity. The experts examined the survey content to establish if the instrument was appropriate and accurate for determining perceptions by emergency department nurses about whether or not capnography is useful in patient assessment, contributes to improving the quality and safety of patient care and to determine if the availability of this technology would be beneficial to other emergency departments. These experts were experienced and knowledgeable in the area of nursing assessment and their familiarity with quantitative research provided suggestions to assist in revisions to the survey. The survey was pilot tested by two emergency department nurses and revisions were performed to improve clarity. This was done to ensure that the survey would closely reflect the clinical practice area where capnography is used. Microsoft Office Excel and JMP databases were designed to manage the survey and demographic data for analysis.

The researcher attended the administrative nurses’ emergency department meeting one month prior to the planned distribution of surveys. The administrative team was informed of the purpose of the study, research and data collection process. A list of all nurses meeting inclusion criteria was formulated at this time. The scheduled date for distribution of surveys was discussed with the administrative team in an attempt to avoid vacations, holidays and any departmental meetings or conferences.

The subjects identified were assigned unique identification numbers in which a master list was created to protect against disclosure of identifying information of subject. The master list is secured in a locked file cabinet at the researcher’s place of
employment that will ensure privacy of subjects. The subjects were sent an introduction email informing them about the study and importance of their participation (Appendix C). The surveys were distributed to the nurse’s confidential emergency department intra-hospital mail box located in the nurse’s break room on the prearranged scheduled time. The surveys were in paper form. Included was an informed consent approved by the IRB of the agreement of the subject to participate in this study. The subjects were informed of a two week deadline for submission and the location of the collection box for completed surveys. The subjects were asked to complete all items and seal the completed survey and consent form in the provided manila envelope. The researcher was available by phone for questions. A reminder e-mail was sent to all participants prior to the specified deadline date (Appendix D). The two week mark was the time surveys were reviewed for completeness and the number of surveys not returned was tallied. Data were reviewed and prepared for data entry.

Quantitative Analysis

An electronic data base was established prior to the distribution of surveys and was password protected. Once the demographic information and surveys were received they were reviewed for missing data, multiple responses and hand written information. Only accurately completed surveys were entered into the data base. The data were examined for outliers and the final results were tabulated. Descriptive and inferential statistical analysis was conducted on the data to determine nurses’ views regarding the implementation, use and effectiveness of capnography. An assistant experienced in statistical analysis was employed to assist in the analysis process. Tables were created to
identify patterns to aid in full exploration of the data. The results will be submitted to a nursing journal for publication and to a nursing conference for presentation to promote nursing knowledge and to assist others in future research projects concerning capnography.

Transitional Statements

“The purposes of descriptive research are to describe concepts, describe and identify relationships among variables, or compare and contrast groups on selected variables” (Burns, & Grove, 2005, p. 83). Emergency department nurses’ input is valuable in regards to determining the usefulness and the impact technology is having on the delivery of nursing care. The study will provide a clearer understanding of the current nursing practice in regards to the use of capnography in the emergency department. Emergency department nurses with direct patient care should have input in regards to the usefulness of technology in the delivery of nursing care. In addition, implementation of new technology should be evaluated to determine how it is utilized and the impact it is having. The next chapter will present and discuss findings from the results of this survey.
CHAPTER IV

RESULTS

This chapter will present and illustrate findings from the survey examining capnography use in the emergency department. The researcher examined two research questions: What are emergency department nurses’ perceptions about the use of capnography in the emergency department setting? What are emergency department nurses’ perceptions about the effectiveness of capnography in the emergency department setting? Orem’s Self Care Theory concepts were used in the analysis phase to determine if nurses view capnography in supporting patient care decisions to meet the needs of their patients’ self care deficit.

Results

Descriptive and inferential statistical analysis was conducted utilizing the JMP statistical package. Findings from the study on the perceptions on the use and effectiveness of capnography in the emergency department are described as follows.

Sample Description

One hundred and six surveys were distributed to emergency department nurses whom frequently provided nursing care to the critically ill and/or injured intubated patients. Ninety-four (90%) completed the survey. Thirty five participants wrote comments on the survey. Of those who responded with demographic information; the
median age was 37.9 years with over seventy percent identified as female (n=68) (Table 1). The nurses’ years of experience as a registered nurse varied greatly with an average of 12 years (n=90). The nursing experience in this emergency department averaged 7 years (n=86). The nurses’ years of experience with capnography varied widely also, with 80 nurses confirming an average of 4.4 years of having worked with capnography. Fifty nurses confirmed they had no experience with capnography outside of this emergency department.

Table 1

Demographic Characteristics of Respondents

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>25 to 58</td>
<td>37.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Years as RN</td>
<td>1.5 to 30</td>
<td>11.9</td>
<td>8.1</td>
</tr>
<tr>
<td>Years in ED</td>
<td>1 to 25</td>
<td>7</td>
<td>5.7</td>
</tr>
<tr>
<td>Years Capnography Experience</td>
<td>1 to 21</td>
<td>.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Years Capnography Experience in ED</td>
<td>0.5 to 11</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Years Capnography Experience outside this ED</td>
<td>0.5 to 18</td>
<td>4.4</td>
<td>4.2</td>
</tr>
</tbody>
</table>
Survey Findings

The majority of nurses were attracted to employment settings that use technology (92%) and found capnography equipment easy to set up (95%). In statistical analysis of subjects that responded to demographic information, the variables “years of experience as a registered nurse” and “attraction to employment settings that use technology” were statistically significantly related dependent variables ($p=0.047$). The analysis showed that those with more years as a registered nurse tended to agree more strongly with attraction to technology settings than those with fewer years as a registered nurse. There was no statistical significance between years of experience with capnography and ease of equipment set up ($p=0.226$).

Nine percent of nurses strongly agreed capnography equipment is readily available. However, forty two percent of nurses found continuous capnography monitors unavailable. Further, several nurses commented that it was often difficult to find a monitor equipped with the capnography module when needed and although capnography is essential, working monitors were lacking.

The ETCO2 values were viewed as accurate (89%) and easy to interpret (96%), especially when “equilibrated with ABGs and used as a trend.” There was no statistical significance between years of experience with capnography and accuracy of ETCO2 values ($p=0.664$), nor ease of capnography interpretation ($p=0.084$). Several nurses commented, “water or moisture” pooling in the ventilator circuit has the potential to cause equipment failure and unreliable readings.

Ninety-two percent of nurses did not view capnography as interfering with patient care or their patients having difficulty tolerating the capnography device. In fact,
one nurse commented, “it is a GREAT monitoring device equal to SpO2” and capnography “enhances patient care.”

Nurses viewed ETCO2 values as assisting in patient assessment with 38% strongly agreeing and 50% agreeing; however, a few nurses commented that capnography waveform and numbers were used more by physicians for their clinical assessment. One nurse cited that emergency department nurses are less familiar with capnography and use it less as a tool, stating “understanding appeared limited.” Others commented capnography is “very helpful in patient care,” “very useful with the critically ill children/patients, especially those on a vent” and “valuable with CO2 monitoring waveforms associated with different situations.” “It is a useful tool, but like anything we must treat the patient, not the monitor!” Nurses with more years of experience with capnography tended to agree more strongly with ETCO2 values assisting in patient assessment ($p=0.004$).

Capnography was found to be an efficient means of monitoring a patient’s ventilator status during transport (89%). There was a statistically significant difference in participants responses, as those with 6 to 10 years of experience with capnography tended to agree more strongly with this statement ($p=0.0002$). One nurse commented on previous experience with capnography during air medical transport and described capnography as an invaluable tool for continuous confirmation of endotracheal tube placement.

Eighty-nine nurses (95%) agreed capnography contributes to improving the safety of patient care. Further, 95% confirmed capnography contributes to quality patient care with nurses having 6 to 10 years of experience with capnography tending to agree
more strongly with this statement ($p=0.006$). The majority of nurses were aware of capnography limitations (83%) and clinical rationale for its use (98%). One nurse commented capnography was “like any piece of technology, we should be wary of relying solely on the equipment, but I think it’s easy to use and enhances patient care.”

The nurses recommended availability of capnography to other emergency departments, with 28% strongly agreeing and 70% agreeing. In addition, one nurse commented, “[capnography] is a great idea and a valuable source of information.”

Transitional Statements

“The research in nursing must address the questions relevant to nurses and must develop a unique body of knowledge for practice” (Burns, & Grove, 2005, p. 2). The survey results demonstrated capnography is viewed as assisting in patient assessment with fairly easy to interpret accurate ETCO2 values. Equipment availability appears to be a concern to nurses as capnography is viewed as contributing to the safety and quality of patient care for which it is recommended for use in other emergency departments. The next chapter will discuss these research findings, implications of the findings for nursing practice, education and research, recommendations for further research.
CHAPTER V

DISCUSSION

Research has shown capnography is a valuable monitoring tool providing information about airway patency and patients’ oxygenation and ventilation status. Capnography has been recommended by national endorsement papers and supported for use by several medical societies. The American College of Emergency Physicians (ACEP) policy statement finds ETCO2 detection “the most accurate and easily available method to monitor correct endotracheal tube position in patients who have adequate tissue perfusion” (ACEP, 2010, para. 6).

Discussion

While research has shown its usefulness in clinical settings, information was lacking whether emergency department nurses’ value capnography as effective and useful in the delivery of care. This study was the first to investigate if emergency department nurses viewed capnography as a necessary adjunct during patient assessment. Further, this study examined a clinical practice change using capnography to promote clinical decision making to support quality care and improve patient safety.

Assessment

This survey demonstrated the majority of nurses’ perceived capnography as assisting in patient assessment. These results are consistent with recommendations in the
literature that support capnography as a valuable tool that can aid in critically assessing, planning and intervening in the care of patients (Couchman, Wetzig, Coyer, & Wheeler, 2007). Nursing assessment is the first step in the nursing process to identify patients’ needs and self care deficits. Frequent nursing assessment is paramount during early patient resuscitation to optimize and improve patient outcome. Along with conventional monitoring such as blood pressure, heart rate, respiratory rate and body temperature, capnography can provide additional assessment information. Nurses in this study with more experience with capnography tended to agree that capnography assisted in patient assessment. Nurses becoming more experienced with capnography will be able to better apply its use during patient assessment and understand that capnography is a valuable assessment tool assisting in treatment and clinical decision-making in the emergency department setting.

Rationale for Use

The majority of nurses confirmed they were aware of the rationale for the use of capnography. ETCO2 is used to assess patients’ endotracheal tube position and adequacy of ventilation. Capnography has been found to be suitable for the emergency department because of its ability to immediately identify ETCO2 estimates (Yosefy, Hay, Nasri, Magen, & Reisin, 2004). While capnography is an easy and effective way to assess endotracheal tube placement and monitor a patient’s ventilator status, it is only one aspect of a thorough respiratory assessment. The current literature states that understanding the use of this technology can aid in planning interventions optimizing patient outcome (Cheifetz, & Myers, 2007). Although nurses confirmed they were aware of the rationale
for the use of capnography, further exploration is needed to determine what nurses’ justification for capnography usage are. Without a clear understanding, this “technology is just one more number to monitor and one more thing to document in the ever-technical critical care environment” (p. 224). It is imperative nurses understand the applications for the use of capnography.

Limitations

The immediate use and continuous monitoring of ETCO2 in the emergency department is valuable, however, capnography use in some patients may be limited. The participants of this study were aware of the limitations of capnography, consistent with the current literature. Capnography provides a “quantitative estimation of the partial pressure of expired CO2” (Cheifetz, & Myers, 2007, p. 4). In trauma patients with poor tissue perfusion, ETCO2 may not accurately reflect PaCO2 and thus the use of ETCO2 for determining ventilation may be misleading (Warner, et al, 2009). Further, certain diseases, and conditions that increase dead space can cause an alteration in patients’ ventilation-perfusion increasing the difference between ETCO2 and PaCO2 (Cheifetz, & Myers, 2007). Several nurses commented that capnography is useful, but recognized similar to other monitoring devices, monitors are limiting as it is vital to “treat the patient not the monitor”. Nurses identified in certain clinical situations ETCO2 values were unreliable, acknowledging capnography has limitations. The emergency department nurses in this study acknowledged awareness that capnography has limitations, which is in agreement with previous studies that have demonstrated capnography usage is limited.
in certain patient populations. Similar to other monitoring devices, capnography should be used as an adjunct to clinical assessment.

Accuracy

The majority of the subjects in this study perceived ETCO2 values as accurate. As discussed previously, there are factors that can affect the relationship between PaCO2 and ETCO2, limiting the accuracy of ETCO2 estimates (Cheifetz, & Myers, 2007). However, numerous studies have shown ETCO2 tends can be used to assess disease and response to treatment. ETCO2 values have been found helpful in neonates to estimate trends in PaCO2 that showed good correlation between ETCO2 and PaCO2 for various clinical situations (Bhat, & Abhishek, 2008). One benefit to neonates is the decrease in number of blood draws, minimizing blood loss. Proper endotracheal intubation can be more accurately and rapidly identified than can other clinical assessments (Cheifetz, & Myers, 2007). The nurses acknowledge ETCO2 values as accurate, but also acknowledge there were clinical situation that can cause inaccuracy especially during pooling of secretions in endotracheal tubes. ETCO2 values were cited as accurate when equilibrated with ABGs and used as a trend. These findings are consistent with previous research studies. The potential clinical benefits of continuous capnography are numerous, however, critically ill patients require nurses to be aware of the interpretation of monitoring data.
Safety

The ETCO2 values were viewed by nurses as contributing to patient safety during airway management. This finding is in agreement with recommendations in the current literature for the use of capnography as a minimum safety standard in the care of intubated patients in critical care (Thomas, & McGrath, 2009). Capnography contributes to patient safety as it has been shown to be more accurate in identifying esophageal intubations than “traditional confirmation methods, including auscultation, chest rise, and tube condensation” (Nagler, & Krauss, 2009, p. 85). In addition, capnography has been found to be far superior to the standard of care, pulse oximetry, which can take minutes to reflect a change (Langhan, & Chen, 2008). Capnography can aid nurses in early recognition and treatment of tube displacement, optimizing safe patient care. Consistent with previous studies, this study also demonstrated capnography is a valuable tool contributing to improving airway safety. The emergency department nurses consider capnography an effective monitoring adjunct in the provision of safe and effective nursing care for intubated patients. Further exploration on nurses’ opinion of why they perceive capnography contributes to safety will provide stronger evidence for capnography application in nursing practice.

Availability

Capnography equipment availability was identified in the survey as inadequate. Although capnography was perceived to be essential, working monitors were lacking and those monitors equipped with the capnography module were difficult to find. Similar to physician policy statements endorsing the use of capnography and a study
describing the lack of physicians embracing this practice, equipment availability at this institution does not support the current standard of practice for which all intubated patients are required to be monitored by capnography. A study surveying pediatric emergency medicine physicians that did not routinely use continuous ETCO2 monitoring reported lack of familiarity, perceived inaccurate measurements, and poor medical literature to support the use of capnography as reasons for underutilization (Langhan, & Chen, 2008). Further, quantitative monitoring was unavailable to the vast majority of those physicians. The physicians’, whose facilities currently use ETCO2 monitoring, felt the results were accurate (97%) and results easy to interpret (91%). Another survey of emergency physicians found 47% of respondents, who had available continuous end-tidal CO2 monitoring, rarely or never used continuous detection (Delorio, 2005). In contrast, this survey found nurses viewed capnography as valuable and working monitors lacking. This study demonstrated that although capnography is a valuable tool, availability is a concern.

Transport

Unrecognized displaced or dislodged artificial airway during transport can have disastrous consequences as displacement is “often difficult to diagnosis prior to severe hypoxia without the use of capnography” (Thomas & McGrath, 2009, p. 363). The potential for these adverse incidents can be of concern to nurses in the emergency department as patients are frequently moved and transported for radiological studies, increasing the chance of these disastrous consequences. The vast majority of nurses in this study did support the efficiency of capnography for monitoring during transport.
Findings are comparable to previous research studies recommending capnography during transport for continuous confirmation of tube placement and as a means of efficiently maintaining ETCO2 levels to avoid hyperventilation and hypocapnia, especially in the traumatic brain injury population (Silvestri, et al., 2005; Uren, Lowell, & Silbergleit, 2009). The American Heart Association (AHA) recommends the use of capnography during in-hospital transport of all infants and children (AHA, 2005). However, 11% of study participants were in disagreement with current research and recommendations endorsing capnography during transport. Nurses with more years of experience with capnography, in contrast, perceived capnography monitoring an efficient means of monitoring ventilator status during transport. Further studies are needed to explore those nurses’ lack of support of capnography during transport. The dissemination of additional information to these nurses about the benefits of capnography during transport may also be warranted.

Ease of Set Up and Tolerated Device

Capnography technology has been modified over the years to accommodate ease of use and reliability. These modifications have made the immediate use of ETCO2 in the emergency department for initial patient assessment and assistance in decision making in patient care very useful (Yosefy, Hay, Nasri, Magen, & Reisin, 2004; Lee, et al., 2009). The majority of nurses found capnography easy to setup and not interfering with patient care. This is consistent with Price, Wilson, and Fee (2006) who found ETCO2 monitoring feasible for use in the pre-hospital transport settings. Findings from this study also support a survey of pediatric emergency medicine physicians who found
100% of respondents, currently using continuous ETCO2, felt it was easy to use in the emergency department setting (Langhan, & Chen, 2008). Langhan and Chen did find a few (6%) respondents that did not routinely use ETCO2 monitoring had difficulty with its use. This study demonstrates nurses found the capnography equipment easy to set up and well tolerated by patients; confirming capnography is practical for the emergency department setting.

Interference

A majority of nurses did not perceive that capnography interfered with patient care; however, there were a few respondents that disagreed. Moisture in the endotracheal tube and ETCO2 monitoring device were cited by several participants as time consuming and detracting from patient care. The disadvantage of moisture is that it can alter and delay ETCO2 readings. The findings are similar to a previous study performed in the transport setting that found no problem with respect to patient tolerance (Price, Wilson, & Fee, 2006). Further exploration of nurses’ responses in this study should be examined in order for there to be full support for the utilization of capnography for the benefit of patients in the emergency department.

Quality and Recommendation

Advances in technology aim to improve the quality of patient care. Capnography is one technology offering useful information that can optimize the delivery of quality patient care. Nurses found capnography to be an effective clinical assessment tool during airway management. Further, the multiple applications this technology has to
offer make it beneficial to nurses working in the emergency department setting. The clinical practice change instituted to improve patient safety and promote quality care has been perceived by emergency department nurses as contributing to quality patient care. The nurses’ input is valuable regarding the impact this technology is having in the emergency department. The participants of this study recommend capnography availability to other emergency departments.

This study has validated support by emergency department nurses on the use and effectiveness of capnography in the emergency department setting. The majority of nurses agree capnography is useful in patient assessment, contributes to improving the quality and safety of patient care. These findings are in agreement with recommendations in the current literature for the use of capnography as a minimum standard in the care of intubated patients (Thomas, & McGrath, 2009).

Theoretical Framework

Dorothea E. Orem’s Self-Care Deficit Theory of Nursing was used as a theoretical framework for this study. The critically ill intubated patient’s inability to maintain a sufficient intake of air is a deficit for which nursing is required. Intubated patients are a challenge for emergency department nurses because of the array of potential or actual complications associated with mechanical ventilation. Capnography is one adjunct that provides valuable clinical assessment information enabling nurses to perform actions to meet individuals’ self care deficits. This study aids in understanding about one nursing intervention in which nurses work to gain knowledge to bring about positive changes for their patients.
The emergency department nurses perceive capnography as providing accurate assessment information supporting nursing actions in the care of intubated patients. Capnography contributes to improving the quality and safety of patient care by rapidly alerting nurses with feedback for clinical management. Individuals self-care deficit require nurses to prevent further problems and work towards promoting individuals own self care. Emergency department nurses are at the forefront of patient care and have found capnography an effective and useful in nurses’ delivery of care. Capnography has been acknowledged by emergency department nurses as a vital adjunct to monitoring; supportive in meeting the needs of patients by identifying and limiting patients’ self care deficits.

Limitations of the Study

This study was conducted at a single academic setting and majority of the nurses were attracted to settings that use technology. Findings may not be representative of all emergency departments. Similar to previous studies most academic settings were more apt to have the monitoring device.

Implication for Practice

Clinical practice protocol based on research has the potential to improve patient care. This study examined one clinical practice protocol aimed at promoting nurses’ clinical decision making to improve patient safety and promote quality care. The change of practice to monitor all intubated patients with capnography was evaluated and emergency department nurses validated this practice change as essential. This study
provides evidence that monitoring intubated patients with capnography is considered necessary by emergency department nurses. This study adds to the growing research evidence supporting the use of capnography in practice guidelines and protocols for emergency department use.

Implications for Research

This study is valuable as it will generate questions and hypotheses that can be used to develop further research. Current research is needed to examine availability and use of this technology at nonacademic and community hospitals. Further studies are indicated to clearly define the role of capnography during nursing assessment and ongoing monitoring in the emergency department. By conducting observations and interviews with nurses, information can be obtained on how capnography is utilized during nurses’ respiratory assessment.

Implications for Education

Availability and knowledge of this technology at nonacademic and community hospitals may be lacking. Dissemination of training curriculum, through nursing conference presentations and publications may increase the utilization of this valuable assessment tool in the emergency department. Research has provided evidence to support the use of capnography, education is vital so that capnography becomes more consistently used.
Implications for Emergency Nurses

This study demonstrated capnography was perceived by emergency department nurses participating in this study as an effective assessment instrument. Emergency department nurses are at the forefront to determine if they value and support the use of capnography in practice. Nurses’ perceptions about the implementation of this technology to support patient care decision making is valuable for nursing care. Limited availability of this valuable monitoring adjunct is concerning however. The practice change to use capnography with all intubated patients was initiated by nursing administrative staff, yet there is a lack of available equipment. The findings from this research study will provide evidence to nursing administration of emergency department nurses’ support of best practice and alert administration to the deficiencies.

Conclusions

This research study has provided positive evidence that nurses view capnography as a vital adjunct in monitoring critically/ill intubated patients. The results of this survey in conjunction with prior research findings are validation for practice change in other emergency departments for the use of capnography. However, despite the strong support for the use of capnography, availability of monitors with capnography capabilities remain a concern. Availability of more monitoring devices can provide additional research evidence to support the consistent use of capnography.
REFERENCES


Informed Consent Form

EXPERIMENTAL SUBJECT’S BILL OF RIGHTS
Medical Research Studies
The rights below are the rights of every person who is asked to be in a medical research study. As an experimental subject, you have the following rights:

1) To be told what the study is trying to determine

2) To be told what will happen to you and whether any of the procedures, drugs, or devices is different from what would be used in standard practice.

3) To be told about the frequent and/or important risks, side effects, or discomforts of the things that will happen to you for research purposes.

4) To be told if you can expect any benefit from participating and, if so, what the benefit might be.

5) To be told the other choices you have and how they may be better or worse than being in the study.

6) To be allowed to ask any questions concerning the study, both before agreeing to be involved and during the course of the study.

7) To be told what sort of medical treatment is available if any complications arise.

8) To refuse to participate or to change your mind about participating after the study is started. This decision will not affect your right to receive the care you would receive if you were not in the study.

9) To receive a copy of the signed and dated consent form.

10) To be free of pressure when considering whether you wish to agree to be in the study.

If you have other questions, please ask the researcher or research assistant. In addition, you may contact the Institutional Review Board, which is concerned with protecting volunteers in research projects. You may reach the IRB office by calling (916) 703-9151, from 8:00 a.m. to 5:00 p.m., Monday through Friday, or by writing to the Institutional Review Board, CTSC Bldg., Suite 1400, Rm. 1429, 2921 Stockton Blvd., Sacramento, California 95817.

_________________________________________  _________________
Signature of Subject or Date                  Legal Representative

54
SOCIAL AND BEHAVIORAL SCIENCE STUDIES MODEL CONSENT FORM

UNIVERSITY OF CALIFORNIA, DAVIS

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Investigator’s Name: Catherine E. Payne
Department/Telephone: Trauma and Emergency Surgery Service

Program (916) 734-5540

Study Title: Nurses’ Perceptions on the Use and Effectiveness of Capnography in the Emergency Department

WHY IS THIS STUDY BEING DONE?
You are being asked to participate in a research study. We hope to learn more about the use of capnography in the Emergency Department. The study will provide a clearer understanding of the current nursing practice in regards to the use of capnography in the Emergency Department. Implementation of new technology should be evaluated to determine how it is utilized and the impact it is having.

WHAT WILL HAPPEN IF I TAKE PART IN THIS STUDY AND HOW MANY PEOPLE WILL PARTICIPATE?
If you decide to volunteer, you will be asked to respond to 14 statements about your current perception of the use of capnography and answer demographic questions. If you would prefer not to participate, simply return the blank survey. Your responses are anonymous; you should not include any identifying information on this survey. The survey should take about 20 minutes to complete. I ask that you try to answer all questions. However, if there are any questions that you would prefer to skip, simply leave the answer blank. It is anticipated all UCDMC Emergency Department nurses will participate in this study. There will be 120 UCDMC Emergency Department nurses invited to participate in this study.

WHAT RISKS CAN I EXPECT FROM BEING IN THIS STUDY?
There is minimal risk to participating in this study.

ARE THERE BENEFITS TO TAKING PART IN THIS STUDY?
It is possible that you will not benefit directly by participating in this study.

WILL MY INFORMATION BE KEPT PRIVATE?
The study data will be coded so they will not be linked to your name. Your identity will not be revealed while the study is being conducted or when the study is reported or published. All study data will be collected by Cathy Payne, stored in a secure place, and not shared with any other person without permission outside the research team. Research documents will be kept confidential in accordance with the law and University policies.

The Institutional Review Board has the authority to review your research records.

WILL I BE COMPENSATED FOR BEING IN THIS STUDY?
You will not be compensated for participating in this study. It is anticipated the results will contribute to the body of nursing knowledge towards the provision of improving the quality of patient care and safety through the use of technology.

WHAT ARE THE COSTS OF TAKING PART IN THIS STUDY?
There is no cost to you beyond the time and effort required to complete the procedure(s) described above.
WHAT HAPPENS IF I AM INJURED BECAUSE I TOOK PART IN THIS STUDY?
If you are injured as a direct result of research procedures, you will receive reasonably necessary medical treatment at no cost. The University of California does not provide any other form of compensation for injury. In the case of injury resulting from this study, you do not lose any of your legal rights to seek payment by signing this form.

CAN I STOP BEING IN THIS STUDY?
You may refuse to participate in this study. You may change your mind about being in the study and quit after the study has started.

The research investigator may withdraw you from participating in this research if circumstances arise which warrant doing so even if you would like to continue.

WHO CAN ANSWER MY QUESTIONS ABOUT THIS STUDY?
If you have any questions about this research project please contact Catherine E. Payne who will answer them at (916) 734-5540.

If you have any questions regarding your rights and participation as a research subject, please contact the IRB Administration at (916) 703-9151 or write to IRB Administration, CTSC Building, Suite 1400, Rm. 1429, 2921 Stockton Blvd., Sacramento, CA 95817. The IRB Administration has also developed a web site designed to make you familiar with your rights. The web site discusses your basic rights as a research participant, an explanation of the informed consent process, the basic requirement that written consent be in a language understandable to you, and suggested sample questions to ask the research investigator regarding your participation in the study. This web site can be accessed at: http://www.research.ucdavis.edu/IRBAdmin

My signature below will indicate that I have decided to participate in this study as a research subject. I have read and understand the information above. I understand that I will be given a signed and dated copy of this consent form and the Bill of Rights.

________________________    __________________________
Signature of Subject or Legal Representative  Print Name
Date        Time

________________________     ______________
Signature of Person Obtaining Consent  Print Name of Person Obtaining Consent
Date        Time
Survey

Identification

Nurses’ Perceptions on the Use and Effectiveness of Capnography in the Emergency Department

Age ______
Gender ______ Female ______ Male
How long have you been a registered nurse? ______ Years
How long have you worked in this emergency department? ______ Years
How long have you had experience with capnography? ______ Years
Have you used capnography on intubated patients in this emergency department? Yes or No ______
Have you had experience with capnography outside of this emergency department? Yes or No ______

Instructions: Please rate how strongly you agree or disagree with each of the following statements by placing a check mark in the appropriate box.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I am attracted to employment settings that use technology</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>2.</td>
<td>I find capnography equipment easy to set up</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>3.</td>
<td>I find capnography equipment is readily available</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>4.</td>
<td>I find ETCO2 values are accurate</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>5.</td>
<td>I find capnography is easy to interpret</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>6.</td>
<td>I find capnography equipment interferes with patient care</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>7.</td>
<td>I find patients do not tolerate the capnography device</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>I find ETCO2 values assist in patient assessment</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>9.</td>
<td>I find capnography an efficient means of monitoring a patient’s ventilator status during transport</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>10.</td>
<td>I find capnography contributes to improving the safety of patient care</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>11.</td>
<td>I recommend availability of capnography to other emergency departments</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>12.</td>
<td>I am aware of the limitations of capnography use</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>13.</td>
<td>I find capnography contributes to quality patient care</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>14.</td>
<td>I am aware of the clinical rationale for the use of capnography</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>15.</td>
<td>I find capnography contributes to improving the safety of patient care</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>16.</td>
<td>I recommend availability of capnography to other emergency departments</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>17.</td>
<td>I am aware of the limitations of capnography use</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>18.</td>
<td>I find capnography contributes to quality patient care</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>19.</td>
<td>I am aware of the clinical rationale for the use of capnography</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
</tbody>
</table>
Please add any additional comments about capnography here:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

*Please return completed survey in the provided sealed envelope to the locked collection box in the emergency department staff break room.*
Letter of Introduction to Emergency Department Nurses

You are invited to participate in a study conducted by myself, Cathy Payne, Master of Science Nursing student, at Chico State. The main purpose of this study is to determine if emergency department nurses consider capnography an effective monitoring adjunct in the provision of safe and effective nursing care for intubated patients. All UCD registered emergency department nurses with direct patient care, who have been trained on the use of capnography and has used capnography on intubated patients are being asked to participate in this study.

The capnography questionnaire will be distributed on July 19, 2010 to participant’s confidential hospital mail box. The survey elicits information about demographic data, and the nurse’s knowledge about capnography. The questionnaire takes approximately 10-20 minutes to complete. Completed questionnaire are to be placed in the collection box located in the emergency department staff break room by August 2, 2010.

There is no risk to those participating in this study. This study may have no direct benefit to you, but the findings of this study will be useful to health professionals who provide care to intubated patients. It is anticipated the results will contribute to the body of nursing knowledge towards the provision of improving the quality of patient care and safety through the use of technology.

You may ask the researcher any questions regarding this study prior to or upon completion of the questionnaire. If you desire further information regarding this study, contact Cathy Payne at (916) 734-5540. Participation is voluntary; refusal to participate will involve no loss of benefits or penalty.

Thank you for participating in this study.
Reminder Letter

If you have already sent in your questionnaire regarding the research study on the use of Capnography, Thank you. If not, read on:

Please complete the survey as soon as possible and place the completed survey in the manila envelope provided and return it to the locked collection box in the emergency department. I count on your responses to help in my effort.

If you need another manila envelope and/or another questionnaire, call me at 530-734-550 and I will send you another.
Human Subjects Clearance / Post Data Collection Forms

California State University, Chico
Chico, California 95929-0875
School of Graduate, International, and Interdisciplinary Studies
Phone: 530-898-6880
Fax: 530-898-6889

May 28, 2010

Catherine Payne
9251 Native Dancer Lane,
Elk Grove, CA 95624

Dear Catherine Payne,

As the Chair of the Campus Institutional Review Board, I have determined that your research proposal entitled "NURSES’ PERCEPTIONS ON THE USE AND EFFECTIVENESS OF CAPNOGRAPHY IN THE EMERGENCY DEPARTMENT" is exempt from full committee review. This clearance allows you to proceed with your study.

I do ask that you notify our office should there be any further modifications to, or complications arising from or within, the study. In addition, should this project continue longer than the authorized date, you will need to apply for an extension from our office. When your data collection is complete, you will need to turn in the attached Post Data Collection Report for final approval. Students should be aware that failure to comply with any HSRC requirements will delay graduation. If you should have any questions regarding this clearance, please do not hesitate to contact me.

Sincerely,

[Signature]
John Mahoney, Ph.D., Chair
Human Subjects in Research Committee

Attachment: Post Data Collection Report

Irene S. Morgan (200)
HUMAN SUBJECTS IN REVIEW COMMITTEE
Post Data Collection Form

Under Federal law relating to the protection of Human Subjects, this report is to be completed by each Principal Investigator at the end of data collection.

Please return to: Diane Smith, HSRC Assistant
Graduate & International Programs
Student Services Center 440
CSU, Chico
Chico, CA 95929-0875

Or Fax it: 530-898-8689

Name: Catherine Payne Chico State Portal ID #: 00434893K

Phone(s) 916-581-2260 Email: FNCPayne@calstate.edu

Faculty Advisor/Thesis Chair (if student): Jennifer Lillibridge Phone: 530-898-6418

College/Department: Natural Sciences/Dept. School of Nursing

Title of Project: Nurses' Perceptions on the Use and Effectiveness of Capnography in the Emergency Department

Date application was approved (mo/yr.): 5/2010 Date collection complete (mo/yr.): 08/2010

How many subjects were recruited? 100 How many subjects actually completed the project? 94

*HARM—Did any subject have a severe reactions or extreme emotional response? No

If yes, please attach a detailed explanation: N/A

Your signature: Catherine Payne Date: 8/30/2010

*Final clearance will not be granted without a complete answer to this question.

Approved By: John Mahoney, Chair Date: 9/1/10

*******************************************************************************

VERY IMPORTANT: If you will or have used this research in your project or thesis you are required to provide a copy of this form (with John Mahoney’s signature in place) to your graduate committee.

Do you want a photo copy of this form mailed to you? Yes

If yes, provide address: 9251 Nature Flanagan Lane
EIR GROVE, CA 95024

COPY