POST-ANESTHETIC RECOVERY ROOM REGISTERED NURSES' EXPERIENCES WITH TECHNOLOGY ASSISTED RESPIRATORY ASSESSMENT DURING PHASE 1 RECOVERY: AN INTERPRETIVE DESCRIPTIVE STUDY

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN NURSING

THE COLLEGE OF GRADUATE STUDIES

THE UNIVERSITY OF BRITISH COLUMBIA

(Okanagan)

August 2019

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Abstract

Background: Technology is prominent in the recovery room, but little is known about nurses' use of technology in performing respiratory assessments, during the critical phase 1 recovery period. The purpose of this study was to investigate PACU nurses' experiences of technology assisted respiratory assessment during phase 1 recovery.

Methods: Interpretive Description was used to understand nurses' experiences. Nine PACU nurses were recruited from three mid-sized hospitals within the same health authority, in a Western Canadian province. Nurse participants were interviewed using a semi-structured interview guide.

Findings: Four themes were constructed from the data. Theme one described nurses' confidence and trust in a visual sensory respiratory assessment process. Theme two described PACU nurses' approach to technology. Theme three highlighted the contextual influences, which sustained the visual sensory approach to respiratory assessment. Theme four described PACU nurses' descriptions of the technical challenges recognising deteriorating phase 1 recovery respiratory function.

Discussion: PACU nurses practiced their intuitive sensory assessments with a projected strong sense of expert practice and minimal dependence on technology. However, a reliance on a sensory assessment and available technology did not always provide timely measures to detect abnormal respiratory function. PACU nurses expressed frustrations with current PACU technology and described some experiences with delayed identification of hypoventilation and hypoxia.

Workplace cultural practices sustained PACU nurses' respiratory assessment practices, the following factors have been highlighted in the literature to affect work place culture and

patient outcomes; current and historical literature on perceptions of expert practice, implications of rationalized behaviors with technology use and alarm suppression, the influence of the wider culture of practice on practice performance, and the physiological challenges of assessing respiratory function on emergence from anesthesia. The case for and against more advanced respiratory monitoring technology is discussed. Marshall McLuhan's tetrad of media effects tool was applied to the findings and found to have relevance and applicability in explaining the contextual elements in the data and bringing together the interpreted findings, under the umbrella of technological effects upon the PACU.

Lay Summary

This research studied Recovery Room Nurses' experiences of bedside monitors and the assessment of breathing.

Methods: Interpretive Description was used to design and guide the study. Semi-structured interviews were recorded and typed, then coded. Main themes were identified from the results.

Results: Nurses rely on their intuition and do not totally rely, or trust, currently available technology such as the bedside monitors. Sometimes this approach did not help nurses to quickly identify patients who needed extra support with their breathing after an anesthetic. Marshall McLuhan's tetrad of media effects tool was used to see if it helped to identify effects of the bedside technology in nurse's work, from the data nurses provided.

Conclusions were drawn that current methods of assessing patients' breathing after anesthetic in the recovery room, showed some areas where technology and process, could be enhanced.

Preface

This study was completed as a requirement for completion of a Master of Nursing Degree. The Student researcher Helen Shannon completed the data collection with the guidance of committee members. Analysis of the data was completed collaboratively with the committee advisor Kathy Rush, who is listed as the principle investigator as required by UBC Okanagan Research Ethics Board.

The writing for this research was done in collaboration with Kathy Rush. All writing was reviewed by all of the committee members: Kathy Rush, Barb Pesut, and Cheryl Holmes. UBC Okanagan Research Ethics, and Interior Health Ethics, approvals were obtained prior to beginning this study (UBC BREB number: 2018-19-006-H) (REB number: H18-01050).

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Acknowledgements

My deepest wishes of gratitude and respect are given to all the faculty and staff at University of British Columbia Okanagan (UBCO), who welcomed me into their world for a few years. I loved being part of a class of experienced nurses wanting to further their knowledge and in doing so; contribute to the body of knowledge of the profession of nursing. I am proud to be a nurse, humble in my limitations, but determined to make a difference, learn from my mistakes, to rise stronger and wiser from every challenge. Special thanks and warm thoughts go to my committee, who each provided me with elements of inspiration, challenged me, and pulled me through. This allowed me the greatest privileged I could dream of achieving: to publish my contribution to nursing care. This means more to me than I could ever express in words.

Dedication

To my loved ones, thank you for being there for me, allowing me to pursue my passion even though it was difficult for you.

Allowing someone to achieve his or her dreams and passions is a gift beyond compare.

Chapter 1: Introduction

1.1 Background

The first phase of recovery from surgery and anesthesia commences when the anesthetizing drugs and gases that maintain anesthesia are discontinued towards the end of the intraoperative phase. Known as the immediate or early recovery period (Hawker, McKillop & Jacobs, 2017; Schick & Windle, 2010), it is a highly critical time for patients because of the prevalence of unrecognized postoperative respiratory complications (Ruscic, Grabitz, Rudolph, & Eikermann, 2017). Quinn and Woodall, (2011) reported one in six patients suffered adverse respiratory events in the recovery area, and in all reported cases, airway obstruction was the root cause of the complication. Of most concern in 50% of cases was a delay in recognizing the problem. Patients often demonstrated hypoxia in the recovery room, with 3% of patients arriving in the recovery room found to be hypoxic with Sp02 < 90% (Rheineck-Leyssius, Kalkman & Trouwborst, 1996).

There are further challenges and limitations to the clinical information provided by current monitoring technology. Desaturation is a 'late' sign of hypoxia and may not be picked up by desaturation alarms during routine Oxygen (0_2) administration (Liao et al., 2017). Evidence indicates that even when ($Sp0_2$) is normal, life-threatening hypercarbia can still be present. Researchers (Overdyk et al., 2007; Oswald, Zeuske, & Pfeffer, 2016) found that respiratory depression measured by ($Sp0_2$) desaturation was only 12% accurate compared to the higher accuracy (41% to 58%) obtained with bradypnea measurement. In contrast capnography is considered a superior, continuous monitoring technology in accurately counting respiratory rate, detecting apnea and confirming expiration gases (Langhan, Li, & Lichtor, 2017), but is rarely used in the Post-Anesthetic Care Unit (PACU). Evidence has shown that capnography is the best

indicator of respiratory depression (Oswald et al., 2016). Despite widespread availability of new technology in capnography monitoring, the literature reviewed suggested policy and standards of practice have not significantly changed, in terms of the monitoring methods routinely available to nurses in the immediate post-operative phase 1 period (Meisenberg, Ness, Sumati, Rhule, & Ley, 2017).

For two decades, research has documented respiratory trends in PACU patients: frequent periods of ($Sp0_2$) less than 90%, bradypnea less than eight breaths per minute, and apnea for greater than 20 seconds (Latham, Bird, & Burke, 2018; Rheineck-Leyssius et al., 1996). Most respiratory complications occur in a small number of patients. Mazo et al. (2014) found 7.9% of post-operative patients (n=5099) had pulmonary complications, with 725 of these complications identified in 404 patients (7.9% of the 5099 patients studied). Additionally, Ruscic, Grabitz, Rudolph, and Eikermann (2017) found patients undergoing abdominal surgery, who developed postoperative respiratory failure, either upper airway or pulmonary in origin, had an approximately 10-fold increase in perioperative 30-day mortality. Further, they found that postoperative pulmonary edema occurred in 1 – 2 % of surgical patients undergoing anesthesia.

Respiratory assessment is critical during phase 1 recovery from anesthesia, to detect complications early, initiate appropriate interventions, and to rapidly restore normal breathing depth, pattern, and adequacy of oxygenation (Brent, 2010; Hatfield & Tronson, 2009). The PACU Registered Nurse (RN) plays a key role in airway assessment and determining interventions to optimize positive patient outcomes (Hawker et al., 2017; Wright, 2013). PACU nurses play a critical role in a patient's recovery from anesthesia and yet, their current assessment methods are relatively unknown. Nursing respiratory assessment methods may present some challenges in detecting signs of respiratory problems occurring in PACU. Problems

with assessment approaches that combine manual techniques and bedside monitoring technology have been well documented, albeit not specifically in PACU (Cooper, Cant, & Sparks, 2014; Cretikos et al., 2008; Flenady, Dwyer, & Applegarth, 2017; Hogan, 2006; Hosking, Considine, & Sands, 2014; Jarzyna et al., 2011; Kennedy, 2007; Odell, 2015; Parkes, 2011).

Relying on technology can promote complacency in nurses' assessment practices (Harley & Timmons, 2010). Harley and Timmons (2010) suggest monitoring may detect major changes in a patient's condition, but it is unable to extract more subtle signs that nurses can notice to pre-empt deterioration. If ($Sp0_2$) is used alone to detect problems with respiration, it will only be able to provide data on the peripheral saturation of capillary blood. Capnography, however, identifies both expired air respiratory rate, and flow. Capnography indicates the function of both upper airway flow and lower airway gas exchange at the alveoli and is an indication of cellular respiratory function (Latham et al., 2018).

Observed signs can also be misinterpreted. It has been found that health care professionals were unable to detect apnea and hypoventilation using conventional monitoring and visual clues alone. For example, Vargo et al., 2002) conducted a randomized controlled trial of patients undergoing therapeutic upper endoscopy with conscious sedation. Graphic assessment of respiratory activity with side stream capnography, made visible only to the researchers, revealed the detection of 49 apnea episodes monitoring ($ETC0_2$). Most concerning however, in thirty-nine patients, restlessness resulting from these capnography-detected episodes of apnea, were misinterpreted by endoscopy staff as discomfort, and additional sedation was inappropriately administered. Could this be happening in the PACU also?

Evidence suggested that manual respiratory assessments have limitations, and intermittent manual respiratory rate assessments are notoriously inaccurate and highly variable

(Eichhorn, Henzier, & Murphy, 2010). Practice recommendations by the American Society for Pain Management Nursing state that "respirations should be counted for a full minute and qualified according to rhythm and depth of chest excursion while the patient is in a restful sleep state in a quiet un-stimulated environment" (Jarzyna et al., 2011, p. 114). Assessing respiration for a full minute is intended to compensate for the irregular rate and or periods of apnea characteristic of a sedated patient or a patient with disordered breathing (Whitaker et al., 2011). Currently, manually recorded respirations are routinely checked every ten minutes on many PACU scoring systems (Hawker et al., 2017). However intermittent 10-minute interval assessments may be too long to detect a rapidly changing patient status during this transitional post-operative period. For example, research has shown that manually counting respirations particularly in post anesthesia patients may not result in appropriate interventions for these patients (Pazar &Yava, 2013). The need for continuous non-invasive and reliable respiratory rate monitoring during recovery from general anesthesia, due to the increased risk of adverse respiratory events has long been recognized (Gravenstein, 1991; Hök, Wiklund, & Henneberg).

The use of technology has greatly enhanced continuous monitoring, and assessment of respiratory status in overcoming the limitations of manual assessments (Hravnak et al., 2008; Prgomet et al., 2016). Bedside monitors for each patient may generate respiratory rate, waveform and alarm settings, ($Sp0_2$), and ($ETC0_2$)., all-important parameters in the PACU period. However, the accuracy of bedside monitoring technology has been a concern for some time, due to 'aberrancy' such as reduced circulation, patient movement, and hypothermia (Creighton-Graham, & Cvach, 2010; Hravnak et al., 2008). Up to 75% of low $Sp0_2$ episodes during postoperative care in the recovery room and ICU have been found to be false readings (Rheineck-Leyssius et al., 1996).

Nurses in critical care areas have a long tradition of interacting with technology, which Mayer et al. (2016) described as a 'human machine interaction.' Evidence suggests that critical care nurses view technology as both a security and obstacle to nursing care (Tunlind, Granstrom, & Engstrom, 2015). According to Harley and Timmons (2010), the relationship between nursing and technology remains contested. There is a concern that technology prompts nurses to rely on readings from machines rather than on their own senses. In a systematic review of the benefits of technology-supported monitoring, there was a lack of randomized controlled trials (RCT's), and no consensus about benefits, such as pulse oximetry and capnography in hospitalized patients, to prevent adverse respiratory events (Jarzyna et al., 2011).

How PACU nurses currently experience and use technology in supporting respiratory assessment during phase 1 recovery is unknown. For example, it has been well documented that clinical alarms, intended to promote safety, are one of the most frequently reported healthcare technology problems, reducing their effectiveness for respiratory assessment (Mayer et al., 2016). An estimated 85 to 99 percent of alarm signals do not require clinical intervention (The Joint Commission, 2013). The unnecessary exposure to alarms has been implicated in clinicians becoming desensitized or immune to the sounds, and overwhelmed by information (Creighton-Graham & Cvach, 2010). The resulting technology-induced alarm fatigue, leads nurses to silence, ignore and disbelieve technical alarms (cardiac leads, apnea alarms, and pulse oximetry) contributing to assumed safety risks for patients (Creighton-Graham & Cvach, 2010). This response to technology over time forms a collective nursing culture in dealing with respiratory assessment challenges that becomes difficult to change (Mayer et al., 2016).

Theoretical explanations for nurses' interactions and relationship with technology have been limited. Marshal McLuhan (2013) described a theory that may help explain nurses'

interaction with technology and the slow adoption of new technology such as capnography that has shown promising outcomes. Briefly, McLuhan coined the term, 'the sensorium of media effects' that refers to all electronic technology as a medium that alters and affects our senses, our immediate environment, and the greater society. He developed the idea of using four tetrads as a practical tool to help in understanding the patterns or effects different media produce. According to McLuhan and McLuhan (2007) the tetrads apply a consistent mode of analysis to different media as tools and triggers. Using the Tetrad to analyze the patterns of effects that different technologies produce, McLuhan suggested using four questions; 1) What does it enhance? 2) What does it make obsolete? 3) What does it retrieve that had been obsolesced earlier? 4) What does it flip into when pushed to extremes? (Collections Canada, 2018). These four tetrad questions will be used to analyse the findings after themes were inductively generated.

1.2 Purpose of the Study

The purpose of this study was to investigate PAR/Recovery room/PACU nurses' experiences of technology assisted respiratory assessment during phase 1 recovery, using Interpretive Descriptive qualitative methodology (Thorne, 2016).

1.3 Definitions

Apnea: Respirations cease for several seconds. Persistent cessation results in respiratory arrest (Perry, Potter, & Ostendorf, 2014).

Biot's respiration: Irregular respirations vary in depth and are interrupted by periods of apnea (Perry et al., 2014).

Bradypnea: Rate of breathing is regular but abnormally slow (fewer than 12 breaths/min) (Perry et al., 2014).

Capnography: The breath-by-breath assessment of a patient's ventilation status to obtain a non-invasive measurement of the partial pressure of carbon dioxide (C02) in exhaled breath, expressed as the C02 concentration over time (Latham et al., 2018).

Hypoventilation: Respiratory rate is abnormally low; depth of ventilation may be depressed (Perry et al., 2014).

Hypercarbia: An abnormally elevated level of (CO_2) in the blood may occur (Perry et al., 2014).

Perianesthesia Nurse: In 1989 AACN formally recognized post anesthesia nursing as a critical care specialty (Schick & Windle, 2010).

Post Anesthetic Care Unit: In the author's health authority in a Western Canadian Province the post anesthetic care unit (PACU) is a hospital area located close to the operating rooms, equipped with bedside electronic monitoring equipment, emergency resuscitation equipment and trained specialty registered nursing staff. Nurses in this area are able to manage phase 1 recovery patients, including intubated patients and patients with airways, and manage resuscitation situations post anesthesia. Nurses either hold a Perianesthesia certificate, or a critical care certificate.

Post anesthesia phase 1: The immediate post anesthesia period, with basic life–sustaining needs, and constant vigilance. (Schick & Windle, 2010).

Pulse oximetry: A device that measures the ($Sp0_2$) of arterial blood in a person by utilizing a sensor attached typically to a finger, toe, or ear to determine the percentage of oxyhemoglobin in blood pulsating through a network of capillaries (Meriam-Webster, 2018).

Regulation of post anesthesia nursing: In North America the scope of Perianesthesia nursing is regulated by facility policies, and procedures, state and facility policies and procedures, national accreditation bodies, and professional nursing organizations (Schick & Windle, 2010).

Respiration: is the exchange of (0_2) and ($C0_2$) between the body and the atmosphere. Three processes of respiration are: ventilation, mechanical movement of gases into and out of the lungs; diffusion, movement of (0_2) and ($C0_2$) between the alveoli and the red blood cells; and perfusion, distribution of red blood cells to and from the pulmonary capillaries. (Perry et al., 2014).

Respiratory rate assessment: The recommended method for respiratory rate assessment is as follows; if rhythm is regular, count number of respirations in 30 seconds and multiply by 2, if rhythm is irregular, less than 12, or greater than 20, count for 1 full minute. If irregularities are suspected a full minute of assessment is required, to assess depth, palpate the chest wall excursion, or auscultate the posterior thorax, (Perry et al., 2014, p. 89).

1.4 Assumptions

Held in common with the author's personal experience as a recovery room nurse, is the assumption that current technology has limited use in assisting with detecting hypoventilation. PACU nurses use capnography to a limited extent, have practice restrictions with capnography, and receive little education on capnography. With currently available technology, nurses are experiencing issues with delayed patient awakening, desaturation, and apnea, and may possibly be experiencing anxiety with effectively identifying hypoventilation in non-ventilated recovery room patients. It is assumed that nuisance alarms are a factor in how technology is perceived by recovery room nurses and may negatively influence patient care.

Chapter 2: Literature review

2.1 Overview

The literature review was based on the results of a structured search of evidence-based literature from selected health care databases - Cumulative Index of Nursing and Allied Health Literature (CINAHL) and Medline - using controlled vocabulary and mesh or equivalent terms. The evidence included in this summary is from two large data base searches. Selected papers were restricted to the period from 2000 to 2017, to capture both recent and historical developments in respiratory assessment research.

2.2 Method of Literature review

An initial broad search using the terms “respiratory assessment” and “respiratory care” was completed to locate research-based papers, quantitative or qualitative, that addressed aspects of respiratory nursing assessment related to the PACU, and this produced 0 relevant results. The search strategy was widened to capture a wide range of research related to recovery room respiratory assessment.

2.3 Findings of Literature Review

Controlled vocabulary searches were conducted in CINAHL, using Headings terms: ‘Oxygen saturation’ ‘carbon dioxide’ and ‘capnography’, combining all subheadings linked with ‘or’ full text with abstract available. Although the search criteria limited the search significantly, it did reveal 404 results, of which 35 were selected as relevant for review. Articles were uploaded to Refworks. Medline was also searched using the Mesh terms: ‘respiration’, PAR,’ ‘PACU,’ ‘Assessment, ’recovery room,’ ‘respiration,’ ‘post anesthetic nursing,’ and ‘risk assessment.’ Major concepts were selected for all resulting themes, combining selections linked by ‘or.’ The searches were conducted between 2000 and 2017 using academic journals with

abstracts available in English Language. This search yielded 23,824 results, excluding journals related to toxicology pharmacology, physics and radiation, resulting in 57 articles but only three with any relevance and none with direct relevance to respiratory assessment in the PACU. In March of 2018 a mirrored search of each database was completed to confirm initial search numbers. No significant differences were identified, and no additional articles obtained, confirming consistency.

This literature review is organized in four sections. The first section addresses postoperative respiratory complications in the PACU. The second section addresses respiratory assessment and the third, technology in the PACU. The fourth section applies Marshal McLuhan's theory to the main concepts in the literature. Findings from the literature review are compared to McLuhan's concepts - the theory of the sensorium of media effects, the 'tetrad of media effects,' retrieval, reversal and obsolescence, alienation and explosive hybridization.

2.3.1 Phase 1 Recovery

Respiratory assessment is of the utmost importance in the immediate post-op period to detect several respiratory problems. Respiratory problems may include but are not limited to: delayed awakening, residual neuromuscular blockade (RNMB), over sedation and respiratory depression, airway obstruction or obstructive sleep apnea (OSA). These conditions result in poor ventilation or ineffective cellular respiration, or hypoxia and hypercapnia (Chung, Yuan, & Chung, 2016). Chung and colleagues (2016) explained, that poor ventilation and airway compromise contribute to low partial pressure of oxygen ($P0_2$). The low $P0_2$, which results in hypoxia and rising $C0_2$ or hypercapnia (also known as hypercarbia), puts patients at risk of cardiac, neurological and organic stress which will not immediately be detected by current technical monitoring alarms, until physical signs of stress are evident.

The Interior Health (2017) surgical services clinical practice standard for the post anaesthesia recovery (PAR) record states that vital signs shall be assessed and documented every 5 minutes until the patient is awake and stable, and every 10 minutes thereafter until PAR discharge criteria are met. Although continuous technological monitoring of vital signs occurs in practice, there is no documented requirement for continuous technological monitoring of respiratory function in this written standard. PACU nurses' respiratory assessments are critical during this phase, particularly during the first fifteen minutes in PACU, and performed through a combination of manual techniques and bedside monitoring technology. During this time PACU nurses are often required to initiate urgent and life sustaining interventions such as a jaw thrust, insertion of oral airways and assisted breaths and (0_2) administration via bag valve mask or T Piece ventilation.

2.3.2 Post-Operative Respiratory Complications

The following section describes the literature reviewed pertaining to critical postoperative respiratory complications beginning with the immediate priorities of PACU respiratory assessment in early phase 1 recovery. These include airway obstruction, hypoxia, delayed awakening, OSA, RNMB, over sedation and respiratory depression.

2.3.2.1 Airway Obstruction

Airway obstruction is a major post-operative respiratory complication. Cook, Woodall, and Frerk (2011) conducted a national audit in the United Kingdom (UK) of major complications of airway management, finding that of 133 reports in the category of general anaesthesia, meeting inclusion criteria, 38 events occurred at the end of surgery or during the recovery period, and two in transit. They found that prompt diagnosis of airway obstruction in the recovery room was particularly problematic, with two patients dying following events occurring in the recovery

room. In one particularly poignant case, an inhaled blood clot after tonsillectomy produced total tracheal obstruction, which was initially attributed to asthma and hypoxia requiring cardiopulmonary resuscitation (CPR). Reviewers judged that in several cases, the use of capnography in the recovery area (and its appropriate interpretation) would have led to earlier identification of airway obstruction.

2.3.2.2 Hypoxia

Evidence suggested that some patients are hypoxic on arrival to the PACU, and those that are on (0_2) could be masking hypoventilation since supplemental (0_2) therapy is known to slow the desaturation response (Liao et al., 2017). Labaste et al. (2015) conducted a large prospective, observational study in France and found a 13% incidence of hypoxemia during transfer from the operating theater to the PACU. They also found that 72% of patients were transferred without (0_2), and these patients accounted for the greatest incidence of hypoxemia. Similarly, patients without (0_2) therapy that have been found to be hypo ventilating on arrival, were more likely to be identified quickly than those on supplemental (0_2) (Sivilotti, Messenger, Vlymen, Dungey, & Murray, 2010). This concern regarding hidden hypoventilation may be why PACU's are seeing a trend in anaesthesiologist practice not to apply (0_2) unless indicated on extubation.

2.3.2.3 Delayed Awakening

In otherwise healthy patients who have undergone relatively short operative procedures, the incidence of delayed awakening is said to be practically zero (Frost, 2014). However, many patients are not healthy and delayed awakening occurs frequently. The causes of delayed awakening after anaesthesia are often multifactorial and governed by patient, drug, surgical and metabolic factors, drug overdose and interactions, especially with neuromuscular blocking agents (Frost, 2014). The speed of emergence from inhaled anaesthetic agents directly relates to the

effectiveness of alveolar ventilation and therefore hypoventilation may delay emergence (Frost, 2014).

2.3.2.4 Obstructive Sleep Apnea

Many patients scheduled on the daily operating room list are identified as having OSA. Latham et al. (2018) suggested 43% of United States (US) surgical patients are at high risk of adverse respiratory events after surgery, due to the underlying effects of OSA. As many as 80 – 90% of patients with OSA go undiagnosed, this complicates the effects of anaesthesia medication on an already compromised airway. Latham et al. (2018) and Spence, Han, McGuire & Couture (2015), state that confirmed or suspected high-risk patients, such as those with OSA should be monitored for respiratory rate, oxygenation, end-tidal carbon dioxide ($EtCo_2$) and cardiac rhythms.

2.3.2.5 Residual Neuromuscular Blockade (RNMB)

Residual symptoms from neuromuscular blocking drugs still affecting patients after anaesthesia, occurs frequently resulting in potentially ineffective respiration. RNMB poses challenges by lowering the body's natural defense mechanisms, thus threatening the patient with a range of adverse reactions including death (Stawicki & Gessner, 2018). In a Canadian multicentre prospective trial, 45% of patients transferred to the PACU after a surgical procedure were found to have varying degrees of residual paralysis, lasting more than 2 hours (Fortier et al., 2015). Ruscic, et al. (2017) highlighted that postoperative residual paralysis from non-depolarizing neuromuscular blocking agents (NMBA's) is associated with an increased risk of postoperative desaturation to $Sa0_2$ of less than 90% after extubation, resulting in re-intubation and unplanned admission to an ICU. Stawicki and Gesner (2018) state that the upper airway is compromised by even a small amount of paralytic medications, because negative inspiratory

pressure required at the beginning of the breathing cycle, is weakened or absent and the airway loses its ability to remain open. Farhan, Moreno-Duarte, Mclean, and Eikermann (2014) explain that with RNMB, ventilator drive is halted, causing a drop in inspiration volume and flow and the retention of ($C0_2$). In these situations, carotid arch chemoreceptors, which usually would respond to the resulting hypoxemia, hypercapnia and acidosis by stimulating breathing, may be blunted after exposure to neuromuscular blockade, suppressing the essential compensatory mechanism. Subsequently stimulation of the carotid arch chemoreceptors to increasing $C0_2$, (the normal mechanism by which the body increases breathing effort) is blunted and breathing on extubation, can be severely compromised (Farhan et al., 2014). Further, paralytic drugs are often reversed immediately prior to transfer to the PACU, making the assessment of breathing effort on arrival critical.

2.3.2.6 Over-Sedation and Respiratory Depression

Over-sedation and respiratory depression are commonly reported complications in phase 1 recovery, contributing to several serious adverse patient events (Dahan, Aarts, & Smith, 2012; Meisenberg et al., 2017). Many of these events are associated with technical alarms according to the Joint Commission's (2013) sentinel event database. This database includes records of any unanticipated event in a health care setting resulting in death or serious physical injury to a patient, not related to the course of the patient's illness. It contains 98 reports of monitoring equipment alarm events between January 2009 and June 2012, of which eighty resulted in patient death. In addition, a Food and Drug Administration (FDA) database contains 566 alarm related deaths between January 2005 and June 2010 nationwide (Mayer et al., 2016). Overdyk et al. (2017) found frequent desaturation and bradypnea events during patient-controlled analgesia that contributed to respiratory depression. Vargo et al. (2002) studied patients undergoing endoscopic

procedures with intravenous sedation, finding that 57% of the patients experienced adverse respiratory events including apnea lasting > 30 seconds.

2.3.3 Respiratory Assessment

PACU nurses are responsible for careful respiratory assessment in early phase 1 recovery. Nurses' priorities in performing respiratory assessments during this phase include confirming expiration, detecting hypoventilation, and calculating respiratory rate. These priorities are now described.

Confirming that a patient is able to inhale, and exhale is one of the first safety checks a PACU nurse performs on receiving a patient from the operating room. Inhalation difficulty is usually immediately evident with audible stridor, and distressed respiratory muscle exertion. However there is substantial evidence that hypoventilation is a common mechanism responsible for postoperative hypoxemic events in the majority of even healthy patients in the PACU (Karcz & Papadakos, 2013). Hypoventilation is more difficult to detect, since expired air condensation on an (0_2) mask is only visible if the tidal volume is sufficiently large and forceful and cannot always be visually confirmed in some patients with hypopnea and small tidal volume, such as pediatric patients; it is difficult to establish if these patients are breathing effectively, without advanced monitoring (Langhan et al., 2016). Many patients are not required to use an (0_2) mask, removing this visual option as a confirmation tool from the assessment. In a study by Vargo et al. (2002) visual observation alone was unable to detect any apnea events greater than 30 seconds in duration but were all detected by capnography.

Detecting hypoventilation in the PACU patient is imperative to prevent negative outcomes. Whether it is possible for the PACU nurse to confirm alveolar ventilation and prevent, or at least identify, hypoventilation with current practice and current technology is questionable.

It is well documented that identification of apnea and/or hypoventilation cannot always be immediately identified by physical assessment, respiratory rate monitoring from a cardiac monitoring lead, or continuous ($Sp0_2$) (Hannam et al., 2016). In a recent study, the value of respiratory rate over pulse oximetry and apnea monitoring, was emphasized to reduce opioid-induced over sedation and respiratory depression, suggesting improvements could be made without the use of expanded electronic monitoring (Meisenberg et al., 2017).

The patient with OSA presents further challenges in assessing for hypoventilation. For example during apnea, the patient with OSA will continue to make convincing ventilatory efforts despite airway obstruction (Heuer & Scanlan, 2018). Iin some cases, it can take up to two or three minutes for a state of hypoventilation, either from central or obstructive apnea, to result in a warning desaturation alarm (Gutierrez, Dinh, & Hernandez, 2016; Kurrek & Merchant, 2012), during which there is an insidious increase in undetected hypercarbia, and perhaps more concerning hypoxemia. Unless the nurse is continuously counting manual respiratory effort, auscultating the upper airways for audible expiration, and confirming expired air condensation on a mask, apnea or hypoventilation could remain undetected.

Pulse oximetry has not been shown to reliably recognize hypoventilation or apnea, particularly in the presence of supplemental (0_2) (Langhan, et al., 2016). Compared to pulse oximetry, capnography is 28 times more likely to detect a respiratory event (Latham et al., 2018). The routine use of (0_2) therapy, may give nurses a false sense of security that patients are adequately oxygenated, because, (0_2) therapy has been demonstrated to delay, but not prevent, desaturation alarms caused by hypoventilation, slowing detection but not preventing hypercarbia (Eichhorn et al., 2010; Liao et al., 2017).

2.3.4 Calculating Respiratory Rate

Continuous monitoring of respiratory indicators requires use of technology, as well as vigilant physical assessment skills used intermittently. Previous studies have shown that respiratory rate is an early, highly predictive, and often sole indicator of critical illness (Blankush et al., 2017). Confirming respiration on the arrival of phase 1 patient in the recovery room could be compared to any critical situation where confirming breaths needs to be done quickly before moving to other aspects of a rapid assessment process. Similarly in a critical situation, assessment of breathing without counting a rate should take less than ten seconds (Heart & Stroke, 2011). However in more controlled situations, an accurate full manual respiratory rate count cannot be rushed and is said to require a full minute of uninterrupted focus (Cardona-Morrell et al., 2016). Research studies have shown that respiratory rate is often recorded inaccurately or not even recorded when manual measurement and documentation are required (Cardona-Morrell et al., 2016; Hogan, 2006; McBride, Knight, Piper, & Smith, 2005). Respiratory rate counts achieved manually are notoriously inaccurate (Agnihotri, 2013, Mayer et al., 2016), and do not confirm effective respiration, adequate expired volume, or gas exchange. Practice preferences within the PACU for recording respiration are currently unknown.

2.4 Technology in PACU

This section reviews the literature regarding technology in PACU, including influences, perceptions of deficits and ambiguity evident over practice change. Capnography, human factors and alarm fatigue are addressed.

2.4.1 Influences, Perceptions and Ambiguity

Anesthesiologists are responsible for the patient’s care up to the point of discharge from the PACU. Physician input into new technology in the PACU is therefore essential, and yet there

are relatively few anesthesia publications specifically addressing airway problems occurring in the recovery period (The Fourth National Audit Project of the Royal College of Anesthetists and the difficult airway society, 2011). Reluctance to initiate monitoring interventions, such as continuous capnography, prevents the nurse from having early alerts of patients who appear to be spontaneously breathing, but are not achieving effective respiratory function for various reasons. Lumb (2000) suggested traditional monitoring approaches do not easily detect hypercapnia that would be obvious with the aid of a quantitative $C0_2$ measurement system.

The expansion of technology such as capnography from the operating room to the PACU could be described as the democratization of knowledge. It has been suggested that 'end users' can exert considerable power over technological advancement (Senge et al., 1999). Allowing the nurse to initiate appropriate monitoring tools is essential to safe patient care. Yet, current nursing protocols (American Society of Peri-Anesthesia Nurses (ASPAN), 2017; MOSBY, 2018) limit the nurse's ability to initiate ($EtCo_2$) monitoring, to situations described as "if clinically indicated" but fail to clarify how clinical indication should be identified. This creates ambiguity and leaves the nurse relying on the approval of a physician before this technology can be initiated. Whitaker et al. (2011) states that the Association of Anaesthesiologists of Great Britain and Ireland (AAGBI) guidelines recommend the continuation of monitoring devices until the patient has recovered from the immediate effects of anesthesia, and to do otherwise is illogical (Whitaker et al., 2011).

2.4.2 Capnography

Capnography is defined as the breath-by-breath assessment of a patient's ventilation status, a non-invasive measurement of the partial pressure of ($C0_2$) in exhaled breath, expressed as the $C0_2$ concentration over time (Latham et al., 2018). This breath-by-breath monitor also

provides a highly accurate respiratory rate count. Continuous capnography is gaining popularity as an additional safety measure, but in the literature reviewed, its use has not become routine or standard practice. Guidelines remain tentative and somewhat ambiguous. ASPAN's (2017), nursing standards practice recommendations, state that routine monitoring and the addition of capnography is recommended 'when available' for patients with diagnosed or suspected OSA. However, capnography is standard practice in the operating room, an area managed predominantly by anesthesiologists.

The environment in health care technology is beginning to change; capnography is making its way into professional medical reviews and in 'limited' clinical situations is recommended for continuous monitoring. According to Heuer and Scanlan (2018), capnography is now considered a standard of care during 'moderate sedation' to monitor the adequacy of ventilation in respiratory care. As such, the onus is on health care organizations to implement evidence informed changes. It is interesting to consider why the change in practice takes so long after it is documented to be best practice. This gradual implementation was described by Latham et al. (2018) in their implementation of capnography in a large Midwestern metropolitan hospital in the USA, for patients using patient-controlled analgesia (PCA) pumps in the PACU. They found that once implemented, nurses could see the utility of using capnography for other patients not using PCA pumps, who were sleepier than expected, when tactile stimulation was required to gain a response from a patient, and with a patient who had been admitted for 15 minutes or longer and was still not rousable.

The comfort and routine of monitoring procedures and protocols currently used, may blind nurses to the actual quality, accuracy, and efficacy the newer technology may provide. Capnography immediately available to recovery room nurses on the arrival of a fresh post-

operative patient would provide immediate detection of expiratory breath, accurate continuous respiration rate, and instant detection of hypoventilation and intraoperative hypercarbia. However there remains a lack of RCT evidence for practice with respect to capnography.

There is also a lack of RCT evidence to support the superiority of pulse oximetry technology, in monitoring respiratory status in the postoperative period, compared to intermittent manual nurse observation of respiratory rate and assessment of mental status (Chou et al., 2016), and yet it has been used routinely. Persistent over-reliance on RCT results before practice is changed has been strongly criticized for contributing to a reticence among the medical profession to act preventatively, delaying safety initiatives, and the development of safe practice and policy (Whitaker et al., 2011). However, taking on new technology can have drawbacks and many factors need to be considered before embarking on its adoption. Least among these factors is significant capital outlay and increased labor expenses, but also likely of more importance is the potential effect on the work environment that the technology itself creates. The proliferation of alarms following expanded electronic monitoring has been implicated in patient safety events (Meisenberg et al., 2017).

2.4.3 Human Factors and Alarm Fatigue

Several researchers have highlighted the technical limitations and human pitfalls in using technology to correctly assess effective respiratory function (Abenstein & Narr, 2010; Kodali, 2013; Ruskin & Hueske-Kraus, 2015; Taenzer, Pyke, McGrath, & Bilike, 2010). Mayer et al. (2016) suggest that even though healthcare professionals are trained in using the technology tools required for patient care, they likely don’t have the skills to evaluate the effectiveness of the ‘human machine interaction’ and unfortunately the ‘technology’ can become a source of

patient harm. Developing an awareness of what that human machine interaction is and how to manage it may be crucial education for nurses to prevent alarm fatigue.

Alarm issues are among the most frequently reported healthcare technology problems (Mayer et al., 2016). Clinical alarms can be vital in preventing patient injury or death. However, if alarm conditions are not effectively communicated, patients are put at risk. Alarms are used with a wide variety of equipment such as patient monitoring equipment, ventilators, and dialysis units. To reduce the frequency of alarm-related adverse incidents, the Emergency Care Research Institute was designated an evidence-based practice center by the U.S. Agency for Healthcare Research and Quality (AHRQ) in 1997. They made a number of recommendations to ensure device alarms are handled in a way that is logical, safe, and consistent with a facility's practice, including limiting false or excessive alarms, which can desensitize staff (Legge, 2009). They suggest that to ensure that alarm conditions are quickly and consistently conveyed factors such as speaker volume, floor layout and physical distance, be addressed so the alarms can be heard. Legge (2009) stated that staff needs to understand the purpose and significance of alarms and know how to set alarm limits to appropriate, physiologically meaningful values. It has been shown that low-saturation alarms on pulse oximetry monitors and low minute-volume or high peak-pressure alarms on ventilators are regular subjects of this sort of error (Legge, 2009).

‘Human factors’ is a phrase used to describe behaviors that influence patient safety events (Mayer et al., 2016). The proliferation of alarms from electronic monitoring has indeed been implicated in numerous patient safety incidents (Mayer et al., 2016; Ruskin & Hueske-Kraus, 2013). Medical and nursing staff have been shown to fall into the trap of being blinded to information they needed to recognize, and have failed to engage or react, leading to adverse events (Cook, Woodall, & Frerk, 2011; Cook, Woodall, Harper, & Benger, 2011). It could be

argued that this is more a failure of the human who designed the technology, than of the human attempting to use the information.

When alarm conditions are set too tight, default settings are not adjusted for the individual patient, or for the patient population. The resulting constant barrage of sounds and data results in clinicians becoming desensitized or immune to the significance of sounds, and overwhelmed by information (Creighton-Graham & Cvach, 2010). This is where the human interaction starts. It is useful to consider how clinicians act during alarm fatigue. Do they tune out alarms or does a cultural code of behavior dictate that nurses expect team members to turn down the volume of the alarm, turn it off, or adjust the alarm settings outside safe limits or outside the specifics appropriate for the patient? Does the fact that monitoring parameters need to be frequently adjusted, sensors and electrodes checked and repositioned frequently in the high patient turnover recovery room, add to the desensitization and sense of fatigue? Alarm fatigue has been associated with a lack of response to respiratory alarms (The Joint Commission, 2013). Mayer et al. (2016) found that there was a high frequency of red alarms (the most concerning alarms) for apnea (suspension of breathing), and desaturation (a decrease in (Sp02) in the blood), contributing to alarm fatigue. Such practices can have serious, often fatal, consequences for patients.

Conventional approaches to analyzing alarm fatigue focus on the outcomes of alarm fatigue via the emerging specialism of human factors analysis (Mayer et al., 2016). Human factor analysis focuses on the "Swiss Cheese" model of human error (Reason, 1990). This examines four levels of active errors and latent failures: unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences. Macro effects of the influences on practice from a more theoretical or philosophical discourse analysis are not used.

2.4.4 McLuhan's Theory in the PACU

While searching for ideas to explain the influences of technology in nursing, Marshal McLuhan's concept of a sensorium of media effects resonated as an alternative lens to view the development of technology in healthcare. McLuhan, who believed his theory was scientific, developed it to explain and highlight the effects media has on society (McLuhan & McLuhan, 2007). McLuhan's four laws of media form the tetrad of media effects [see Figure 1]. According to McLuhan and McLuhan (2007) all situations comprise an area of attention, the ('*figure*'), and a very much larger area of inattention called the ('*ground*'). In the example of the PACU nurse, nurse interaction with bedside monitoring technology would be the '*figure*'. The '*ground*' of the monitoring technology is the situation that gives rise to it, the environment (*medium*) of services, and the information they provide for patient vital signs. Potentially harmful actions such as human factors, such as alarm fatigue and learned adaptive behaviours of nurses, may be a consequence of technology. The following section describes the main theoretical concepts of the theory and applies them to the PACU environment. McLuhan's main concepts were later brought together in the four-tetrad questions to produce a tool to critique media technology.

2.4.4.1 The Sensorium

Quantitative research into alarm fatigue does not explore or consider 'context'. McLuhan theorized context as the sensory environment created by various media and perceived by individuals as the 'sensorium,' the unique and changing sensory environments which manipulate the ration of our senses, reshaping the way in which we collectively and individually perceive and understand our environment (Howes, 1991). Continuous monitoring technology in post anesthetic recovery units can be viewed through McLuhan's lens as both

an extension of our own nervous systems and a communication media for nurses. Using McLuhan's interpretation of technology, bedside monitoring technology could be described as a tool for enhancing our ability to read, interpret and analyze the signals and messages our patients' bodies are communicating to us through electrically interpreted means.

McLuhan (1964) suggested a paradigm in which 'the medium is the massage' because it is the medium that shapes and controls the scale and forms of human association and action. In other words, nurses' interpretations of the electrically interpreted signals, manipulates what they hear. Further, the monitors themselves and the technical environment created by continuous monitoring technology, change the PACU nurse's total experience, and their interactions with patients and other staff. Consequently, nurses' interpretations of the patient's status is determined by the way they 'interpret' the media or the technology, suggesting that there are various ways it could be interpreted.

2.4.4.2 Technological Complexity and Super Stimulation

Technology use creates complexity in our interpretation of data. Not only is there a respiratory rate to assess, but there is also an apnea alarm to monitor with alarm settings and multiple parameters to adjust and respond to, sounds and lights. How nurses filter, prioritize, understand, and evaluate this complexity has implications for patient care. Electronic technology is seen to change the scale or pace or pattern that it introduces into human affairs (McLuhan & McLuhan, 2007). Have we become so busy dealing with the barrage of data in our everyday working lives that we have failed to question its relevance? McLuhan suggested that it is only too typical that the 'content' of any medium blinds us to the character of the medium (McLuhan, 1995). McLuhan's statement may be applied to how nurses interpret data on a patient's bedside electronic monitor. Nurses are professionally trained to be objective

and cautious in interpreting data, however the deeper meaning of factors shaping the form of human association between a nurse and the data they interpret must be considered. Mayer et al. (2016) suggest that over time and with staff turnover, a collective working knowledge of the monitor alarm default settings and alarm behavior deteriorates and reduces the capacity for health care professionals to think critically about how the technology contributes to patient care. This could be described as a technological language determined by a subculture, or as McLuhan suggested, there are psychic and social consequences of technology. McLuhan (2013) describes the selection of a single sense for intense stimulus, such as hearing; a single extended, isolated, or "amputated" sense in technology, such as the alarms from the respiratory rate monitor. He suggested that this intense stimulation to one of our senses, have made too violent and 'super stimulated' a social experience for the central nervous system to endure (McLuhan, 2013, p. 680), in part explaining the numbing effect that technology has on its makers and users (McLuhan, 2013).

McLuhan (2013) writes in 'Understanding Media', that everybody experiences far more than he understands; yet it is '*experience'*, rather than understanding, that appears to influence behavior. Especially in collective matters of media and technology where the individual is almost inevitably unaware of these effects upon them. In effect McLuhan identified human factors and alarm fatigue before we had even created the terms.

2.4.4.3 The Technological Revolution

McLuhan described the development of electronic media as creating an 'age of anxiety.' In other words, we can no longer remain neutral, stand aside and observe, or detach ourselves from the media, which may have previously allowed us to de-stress. We are now connected and joined to the technology and receiving constant information, with continual

responsibility to manage the information. McLuhan suggested that ‘others’ who we once held a degree of detachment from, are now integrated, involved in our lives as we are in theirs, “the electric implosion compels commitment and participation” (McLuhan, 2013, p.7). This could be compared to recovery room nurses who used to check on their patients every five minutes for the first fifteen minutes after surgery, and then every ten minutes, but now are electronically connected to every beep, blip and wail of the electronic monitoring device attached to their patient.

This second-by-second technological connection to patients’ every motion raises the question of whether nurses have created safer patient care, and a better environment or whether this connection has increased stress levels. McLuhan (1995) views this connectedness created by technology as a social phenomenon that changes a whole culture. McLuhan (1995) suggested that our cultural awareness, our globalization of awareness, is the result of being made aware by technology, rather than wanting to be aware and using technology to achieve it. While the industrial revolution created a society with a vehement assertion of private outlook, the information age has promoted public transparency in which “In the electric age we wear all mankind as our skin” (McLuhan, 2013, p. 736). Applying this theory to the PACU, we now expect to be connected to our patients at all times and know everything they are doing, what their bodies are experiencing, and technology is expected to provide this information.

2.4.4.4 Alienation

McLuhan (2013) suggested that for three thousand years there has been a specialist explosion and increasing specialism and alienation of humanity. In clinical terms this could be explained in the proliferation of technical mini-professions, specialist doctors and medical

technical roles such as the respiratory therapist, the anaesthesia assistant, the pacemaker technologist. The increased knowledge and skill needed to operate specific technical equipment has required increased specialisms, including in nursing. The PACU is one of the specialisms developed to cope with the increased technology associated with surgery.

McLuhan's concept of alienation comes from the exclusion of others from the specialisms. In the context of nursing and respiratory assessment, at the micro level it can be argued that the nurse can make as much use of the capnogram as the anaesthesiologist. This begs the question: Is the apparent reticence and resistance to expand its use, more about anesthesiologists protecting their specialization, and holding on to power and control, than it is about patient safety and care? McLuhan (2013) suggested that this kind of technological change is itself a disruption, which causes a change of organization and the alteration of social groupings, this may generate resistance.

2.4.4.5 Explosive Hybridizations

McLuhan describes needing hybrid energy or explosive hybridizations, when a society is moving from one dominant medium to another, in order to snap us out of the usual sensory numbness and narcosis our media forms induce in us. A simpler description of this would be learning new technology or new processes. One of McLuhan's antidotes to the deleterious effects of media is awareness; by being aware of the effects our media have on us, the better we can position ourselves to counteract the negatives. The author's application of this understanding is that we are currently using outdated manual respiratory rate assessment practices in the PACU to compensate for inaccuracy in the current respiratory rate technology, which we have come to distrust. This awareness may be the impetus for understanding that our practices are as flawed as the technology we feel we have to live with, and that we need to adopt better technology and

better awareness of the technological effects on our environment and behavior. The process needed to transition from evidence-informed to evidence-implemented knowledge, is complex. According to McLuhan the introduction of new technology is usually gradual and can cause resistance and revolutions as it creates a totally new human environment (McLuhan, 2013). For McLuhan's theory of the Tetrad of Media effects applied to respiratory technology [see Figure 1 & 2].

2.4.5 Summary of Literature

The literature review has highlighted common postoperative respiratory complications in the PACU. These complications result in significant delays to recovery. There is substantial evidence that prompt detection of these complications is challenging with current practices and technology and missed detection often responsible for adverse postoperative events in the PACU. There is a lack of RCT evidence for pulse oximetry or capnography in PACU. The use and appropriate interpretation of capnography in the recovery area is promoted in the literature, with assumption it would make a difference to earlier identification of some critical events. Capnography has been shown to be 28 times more likely to detect a respiratory event (Latham et al., 2018). Current nursing protocols (ASPAN, 2017; MOSBY, 2018) limit the nurse's ability to initiate ($EtCo_2$) monitoring, to situations described as "if clinically indicated," these guidelines remain tentative and somewhat ambiguous.

McLuhan proposed the idea of a sensorium of media effects, to explain how technology affects all society in a macro way, and developed the tetrad of media effects to help analyse technology and its contextual effects on human behaviour. Applying the concepts of a sensorium of media effects, and the Tetrad tool to the PACU, facilitated a broader lens to consider the wider

implications of technology within this healthcare environment, to consider the psychic and social consequences of technology.

Chapter 3: Research Methods

3.1 Positioning Self (Ontology)

In the author's experience as an RN, working in the PACU, many potential airway problems can occur including respiratory arrest, delayed awakening, inadequate respiratory efforts and obstructive airway issues (Chung et al., 2008). Common symptoms include: apnea, biot's respiration, bradypnea, hypoventilation, desaturations, and insidious risk of hypercarbia. As a nurse, I have a passion for compassionate care, making a difference for one individual in need of care, one client at a time. I aspire to be that nurse who patients and students receive more from; my reward for belonging to the greatest profession in the world. Working in acute care - cardiac telemetry, ICU and now the PACU – and working with technology and critically ill patients has been a career long passion. As a PACU nurse, my lens is clinical, and my motivation is patient safety and defining best practice to enhance clarity for PACU nurses. I am also a life-long student with a passion for learning and self-improvement, and a humble understanding of my limitations as a neophyte researcher and academic. My influences throughout my career have come in many forms, including clinical teachers, reading research and academic teachers.

I have been intrigued by the influences on nursing practice, organisational, political, and social. I have been inspired by reading articles on human factors analysis, philosophy, particularly phenomenology, Chaos theory and theories of leadership and change. Using McLuhan's Tetrad of media effects challenged my thinking and allowed me to look at the challenges of respiratory assessment in phase 1 from a completely different perspective than my professional nursing experience has led me to take.

3.2 Study Design

Interpretive description was chosen as the qualitative design guiding this study (Thorne, 2016). Interpretive Description in nursing has been defined as a non-categorical methodology (Thorne, Reimer Kirkam, & MacDonald-Emes, 1997). Thorne (2016) suggested that a robust, mature program of interpretive description research may ultimately draw inspiration from techniques devised from a wide range of approaches, including some aspects of grounded theory, naturalistic inquiry and ethnography, and some data collection values from phenomenology that distinguishes interpretive description. Thorne suggested however, that none of these approaches is borrowed uncritically or used in a manner that is entirely faithful to the original tradition, owing to the immersive process of repeated analysis of the data to identify themes and phenomena. Interpretive Description is a meaning making activity directed at a particular kind of audience: 'applied practitioners,' with the purpose of rendering a new enriched way of making sense of some problem or issue (Thorne, 2016). This approach appealed to the author as a way to challenge conventional thinking about a familiar problem through a different lens.

Interpretive description was also selected as a fit for this project, because it has been described as a method suitable for the investigation of a clinical phenomenon of interest (Thorne, 2016). It is also a methodology, which has prior utilization with the author's university, with local professorial experience to support the novice researcher author in its application, and previous competency in its application to graduate degree projects. Interpretive description is particularly useful in nursing for the purpose of capturing themes and patterns within subjective perceptions and generating an interpretive description capable of informing clinical understanding (Thorne, Reimer-Kirkham, & Flynn-Magee, 2004). The goal for the author in this project is to discover the technological influences on nurses' respiratory assessments in the

PACU, and identify themes that may suggest where improvements can be made to patient care, through identification of technological, environmental, and knowledge factors influencing patient care. Interpretive description appeared to fit. As a nurse, it is also hard to deny the efficacy of using a methodology specifically designed, tried and tested by nurses for nurse's specific needs.

3.2.1 Sampling and Recruitment

Following harmonized ethics approval # H18-01050 (University of British Columbia Okanagan and Interior Health), recruitment commenced. Thorne et al. (1997) suggested the goal of research is to gain an in-depth understanding of nurses' experiences of some phenomenon, used in this case to interpret technology assisted respiratory assessment during phase 1 recovery. Ideally, this would be accomplished through using maximal variation sampling and selecting a small number of participants that maximize the diversity relevant to the research question. To the extent possible, nurses with differing years of experience, having worked in different places, and with demographic variation (such as age, sex) were recruited. However, the positions and experiences of prospective participants was unknown, and coupled with recruitment challenges previously reported with PACU RNs (White, Pesut, & Rush, 2014), it was anticipated that convenience sampling would be necessary. In qualitative research, small sample sizes are appropriate to obtain rich experiences from those with the expertise and experience to be comfortable contributing. Nurses with at least 6 months of PACU experience were included, as this allowed time for them to have oriented and gained familiarity with custom and practice within the PACU, and this level of experience was found to be functional in a similar sized study using recovery room nurses (White, et al., 2014). In this study, which is targeting highly specialized nurses; the pool of potential participants is more limited. Therefore, this study aimed

to obtain a sample size of 6-10 participants as had been used in a previous interpretive descriptive study with PACU nurses (White, et al., 2014). Nurses from three mid-sized hospitals were recruited for this study. To avoid introducing bias, the researcher recruited staff from other local hospital PACUs, and not the researchers own work location. The hospitals included two regional and one tertiary hospital within one health authority.

Participants were recruited in the following manner. E-mail was sent to the local PACU Manager and/or the Patient Care Coordinators, (see Appendix A) briefly explaining the study and soliciting their help in sending a recruitment poster to their PACU staff. The recruitment brochure provided a brief description of the study and the researcher's contact email for prospective PACU RNs to respond, if they were interested in participating in the study. H. Shannon emailed interested nurses who responded to the email, sent them a copy of the consent, and gave them an opportunity to talk by phone to obtain more information about the study and answer any of their questions. If they consented, the interview was arranged with them at a time and place convenient. Seven participants preferred interviews at their work site, at a time convenient in a quiet private area away from patient care. Two participants preferred to meet outside of the work area at a convenient time and location. A small honorarium in the form of a coffee card was given to the participant as a thank you for participating.

3.2.2 Data Collection

Prior to data collection, all participants were given the opportunity to have any outstanding questions addressed and to provide written consent (see Appendix B – Nurse Consent). At this time they also completed a demographic information form that asked about years of experience as a nurse, as a PACU nurse, specialty education attained and level of education (see Appendix C – Demographic Form). The goal of data collection was to elicit

nurses real practice experiences and personal preferences for practice techniques in respiratory assessment. Participants were interviewed individually and confidentially using a semi-structured format to guide the conversation (see Appendix D -Interview Guide). Questions addressed nurses' experiences broadly to obtain an understanding of their current practices in respiratory assessment, both manual and technology assisted. Questions specific to respiratory assessment were addressed including their perceptions of alarm fatigue in respiratory technology, detection of hypoventilation, and their familiarity and use of capnography. Additional interview foci included perceived benefits vs. desire for change in current technology, and perceptions of frequency of adverse respiratory events. Probes were used to encourage elaboration of details of their experiences and to obtain clarification on aspects of their accounts. Interviews ranged in length from half hour to one hour; with some interruptions for patient care occurring during workplace interviews. Interviews were digitally recorded. The interview guide was piloted with PACU colleagues to determine clarity of the questions and was edited to ensure plain English facilitated clarity in the responses. The student researcher transcribed the recorded interviews.

Confidentiality was maintained through elimination of all identifiers that could link the data collected to a participant or PACU. Field notes were written during and after each interview. Field notes were made of research process observations, context, and any emphasis the participants made in their responses to questions, and any thoughts, reflections, or observations the interviewer made during the interviews.

3.2.3 Data Analysis

The student researcher transcribed interview data verbatim. Thorne (2016) recommends a process of hands on research, where the researcher rather than a transcriptionist does the interview and transcriptions, so that the professional nuances of the language are not lost on the

researcher through the interpretation and transcription. The transcription itself becomes a powerful and potentially emotionally complex experience. Transcriptions were checked against audio-recordings.

Analysis began with open coding of data. Supervisor and student researcher undertook open coding of the first two transcripts. They initially coded the transcripts line-by-line for possible meaning and assigned codes to words, phrases, sentences, or paragraphs. Subsequently they clustered similar codes into sub-themes as they emerged. The main themes and their respective sub-themes served as a preliminary coding schema to code the remaining transcripts. To avoid premature closure, described as serious threats to high quality analysis (Thorne, 2016), the coding schema was used loosely and was refined during the immersive process of repeated analysis of the data until all data had been accounted for and interpreted.

The findings were then applied to Marshall McLuhan's tetrad of media effects [see Figure 1]. Aspects of respiratory assessment that are believed to be ***enhanced*** by technology, aspects of respiratory assessment that are believed to be ***reversed*** by technology, aspects of respiratory assessment that are ***obsolesced*** by technology and aspects of respiratory assessment that are ***retrieved*** by the technology [see Figure 2].

The student researchers' committee members in this study helped focus the interpretation process and provide alternative insights and perspectives on the data. Reflective journaling was used during data analysis to maintain the integrity of the process and reduce the inevitable researcher bias from overtaking the data. Glesne (2011) describes reflexivity where researchers write frequently in personal journals during their research activity to monitor and become aware of their personal biases and feelings. Another aspect of interpretive description that was attractive to the author is the ongoing nature of maintaining reflexivity in the coding process and

establishing an audit trail of decisions related to the analytic process (Thorne, 2016). The reflexivity of the coding process allowed for adjustments and recoding of the data, and enabled the data to tell the story, and allow for new conceptualizations to occur. Constant discussion between researcher and supervisor enabled this reflexivity by facilitating deeper thought and focus on what the main themes and codes emerging where. An example of the support from the supervisory committee in helping the researcher reflect on the coding was identifying the significance of the adverse respiratory events identified by participants as a main theme in the findings. This process of reflexivity allows the researcher to challenge themselves to understand how their perspectives may be shaping the method, interviews, analysis and interpretations (Barroso & Cameron, 2013).

One example from the data collection that I reflected on as the field researcher was why so many of my participants raised the subject of low stethoscope use as a topic with strong passions and opinions, because I did not use this subject as an interview question. I concluded after a lot of deep thoughts, that the recruitment poster may have been influential in stimulating this topic, as I had used images of health care workers wearing stethoscopes in the poster (Appendix E.) The poster was aimed to represent nursing respiratory assessment and technology. I therefore considered if the poster might have inadvertently drawn the participants to respond because they had strong feelings about this subject.

3.3 Rigor/Trustworthiness

Rigor or trustworthiness are both terms that refer to the extent that the research and its findings are worth paying attention to (Lincoln & Guba, 1985; Morse, 2015). Various criteria have been used to determine trustworthiness. Terms such as ‘internal validity’ and ‘credibility’ have been used. Morse (2015) prefers to use the term ‘rigor’ as an overall concept and argues for

use of the term ‘internal validity’. She describes checks and balances as proof of rigorous enquiry as the various strategies for ensuring validity; prolonged engagement, persistent observation; thick, rich description; negative case analysis; peer review or debriefing; clarifying researcher bias; member checking; external audits; and triangulation (Morse, 2015). Validity is described as the results accurately reflecting the phenomena studied, and reliability is that the same results would be obtained if the study were replicated (Richards & Morse, 2013).

3.3.1 Current Study Methods Designed to Introduce Rigor/Trustworthiness

Within the research design checks and balances in this study were achieved through the due diligence of the research team. Design has been achieved with the collaboration of an experienced team of researchers, who have specific qualifications and experience in interpretive descriptive research and qualitative interview techniques. Preparation of the student researcher included completion of the TCPS 2 Core Certificate.

Data collection commenced following a pilot of the interview guide to address any issues prior to the actual interviews. A PAR colleague of the student researcher volunteered to assist in identifying the clarity and usability of the interview guide and identified any issues with the terminology or sensitivity of the questions. Interpretation was achieved by using a digitally tape-recorded interview, to capture verbatim responses of the participants and allow transcription accuracy. Transcription double checks ensured accurate interpretation, and coding utilized a team approach so the whole research team agreed upon identification of main themes. Communication of the findings is planned by presentation of the findings to Interior Health, and is produced with the aim of publishing the findings to share with a wider audience.

3.3.2 Credibility

As Thorn (2016) wrote, new knowledge will be made available to our intended disciplinary audience, she points out that findings may be taken up in the practice context, this could be based on the impression of the paper alone, rather than extensive research testing, she suggests that clinicians and readers of the research may find themselves unconsciously adjusting their practice based on the impressions made by the research they read. The responsibility of the researcher to credibly represent their findings and make careful interpretations based on the data becomes paramount and a huge responsibility to remain credible. According to Thorn (2016) the terms validity and reliability familiar in quantitative research do not match the philosophical assumptions and aims of qualitative work but do have the same underlying principles. Morse suggested posing the following questions to determine validity: 1) is the resemblance accurate? 2) Does the description of the essence match the essence of the phenomenon? 3) Can the description be recognized by others, who have had the experience? 4) Can the description be appreciated, by those who have not had the experience? Verification that the analysis reflected the participants' experiences was achieved by having multiple people with clinical and research experience on the committee and involved in the analytical process. Data collection allowed enough time for participants to share in-depth accounts of their experiences and provide rich description. The student's committee reviewed the transcribed data, agreeing on the coding and identification of categorization and themes. Morse (2015) does not recommend giving the transcribed interview (or the completed analysis) back to the participant to obtain additional information or to correct data, (member checking) as this can cause difficulties where ideas have been generalized, blended and otherwise interpreted. The student researcher continuously reflected on the impressions made and any information missing, what and why she was noticing

some things and missing others and provided enough time to complete a full analysis. To mitigate researcher bias, the researcher continually reflected on her influence and biases on the research during data collection and analysis via journaling.

3.3.3 Transferability

The participants in this study are from multiple sites and a variety of settings including tertiary and regional PACU's. The subject matter is believed to be applicable and transferable to other PACUs. As suggested by Korstjens and Moser (2018) transferability is the reader's decision, not the authors. Strategies used in this study to ensure optimal transferability included: Prolonged engagement with the data; being familiar with the setting and context; spending time building trust and allowing time for interviews during the participants working shifts to ensure rich data. Other strategies included triangulating by gathering data at different times of the day, evening and night, in multiple sites and different individuals with different levels of experience, and using thick description of the participant's experiences and the context of their experiences. Transparency in the research steps and examining the researchers own conceptual lens, explicit and implicit assumptions preconceptions values and how these affected the research decisions at all stages of the research process

3.3.4 Dependability

Dependability is described as transparently describing the research steps from the start to finish of the process in order to provide an audit trail (Korstjens & Moser, 2018). Clear process steps were included in the final report, in order to allow for repeatable research by others. The student researcher worked closely with her committee during data analysis to ensure integrity, interpretation and adherence to the research plan.

3.3.5 Confirmability

Confirmability was understood to be the extent to which the findings of the research could be confirmed by other researchers (Korstjens and Moser, 2018). Confirmability was therefore ensured by clearly documented steps taken in the research, diligent record keeping and analysis of the transcripts for accuracy and verification of interpretation with the committee members, to avoid misinterpretation or missed emphasis. Frequent discussion and consensus was sought from the committee members as to the interpretation of findings, to ensure that data and interpretations of the findings were not figments of the inquirer's imagination, but clearly derived from the data (Korstjens and Moser, 2018).

3.4 Ethical Considerations

As a health care practitioner, with insight and professional bias, the author is cognisant of the mental shift in perspective needed to adapt from practitioner and employee to researcher; to become an appropriate and acceptable visitor into the world of the participant (Thorne, 2016). I used three core principles for conducting ethical research including "respect for person", "concern for welfare", and "justice" (Lobiondo-Wood, Harber, Cameron, & Sing, 2013), to protect participants and their respective organisations from inadvertent breaches of confidentiality, or exposure to stress or discomfort in anyway, while achieving authentic and useful results.

Several ethical dilemmas were considered to potentially emerge from the qualitative researcher's interaction with participants, including exploiter, intervener or reformer, advocate, or friend. (Lobiondo-Wood, et al., 2013). Inevitably researchers use participants to meet their own needs to some extent, with the potential for exploitation. Although I acknowledge my need to complete my thesis for personal satisfaction and wellbeing, and not for accolades or personal

career advancement, I also wanted my findings to be useful. The aim was to establish a practice guide for PACU respiratory assessment, which did not currently exist. I had an academic need to develop a deeper understanding of the influence technology was having on PACU nursing practice, and a desire to make a difference in patient care. This is how I presented my motivation openly to participants. Thorne's (2016) comprehensive guideline for the interpretive description process was followed to ensure ethical practice, from making field notes during audio recorded interviewing, to protecting the confidentiality of the interview participants, data cleansing of names, institutions, locations and using sanitized copies for analysis. The student researcher ensured complete comfort, confidentiality, and as much convenience as possible for the gracious participants' to ensure they understood their contributions were greatly appreciated and would assist in a generic way to increasing nursing knowledge. The process was structured to protect participants from personal adverse consequences emotional, professional or physical in nature, including the process of voluntary participation, clear explanations, allowing time, respectful communication, listening skills and participant reflection during the interview and at the end. Facilitating exit and withdrawal from the process at any time and offering debriefing to any participant who felt the need was included. Approval for this research was obtained from the Ethics Board of the University of British Columbia, Okanagan campus and Interior Health Authority [REB #H18-01050].

3.5 Dealing with Insider Status

My position during this research was that of the researcher and not as an employee or PACU Nurse. I made a conscious effort to focus on what the data was telling me and avoid assumptions based on my practice knowledge. This required constant reflection and focus and helpful discussions with my committee to filter out the inevitable bias that presented itself. The

information I received during the interviews was treated as confidential and retrospective in nature, meaning the interview process would not directly affect patient care. Any information I received which may have concerned general competence or raised a practice issues was addressed thorough the general written recommendations for practice and education. My goal was to assist in enhancing and developing best practice and not to highlight an area of poor practice. However, I am bound and guided also by my BCCNP practice standards and must act within those boundaries. Therefore, if I had come across a situation presenting to me during field research that had clearly defined an unsafe practice, threat to patient safety or staff, I would have acted in the appropriate manner to report it to the nurse and manager involved. However this did not occur.

Recruiting staff from other hospitals was intended to avoid introducing coercion and bias. By using multiple sites, I was able to avoid the labeling and identification of individuals and units. As a clinician researcher, participants may have viewed me differently as a PACU nurse colleague with expectations of their practice. I preferred to be situated as a research student with an interest in their particular practice experience with no knowledge of their day-to-day practice performance; this positioned me as a student researcher to make participants feel more comfortable and less threatened. Thorne (2016) suggested being an insider researcher has its advantages and challenges. Initially it provides access into practice areas that outside researchers find challenging, but also creates dynamics for the research that require special care and attention, to avoid damaging working relations and to protect the integrity of working environments.

It was important to me as a researcher to provide a safe space and comfort level for my individual participants and the units in which they worked. I have been in the position of being

an interview participant in a colleague's graduate research and this has allowed me valuable insight into the influence insider research can have on a participant and the interviewer. I believed participation was more likely if the volunteers felt respected, un-judged and understood the research was motivated to benefit their practice environment rather than to critique it. It was also imperative that any descriptions participants gave about patient experiences did not identify patients in any way. When this was suspected, the author altered contextual details to prevent this occurring in discussion with co-researcher committee group members, and in the results.

3.6 Balancing Benefit, VS. Harm

Careful planning regarding the recruitment methods and interview techniques was undertaken, to ensure participant's rights to anonymity, privacy and personal wellbeing throughout the interview process. Action was taken to enable the researcher to follow a protocol during interviews, which included confirming consent, and allowing participants to opt out of the interview or any questions at any time. The interviewer was prepared to recognize any signs of discomfort or anxiety during the interviews and suspend or terminate the interview if participant distress was suspected. The recruitment process ensured the participants were volunteers and no participant was identified to the research committee or the employer.

The researcher carried counseling leaflets during the interviews to leave with any participant evidently distressed from the interview, and felt the need to further debrief with a trained counselor following the reflection. No participants during the study indicated the need to undertake counseling or to express any signs of distress. The benefit in doing the research was to identify practices that could be improved. This requires a critique of current practices that does not reflect on any individual, hospital or team but is aimed at identifying common themes within practice that can potentially be improved. Benefits were balanced against publishing, being

transparent and identifying the health authority. The desired goal was to identify best practice, which necessitated identifying the health authority in granting permission for the research activity. This research was conducted within one health authority with multiple sites and that identifies the health authority and the associated university. This was unavoidable and respected. The purpose and generalizability of the findings will be directed to assisting the health authority in evaluating resource allocation and education in general to achieving PACU standards and highlighting the nuances of respiratory assessment in phase 1 recovery, with the aim of providing general recommendations for practice and resources.

Chapter 4: Findings

This chapter presents the findings from the themes and codes identified. Demographics are provided in [Figure 3]. The immediate and most obvious theme to emerge from the data was the *Post Anesthetic Care Unit Visual Sensory Respiratory Assessment Process*, which included four well-defined actions and some adaptations. Theme two described PACU nurses' approach to technology, which included guardedly trusting elements of the technology or rationalizing mistrust of technology. Theme three highlighted the contextual influences, which sustained the visual sensory approach to respiratory assessment, and the PACU nurses' approach to technology. Theme four described PACU nurses' descriptions of the limitations of their current respiratory assessment process and the technology they used. Examples were given where assessment processes and monitoring indicators were not timely enough in all circumstances, to alert the PACU nurse to deteriorating respiratory function. Before these themes are elaborated, a description of the study participants is provided.

4.1 Description of Study Participants

The PACU is considered a specialty critical care area, as patients in post anesthetic recovery can be critically ill, undergoing planned or emergent surgery, and/or highly dependent on emergence from anesthesia. A total of nine anonymous participants responded to a recruitment advertisement and all were interviewed. Demographic data of the participants and their qualifications are presented in detail in [Figure 3]: Five participants were very experienced in post anesthetic care; one participant had sixteen to twenty years of experience, three participants had eleven to fifteen years of experience, and one participant had six to ten years of experience in post anesthetic care. Of the other less experienced participants: two had two to five

years of experience in post anesthetic care and the other two participants had less than two years of post-anesthetic care experience.

Seven of the participants had a bachelor of nursing degree, while two had nursing diplomas: The majority (n=6) held a critical care certificate; which focuses on patients with critical illness and prepares nurses for work within critical care units such as multisystem intensive care units (ICU's). The other three participants held a post anesthetic care certificate (n=3), which focuses on the specialty of post anesthetic recovery and prepares nurses to care for patients recovering from anesthesia.

Table 1: Demographic Questionnaire

Questions	(n) Of Participants answering	(n) Of Participants answering	(n) Of Participants answering	(n) Of Participants answering	(n) Of Participants answering	(n) Of Participants answering
How often do you care for an adult in early phase 1 recovery, after the anesthesiologist leaves the bedside, that is unconscious with a Laryngeal Mask Airway or Endotracheal tube in Situ'	Daily: n= 8 respondents.	More than daily: n=1 respondent.				
If you have a patient in early phase 1 with an LMA or ET tube in situ how long can they take to wake and be ready to extubate in your experience	Ten Minutes: n=4 Respondents.	15 Minutes: n=1 respondent.	Longer than 15 minutes: n=4 respondents.			
How often do you find you need to provide additional airway support such as a jaw thrust or chin lift, or T-piece (02) to an LMA in the early phase 1 recovery	Daily: n=4 respondents.	Rarely: n=1 respondent.	More than Daily: n=4 respondents.			
How frequently do you count a respiratory rate manually during phase 1	n=1 respondent stated "Frequently"	n=2 respondents stated "always"	n=3 respondents stated "every five minutes"	n=1 Respondent stated "q 10 minutes"	n=1 respondent stated "At least every patient x1."	n=1 respondent stated: "This depends on patient's respiratory status. Q minute if there are problems, Q five minutes until aware, then Q ten minutes or more frequently if there are problems."

4.2 A Visual Sensory Respiratory Assessment Process

Nurses described a well-defined embedded respiratory assessment process [Figure 4] that was highly intuitive, automatic and reflected nurses continuously adapting their assessments, and prioritizing and reprioritizing as the phase 1 recovery process unfolded. Participants described their practice during the initial respiratory assessment as being without conscious decision making, without thinking, an instinctual process; encompassing everything that needed to be

addressed in a very short time frame, a confidence perhaps in their professional practice. Participants struggled to articulate this instinctual assessment process. P (1) described a subconscious, intuitive assessment approach, “I think once you have done it long enough, it sort of becomes second nature, and you kind of don’t even notice that you are doing it.” P (2) clearly described the automaticity and intuitive nature of this first assessment phase that made it difficult to articulate, “Most of the time, a lot of the assessments... it’s uh, it’s difficult because you just do it as second nature right.”

The respiratory assessment process consisted of three main, rapidly occurring events: [see Fig 5]. First the ‘arrival walk’ described the arrival of the patient into the PACU bay, where the recovery nurses gained their first visual impressions of the patient. Secondly, the ‘bedside hook up’ where the patient was attached to the bedside monitors, was when the nurses began their visual sensory assessment. Third, nurses quickly assessed respiration, focusing on confirming breathing and counting respirations on arrival.

4.2.1 The Arrival Walk – Gaining a Visual Impression

The assessment process began and was followed consistently by all participants and is illustrated in the process flow diagram [see Figure 4]. New patients arrived frequently from the operating room, and with little prior notification. Consistent with their intuitive sensory approach to respiratory assessment, nurses described visualization as one of the key skills used in their assessments as P (1) stated, “Haven’t met a machine yet, that I would say does that. So much of our job comes from visualizing the patient.” Visualization started from a distance with the very first glimpse of the patient being delivered along the corridor by the operating room team. This first glimpse termed the ‘arrival walk’ emerged strongly as an important first method of prioritizing, forming initial impressions of the patient and their respiratory status and anticipating

patient needs. During this arrival time, PACU nurses described relying on intuition, and initial impressions of the patient, to guide the depth of their subsequent assessments. The arrival of the patient was characterized by time pressures and nurses scrambling for information. P (7) described how she attempted to get ahead of the game, by starting the assessment during 'the arrival walk:' "I am trying to do a resp rate as they are coming; I am looking for steaming in the tube, um as soon as they come." P (8) with less than two years' experience in PACU estimated that there are: *"*About a third that are still intubated to give it a rough estimate maybe a little less, maybe a quarter," thus describing the frequency of expecting to receive patients requiring additional supports in the early recovery phase.

PACU nurses relied heavily on this visual approach to respiratory assessment, repeatedly describing the importance of visual information, in allowing them to mentally prioritize for the patient's arrival, identify respiratory needs and get additional supports and assistance at the bedside quickly, such as airway and ventilation equipment. P (2) with 11-15 years' experience described how she visualized patients arriving from the operating room, before they had been wheeled into her station, to prepare for urgent interventions if needed: *"*If they are coming around the corner and they are grey, you know right... ok we are going to need some additional supports here."

All participants described key visual clues – color, chest rise, signs of struggle to breathe - that were the focus of their attention during this time. Nurses emphasized the significance of color in these first few seconds of the patients 'arrival walk.' P (1) with 11-15 years PACU experience described: *"*Basically as soon as they roll in the door you are looking at their color...you can see coming around the corner by color if you're going to be needing assistance."

Nurses used visualization with new patients arriving from the operating room to identify the type of airway the anesthesiologist had used to maintain the patient's airway during surgery, such as a laryngeal mask airway (LMA), or endotracheal tube (ET), to determine if the tube was still in situ, how alert the patients were, and what type of (02) delivery was being used in transport. These observations provided the nurse with information about the kind of (02) administration apparatus they were going to need, and gave a few extra seconds to prepare equipment to rapidly attach when patients arrived.

Receiving patients with advanced airways was routine for these highly skilled PACU nurses, however the frequency of unstable patients arriving in PACU heightened not only the urgency but added to the challenge of respiratory assessment requirements. Participants from one PACU described an agreement with the operating room to inform them in advance if the patient was coming from the operating room to the recovery room intubated or with an advanced airway. This agreement reduced stress and allowed for better workload planning to deal with advanced airways. Nurses were able to allocate resources based on this advanced knowledge. Other PACU's included in this study did not have an agreement with the operating room to notify them if the patients would be arriving with advanced airways, P (2) described:

> Umm so I am told we are one of the few recovery rooms that get patients that are still Intubated, so our assessments kinda differ a little bit, depending on if they have an ET tube in or LMA or if they are wearing a half mask or full mask, but basically as soon as they roll in the door you are looking at their color.

Receiving intubated patients from the operating room, made the 'arrival walk' information more significant for nurses, for planning their respiratory assessment and priority

setting. Without prior knowledge of advanced airways, PACU nurses were often scrambling to support colleagues with intubated arrivals.

In summary, the respiratory assessment process began prior to the arrival of the patient at the bedside and followed an intuitive sensory visualization of the patient to give an overview of their status before arrival, information about specific needs, and resources or equipment that were required.

4.2.2 The Bedside Hook-Up – Validating Initial Visual Impressions

The bedside 'hook-up' referred to the process of attaching the newly arrived patient from the operating room, to all the monitoring equipment at the bedside in the recovery room. Once in the PACU bay, the routine priority described by all participants for respiratory assessments was to confirm that their patients were breathing, and to validate their initial impression from the 'arrival walk visualization', with 'hands on' assessment. The nurses' role also involved listening to verbal reports from both the operating room nurse and anesthesiologist, while also recording and meeting charting expectations, attempting to count an immediate respiratory rate, assessing other vital signs, ensuring other aspects of the patient's recent surgery were stable, and intervening when required. Participants continued to identify visualization as their 'go to method' of identifying respiration throughout the patients stay in phase 1 recovery, essentially the patient's stay in the PACU. P (9) detailed her prioritizing assessment process that needed to be fast and efficient: "So I think the first thing is like, visually seeing the patient, and putting the sat monitor on and then listening for resp's as well. So, kind of doing it all, at the same time."

Participants continued to emphasize visual assessment at this stage, but the goal now shifted, from gaining an impression to confirming breathing. Participants spoke of the urgency of establishing whether patients were breathing or not, to provide a basis for identifying their

priorities. During this time participants still used visual cues to make rapid decisions as patients status changed. P (6) described a sense of urgency and multitasking:

> ...Umm I guess first of all, look at the patient are they talking, are they breathing what they look like, is their chest moving, count their resp's and put the sat probe on kind of all in the same breath.

The level of support received from the anesthesiologist at this stage in the assessment process, may have contributed to the urgency in identifying respiratory issues. Fear of being left with a problem after the anesthesiologist had returned to the operating room appeared to be a reason for the urgency. P (7) described this inconsistent support:

> If there are any issues whatsoever, then I usually interrupt the anesthesiologist, and they just have to wait, because I am not happy with whatever is going on, but if there are any issues, the anesthesiologist, they have to wait and they do, well.... *there's one or two that walk off* [emphasis added].

In summary, this brief period of hooking the patient up and the initial assessment was described as a sensory process of validating initial impressions, looking, listening and counting breaths. However, it was clearly described as a frantic scramble of prioritizing, adapting to specific patient needs, deciding if the patient's airway was stable based on an intuitive sensory assessment and often finding otherwise and rapidly intervening, while attempting to meet charting and assessment requirements. All of this needed to be completed as quickly as possible to enable the operating team to return to the operating room for the next case.

4.2.3 The Process of Confirming Breaths

During hook-up, PACU nurse's priority was assessing breaths. Participants described an assessment process for identifying breaths using subjective visual means. P (9) stated, "If they

have an (0_2) mask with an LMA or even without, you can see the misting in the mask, and you can see that there is air coming in and out." Participants, such as P (1), identified misting as a key visual clue, "If you have got any mist in the tubing to see that you have got adequate air movement."

When there was no mask or tube present to visualize misting to confirm breaths, participants described moving to more tactile, but still subjective assessments. P (3) described use of touch to confirm respiration when a patient lacked a mask, "If they don't have a mask on, looking for any like condensation on the mask, if they don't have a mask on then 'feeling' is the first thing that I do." Another participant, P (7) similarly confirmed respiration through touch, identifying it as a first choice over using the audible assessment provided with a stethoscope, "The feeling that my hand is just to confirm that their abdomen is moving at the same time, not necessarily using my stethoscope." P (3) highlighted that visual cues are used first, and only when her subjective assessments raised concerns were tools and technology utilized, "If they look like they are not breathing, then we usually get all of our stuff on [meaning the bedside monitor and saturation probe] and we listen to resp's with our stethoscopes."

In summary, truly confirming adequate airflow at this stage remained subjective for many of the participants, with a process of moving from visualization to tactile assessments, with some participants resorting to audible assessments with a stethoscope and technology, when uncertain.

4.2.4 Counting Respirations

Counting the manual respiratory rate (MRR) was described as an integral part of the participants PACU nursing routine and was carried out during the first few minutes while the OR team was still present. Obtaining the initial (MRR) was particularly problematic because of time pressures during the patient's arrival in the PACU.

Manual rate counts, if done, were very brief, with eight of the nine participants allowing the minimum time possible, and counting for only 15-seconds to estimate the (MRR). Two participants described their practice was to perform one-minute assessments, only if an issue was identified within the first 15-seconds. P (3) stated, "I usually do 15 seconds if it's good... if it's like one every 15 seconds, then I do a full minute." It was not unusual for nurses to determine an estimated (MRR) during their initial visual impressions, on the arrival walk and incrementally extend the (MRR) count if there was an issue as P (2) elaborates:

> I usually count for... usually I will count for 15 seconds at least... but if I only get one resp in that, in 15 seconds, then I will wait for 30, and then if it doesn't pick up, then you do the full minute, but usually if they are coming out...[During the arrival walk], if their, you know 16 or 20 resp's, then its ok, their ok, and then of course every time you do your vital signs you count again.

Despite the participants declared priority in obtaining the initial (MRR), there was considerable variability as to when PACU nurses performed the (MRR) during OR handover. Some nurses described not attempting to record an (MRR) immediately, as it was not always a priority and other more urgent needs demanded their attention. P (4) described delaying (MRR) during this initial stage, "if the patient comes out and they are breathing fine... it may come two minutes later and not be the immediate thing that I do." P (8), although clearly describing her understanding of the protocol for recording the initial and subsequent (MRR)'s, also described adapting this protocol:

> The initial respiratory rate we ...report off the anesthesiologist, who is with the patient when they come to the recovery room. I also chart it in my par record, and we check their resp's every five to ten minutes until they wake up and I chart that every 5 – 10...

P (8) further elaborated on her respiratory rate assessments suggesting a practice of estimated (MRR), and if the patient appeared to be breathing ok, confirming breaths was prioritized rather than the RR:

> I just like to see that basically they are moving their chest, that they have adequate chest expansion, and if they're on a mask, to make sure they have a good fog in there...If I'm concerned about their breathing, that I will manually count, but usually you know, if I see that they're actually breathing that's enough.

PACU nurses described difficulties in obtaining a (MRR) during the initial assessment. Not only was the value of the respiratory rate at this stage questionable to the participants, but also physically obtaining an immediate (MRR), was described as practically challenging. This was due to frequent interruptions to receive verbal report or attend to airway and respiratory dysfunctions. P (7) described these interruptions, "My hand is usually on their abdomen but there's an interruption, because of getting the report from the anesthesiologist, so I am relying on my second nurse to do that." This made it difficult to obtain an accurate initial respiratory rate count, and although attempts were made to obtain it through tactile assessment, some PACU nurses, as described above by P (7) deferred to a colleague to do the actual rate assessment.

Diverting away from the routine RR counting process during handover were emergencies, such as airway obstructions that made it impossible to do an immediate arrival (MRR). Participants described their priorities as dealing with airway issues, which were relatively common, and made the (MRR) seem somewhat redundant at this juncture (See table 1). P (9) described a patient who arrived cyanotic from the OR, disrupting routine assessments and detracted from meeting timeframe protocols, due to the need for urgent interventions:

> Yah, absolutely, we didn't continue to put on the rest of the monitors, like airway was number one, so like, getting an airway and jaw thrusting, or umm... For that case someone was having laryngospasm, so we were dealing with that.

Repeated (MRR) counts were part of the PACU respiratory assessment protocol. However, participants described inconsistencies in how often they were performed. Participant responses were generally vague when describing the frequency of (MRR)'s, from not at all, to 'frequently' 'always' 'every five minutes' 'every ten minutes' 'at least every patient x 1.'

In summary, counting respirations was described as a requirement, but difficult to obtain during the initial arrival assessment, and of questionable relevance, resulting in nurses rationalizing its frequency, modifying the process of obtaining it, and sometimes possibly estimating it for documentation purposes, based on brief subjective visual assessments.

4.2.5 Adapting to Anesthesiologist Practices

Participants frequently mentioned their very positive interactions with anesthesiologists, and the importance of this relationship to their work environments. P (9) for example stated, "*We have great relationships with them here* [emphasis added]." Participants described trusting and relying on anesthesia colleagues for support, with the expectation they bring stable patients to the recovery room as very important. However, PACU nurses repeatedly described variable anesthesiologist handover practices, techniques, preferences and behaviors that influenced their respiratory assessment practices. PACU nurses described being confused by the variability in individual anesthesiologist practices. Participants described receiving patients from the operating room sometimes with or without advanced airways, and sometimes patients arrived in respiratory distress with limited understanding of the rationale for the different patient presentations. Participants described having to adapt their respiratory assessment process and priorities

accordingly. Participants described three main areas of adapted practice: manual respiratory rate count reporting, adjusting to variable (02) prescribing practices, and variable respiratory dependency.

4.2.5.1 Adapting to Anesthesiologist Respiratory Rate Reporting Preferences

Anesthesiologists varied in their expectations related to nurse reporting of a (MRR) during the initial handover period, and whether they waited for the initial respiratory count or interrupted the nurse to give their own verbal handover report. Nurses were unclear about the rationale, protocol and clinical relevance of this (MRR) reporting process. The inconsistencies and the attitudes of some anesthesiologists related to the (MRR), competed with PACU nurses' own priorities and more pressing needs to support advanced airways and confirm breathing. Some PACU nurses had never been asked for a respiratory rate by an anesthesiologist and in some cases were actively discouraged by colleagues for attempting to count the MRR on arrival of the patient, such as P (6) who described:

> I feel like anesthesiologists never especially at one the hospitals I worked umm kind of often are like '*I know the respiratory rate I can see that their breathing, so why bother even telling me a rate?*' *and that's been encouraged by staff as well* [emphasis added].

Other participants described some anesthesiologists waiting for the PACU nurse to count a manual respiratory rate for their records, before they returned to the operating room while other anesthesiologists walked away or were not interested in the manual respiratory rate count at all.

Anesthesiologist documentation requirements and nursing protocols dictated when MMR was recorded in the immediate arrival period. P (3) described obtaining the (MRR) immediately for the anesthesiologist, and appeared to feel under some pressure to obtain it, some frustration at the delegated role and '*just'* to meet documentation requirements, " I do it automatically... just

because I have to tick off on my par record that you know how were the resp's." Recording the (MRR) appeared to be more for the anesthesiologist's records than for nurses' assessment of the patients' respiratory function, as P (2) alludes:

> 95% of anesthesiologists ask for a respiratory rate, and stay for the first set of vital signs including respiratory rate and temperature...If they come out and they have umm a tube whether it's an ET tube or an LMA, its every five minutes ok umm, once their extubated, or if they don't have an oral airway or nasal airway then every ten minutes until phase 2.

P (3) described the variability in anesthesiologist expectations, and her feeling of being questioned for attempting to keep to a protocol of obtaining manual respiratory rate counts, during the initial handover assessment:

> Some do, some don't, and some say that if their Sat's are good, then why are you listening to resp rates? *With some of the* anesthesiologists *ya* [emphasis added], because some of them sit there until they get a resp rate.

Nurses described adapting their assessment of MRR depending on patients' immediate needs for airway support, individual preferences of anesthesiologist and hinted at pressure from colleagues in some situations where counting the RR was 'discouraged.'

4.2.5.2 Adapting to Anesthesiologist (0_2) Prescribing Preferences

Variable individual anesthesiologist practices related to (0_2) prescribing were a recurring theme, which was confusing and frustrating for PACU nurses. Some participants indicated (0_2) had been more commonly applied by anesthesiologists, for transport from the operating room within the "*last couple of years,*" while others described inconsistent practices. P (2) expressed her frustration with variable practice, "There are some anesthesiologists that will never have 0_2 on a patient, when they come out with a (LMA) in, whereas there are some that always do...

different levels too, different flow rates." Participants expressed comfort with (0_2) being administered, discomfort when it was not, and many expected it to be applied. P (6) expressed her preference for patients to be on (0_2):

> *Gosh its tough* [emphasis added], it would have to depend on the patient, but I would like expect for patients that are being transported off the monitor, you know pediatric patients included, coming out especially with an airway, that they would be coming out with a little bit of 0_2...*but that doesn't always happen* [emphasis added].

Nurses expressed frustration with anesthesiologist's variable choices regarding (0_2) mask usage. They often described relying on the visible misting from the (0_2) mask for visual confirmation of respiration, during patient's arrival. P (7) highlighted, "I am looking for the steaming and misting for the air movement", and P (9) "if they have an (0_2) mask with an LMA or even without you can see the misting in the mask, and you can see that there is air coming in and out." This was especially important when patient's breaths were still shallow and difficult to identify by other visual means.

Nurses described adapting to variable anesthesiologist practices when patients arrived in PACU without (0_2). Nurses responded to the lack of (0_2) on the patient in a variety of ways – acquiescing without questioning, actively resisting anesthesiologist (0_2) prescribing, or sticking to a routine application of (0_2), irrespective of known anesthesiologist preferences. It was common for PACU nurses to assume an acquiescing stance with anesthesiologists, despite their preferences/expectations about (0_2), and the challenges it created for them when it was not being administered to recovering patients in phase 1. Remaining accepting and unquestioning on the surface, was often used to preserve the relationship with anesthesiologists, even while they privately expressed some frustration and anxiety with the decision and needed more rationale for

the prescribing decision. P (9) thought more education and rationale from the anesthesiologist about their (0_2) prescribing practices would be beneficial:

> I think from my perspective education, more education would be huge, education generally could be better in terms of what's expected, why is it that one anesthesiologist says they don't need (0_2) and another one does, things like that, what's the thought process behind that *and why isn't it being passed on to us* [emphasis added].

Despite the appearance of acquiescing, some nurses described actively resisting anesthesiologist (0_2) prescribing practices. This active resistance was based on assessments of the patient's need. P (9) described determining (0_2) based on needs assessment:

> It's difficult because there are times... *like I do feel my patient needs (0_2)* [emphasis added] and I'll.... he [anesthesiologist] will walk away and I will pop it on, and then get them [the patient] over to day care or something [laughs], as bad as that is [laughs].

P (9) similarly 'tried' not to question the anesthesiologist decision, but also made decisions about (0_2) need, based on her assessments but elaborated her decision to use (0_2) despite anesthesiologist preference:

> There is one anesthesiologist that doesn't want (0_2) on his patient at all, and I will put it on when their Sat's are 87% and he will say it's...he would rather you didn't... because its pain medicine, and you need to tell them to keep breathing kind of thing.... *ha-ha it's frustrating.... it's very frustrating* [emphasis added] ... but.... He's probably one of our best anesthesiologists, so I try not to like you know question him.

PACU nurses described applying (0_2) routinely in a variety of situations such as patients arriving with a tube, "if they have a tube involved, especially if you have a tube involved like an ET or LMA, (P1)." Applying (0_2) with advanced airways in situ appeared to be routine practice,

particularly when extubation was delayed. Participants described routine use of (0_2) as part of PACU culture. P (2) described being oriented to this practice as a new PACU nurse, "that's what I was told six years ago when I first started in here.... *I have been told* [emphasis added]... they are supposed to have (0_2) for twenty minutes...." Nurses were oriented to a culture where (0_2) therapy was part of their routine, and where everyone was expected to adhere to the common practice.

4.2.5.3 Adapting to Variable Levels of Respiratory Dependency on Arrival

As highly skilled critical care nurses, PACU RNs routinely assessed advanced airways and identified respiratory dysfunction such as airway obstruction, hypoventilation, desaturation, RNMB and laryngospasm. Respiratory assessments were adapted accordingly, and if necessary, intervention initiated immediately. Patients arriving in PACU had variable levels of dependency due to anesthesiologist decisions to leave extubation until arrival in PACU, and due to residual effects from anesthesia drugs, particularly the administration of narcotics during surgery and residual effects from neuromuscular blockade. This significantly affected PACU nurse's assessment priorities and ability to perform their routine respiratory assessment and increased the number of PACU nurses needed to support each patient's respiration during their recovery. Participants suggested that the workload required to support patients with advanced airways on arrival, varied depending upon the level of support offered by the anesthesiologist, and whether the anesthesiologist remained present until extubation or returned immediately to the operating room. P (4) described, "The anesthesiologist is supposed to stay if they have an airway in, but sometimes they *don't* [emphasis added]."

4.2.5.3.1 Extubations

Planned removal of advanced airways including endotracheal tubes, laryngeal mask airways and oral airway devices occurred frequently in the PACU (see Table 1). Most often performed by the PACU RN, participants described adapting their routine respiratory assessment processes for PACU extubation, when patients arrived with advanced airways still in situ. Priorities changed significantly from a routine assessment of respiration and respiratory rate, to immediately and continuously assessing the patient's respiration and oxygenation and readiness for extubation (see section 4.2.4). Participants described this variable airway dependence of patients on arrival, as largely specific to anesthesiologist preferences. Patients with advanced airways needed more respiratory support and assessment from two PACU nurses, thus increasing their workload. Participants described how they commonly dealt with intubated patients, which significantly impacted their focus for up to ten minutes in some cases (P3) described:

> We had to do jaw thrust on the patient for maybe like ten minutes with an LMA in ... and *the* anesthesiologist *didn't really believe us* [emphasis added], she said she had never seen that before [Laughs] ... but it happens all the time.

Some participants expressed frustration with the rationale for some anesthesia decisions P (2) described:

> I actually asked when I first started in here, I asked those [PACU Staff], "You know some of the patients come out extubated, and some come out with the tube. Why is there a difference?" ...*It doesn't make any sense to me* [emphasis added], one doctor said that he likes to bring his patients here with the tube, because he has a guaranteed airway... other doctors prefer to extubate in the OR, because if they are failing, they have everything right there, that they need ...so it was just their preference.

Once extubated participants' assessment priorities adapted to identify and support any extubation complications, such as laryngospasm. P (7) described, "Once they are extubated I am listening for laryngospasm..."

4.2.5.3.2 Adverse Medication Effects in the PACU

Participants also described adapting assessment processes for patients with RNMB or narcotic sedation. They described receiving some patients from the operating room whose respiratory function was adversely affected by inadequate reversal from neuromuscular blockade or ongoing narcotic sedation from analgesia given during surgery. This was often seen as an individual anesthesiologist prescribing choice or practice. P (4) described how medication effects sometimes adversely affected patient's variable levels of consciousness on arrival in the PACU, impacting their respiratory assessments:

> Respiratory assessments can be challenging when our acuity is high in the unit, and we are short staffed that's a biggie. It's difficult, and they come out with an airway or if they have been extubated too soon, and not reversed, then they are not actually moving air, then they are not properly reversed, and it's just not manageable very well. And it was the same anesthesiologist ok, not quite reversed, probably trying to get out of the room, and turn it over so they can get on with the next case.

P (8) also described patients arriving in different levels of consciousness, "...ahh it varies anesthesiologist to anesthesiologist, umm some definitely come out, some wake up their patients more before they bring them out to us compared to others."

Participants described the frequency of patients presenting with RNMB symptoms, and the decisions that they were required to make when these symptoms presented. Participant (5) described common experiences with residual medication effects affecting respiration, "I have

probably had, probably one every two weeks, ya I am part time ...so I find I will get one every two weeks ya, and they're not completely reversed or they are just, *they're over sedated* [emphasis added]." P (1) described visually identifying residual medication effects and prioritizing her decision-making process, on when to remove advanced airways, based on multiple visual cues to identify respiratory distress:

> You can see they are struggling to have that abdominal movement, but not necessarily getting the chest wall moving, and just look uncomfortable, and like they are struggling to breathe... if they have an LMA or ET tube in place, you might be questioning whether it would be wise to remove that at this time.

To summarize, PACU nurses' respiratory assessment practices were highly dependent on anesthesiologist practices. Whether the patient presented to the PACU intubated, extubated, unconscious or awake, made significant difference to the respiratory assessment process of the PACU nurses, and influenced the relationships with anesthesiologists. Anesthesiologist decisions were often poorly conveyed and considered variable due to individual preference. PACU nurses adapted their practices around individual anesthesiologist's preferences but expressed several frustrations with the process including difficulties obtaining an (MRR) during handover, and receiving consistent support from anesthesiologists when they had patient concerns in the very early stages of recovery. Whether the patient was stable or unconscious and whether they were breathing independently or requiring airway supports made a huge impact on the nurse's workload, and their ability to support respiration and routinely assess their patients' respirations in the early stages. Confusion and resistance to (0_2) prescribing rationale was a significant issue for PACU nurses, with a lack of understanding and education on evidence informed (0_2) prescribing practices, and a preference to rely on and default to a routine application of (0_2).

4.3 Technology: Guarded Trust or Rationalized Mistrust

PACU nurses acknowledged the presence of technology in their early respiratory assessments. In contrast to the high degree of trust they had in their sensory visual assessments, they had a more tenuous relationship with technology. The expert practice of the PACU nurses, and their declared reliance on visual/tactile/manual assessments of respiration remained the most trusted method for respiratory assessment. Nevertheless, PACU nurses described reliance on certain technology, which remained critical to their respiratory assessment practices and spanned the entire phase 1 recovery - from handover in early phase 1, to late phase 1.

Even though they automatically and intuitively prioritized technology use, nevertheless nurses remained cautious in their approach to it. Nurses frequently used the term 'trust' and 'mistrust' to describe their relationship to technology. Trust criteria included expectations that the data provided by the technology would mirror and confirm subjective manual assessment findings. More commonly, participants described trust issues with technology that ranged from guarded trust to rationalized mistrust and underuse of certain tools. PACU culture and their level of comfort, understanding and education with the technology and its operation affected both trust and distrust.

4.3.1 Guarded Trust in the ($Sp0_2$) Module

The module most often described as trusted was the ($Sp0_2$) module. The ($Sp0_2$) module was prioritized immediately on the arrival of the patient, "The first thing we attach is definitely the sat probe" (P9). Connecting patients to the ($Sp0_2$) probe often preceded breathing and respiratory rate assessment: "first thing *you want to do is put on the sat probe* [emphasis added], and then see if they are breathing and count their resp's" (P6). Despite participants expressed reliance on the ($Sp0_2$) data, the trust bestowed on the ($Sp0_2$) remained guarded. PACU nurses

often used it as a backup to confirm or validate other respiratory physical assessments as P (2) illustrated:

> *One of the first pieces of equipment to go on is the ($Sp0_2$) monitor* [emphasis added], to see where we are at, as far as numbers go... just sort of gives you like a backup that we have got an issue...but... you're still looking at the color and you're counting the resp's.

P (5) also highlighted secondary use of the bedside saturation module to confirm respiration,

> Ya no, I will do a quick 15 second count on how often they are breathing, but once we get them hooked up to the monitor, we you know ...look at the chest and see if they are breathing, and usually *we hook them up pretty quick to the sat monitor too* [emphasis added].

P (4) described her guarded reliance on the ($Sp0_2$) with a patient who was decompensated and de-saturating, due to RNMB:

> With RNMB we see desaturations, *they are not responsive, their whole body is stiff um* [emphasis added], we have to put like high flow O_2 13-15 liters, and *you're constantly stimulating them* [emphasis added], so it's not a nice wakeup. Probably takes them about completely an average of ten to fifteen minutes for the effects to wear off. So we are usually looking at Sat's, the last one I had, her Sat's on 13 – 15 liters, her Sat's were 91 – 92 not great, and finally in about ten minutes when she finally kind of settled, they were back up, but she ...both those cases had rocuronium.

4.3.2 Guarded Trust in the Respiratory Module

Participants expressed guarded trust in some aspects of the respiratory module, a trust they described as cautious and conditional. P (8) used subjective visual assessment of the patient, and a manual respiratory rate to validate the accuracy of the technical respiratory rate (TRR),

demonstrating a guarded trust in the technology if it mirrored the nurse's manual respiratory rate assessment:

> Do the resp rate as well ...again depending on the state of the patient, it does give us a number, if its accurate then we will take it, and if it's not, because we check with that number, just how the patient is actually looking, ahh ...sometimes if they are moving around, that alarms that the resp rate is really high, and into the 50's, that it is just interference and they are moving, umm sometimes the sat probe as well if their hands are cold.

Some nurses expressed guarded trust of the respiratory module when out of necessity they couldn't always be present at the bedside. In these cases when nurses could not rely on their visual assessment from a distance, they recognized the need to utilize the technology to keep the patient safe. However, this reliance on technology from afar had to pass the reliability test first, as one participant elaborates,

> *I use it as a 'tool'* [emphasis added], so if I walk across the room to help somebody, I can still see that waveform, because I might not be able to see chest rise, but there are certain patients that I would not leave the bedside with, *if I did trust it* [emphasis added] and it had been working well, then I am ok with leaving. (P 3)

Nurses described other situations when they relied on technology, such as when they were busy with fresh PACU patients or had patients who took longer to recover and needed lower level manual observation during phase 1. P (1) described using the respiratory waveform module in some limited circumstances, "not generally no....we will put it on if we have got a patient who has been there for a while.... but it's not present on our screens right away."

To summarize, participants described a cautious dependency on technology in their early respiratory assessments, relying on ($Sp0_2$) to provide confirmation of their sensory assessments, and using the respiratory module and TRR count with considerably more caution and limited rationale. Participants were also quick to clarify how both technologies were used with reservation; subjective physical assessments were given first priority and a higher degree of trust and were in fact used to confirm what the technology was presenting as accurate.

4.3.3 Guarded Trust in Advanced Respiratory Monitoring Technology

At the same time as participants expressed a guarded trust in some aspects of the current monitoring technology, they lamented about the lack of available advanced monitoring technology, describing how they would trust a technology that directly measured the patient's respiratory flow, as opposed to indirect measurements via electrodes and sensors. They expressed frustration and a sense of being more limited than the general wards in their technological resources to safely monitor patients.

PACU participants spoke of other wards having technology that they themselves lacked, such as capnography and protocols for OSA. P (1) described, "*They actually have OSAM (Obstructive Sleep Apnea Monitoring) monitors on our day care extended and on both of our surgical wards; both floors actually have capnography* [emphasis added]. They have better monitoring than we do here." The feeling of having inferior technology, was not only frustrating for participants, but also left them concerned about being able to safely monitor patients, suggesting a perception that their visual assessment skills were not enough. For example, P (1) elaborated the lack of protocols for OSA patients in PACU, which left her feeling handicapped in safely monitoring these high-risk patients,

> So we have had issues here, where a surgeon and anesthesiologist have wanted us to keep them here [OSA Patients] because they felt they would be better monitored, but from a technical point of view, they actually have better monitoring on the floor [Surgical Ward], because we are just running a sat probe. So, we don't know what the $C0_2$ levels are. *And we are just physically eyeballing them basically* [emphasis added] ...*at* [another health region] our OSA patients were always a 4 hour stay, and there was a protocol that they would go through, depending if they were categorized as mild moderate or severe OSA, and preoperatively anesthesiologist would tick which category they were in. And post operatively that would indicate as to what their plan was after their four hours stay, if they were staying on the unit, on like a continuous 24-hour O_2 sat monitoring, or if we could send them to the ward.

Participants perceived that lack of advanced technology, such as capnography, limited accessible information about patient status to detect when something was going wrong, and suggested that the advanced technology would be more trusted and more informative. P (7) identified the impact of restricted technology for monitoring obstructive apnea "I guess if the ($EtC0_2$) is being monitored, you get a different response to what's going wrong, you would have more information *but we don't have that here* [emphasis added]." The lack of technologically rich information, left participants with the feeling of 'making do' with what technology they had, and lamenting the lack of technology that they would trust more, to truly know their patient's status, as P (6), elaborates,

> Ya I think umm *I* ***trust*** *the numbers of something that's actually connected* [emphasis added]... so like any sort of capnography, umm *where I can actually see what's being blown off* [emphasis added], umm and what the volumes are that are being blown off, if

> anything is actually coming out... [Laughs] it would be nice to have the $C0_2$ capability for our OSA patients, because then you would know truly. It would be a better assessment as to which ones were truly sleep apneic. I mean we get better at picking them out, but sometimes it can get a bit grey if you have the narcotics on board, if it's a mechanical obstruction because they are so sedated, or is it long term true sleep apnea that needs to be monitored overnight... *but umm we make do I guess... I don't know* [emphasis added].

Nurses demonstrated how they currently lacked this definitive data to confirm the stability of their patient's respiratory status. Examples were described where PAR nurses adapted assessment methods when capnography was unavailable to them. Nurses used other information in making assessments and the most rationalized; best guess at what was happening in ensuring patient safety. For example, participant (7), described 'sleuthing' to isolate the cause of her patients' drowsiness,

> *We do a lot of chart reading and sleuthing to figure out what the situation is* [emphasis added]. Sometime last week, I had a patient that was absolutely exhausted, and turns out she was a new mom and she hadn't slept for seven weeks by her statement, and she was absolutely beat and really emotional, she could barely keep her eyes open, so I just let her sleep. Normally I would have moved them along, [Transferred the patient to the ward] but I just kept her, for probably another 45 minutes, and let her nap. *But probably there was nothing wrong with her respiratory* [emphasis added].

Despite participants perceptions that capnography was not available in PACU, several participants in fact described its limited use in PACU. Capnography although present was restricted for use for Electroconvulsive Therapy (ECT), which meant many nurses had not used it. As Participant (3) reported:

> We have one [Capnography module], like we have ...I know we have it, because we do ECTs, and so it's hooked up when they are doing ECTs. When they are bagging the patient with (0_2) , and so the module is in there, and it does alarm, but it's only in that one bay, and I don't think I have ever... it's just used for ECTs.

Two participants had used capnography in previous recovery rooms in which they had worked. They described having used capnography to confirm airway positioning in early phase 1 recovery patients, to detect insidious onset of hypercarbia, to monitor respiratory function and to confirm expiratory gases more accurately. One PACU nurse had used capnography on a unit prior to transferring to the recovery room,

> Before I came down here we did OSA monitoring (OSAM) on the floors, and we had capnography Umm... those were just coming in to use before I came down here, so I had maybe 6 – 8 months experience of using the capnography, but down here we don't use it, we don't have access to it, (P6).

In summary, participants' perceptions were that capnography was not available in PACU, although the modules were present and used in a limited way with ECT recovery by the anesthesiologist in the PACU. Without capnography protocols or access to the technology, nurses described situations where they were not entirely sure if their patients were drowsy due to rising ($C0_2$) and hypoventilation or just fatigue. They described limited experience and limited knowledge of the capnography module, but also suggested it might be more trusted if connected directly to the patient.

4.3.4 Rationalized Mistrust

Rationalized mistrust arose when the cautious trust in technology gave way to mistrust. Mistrust arose from a mismatch between subjective data and technological data, nurses'

beliefs that technology needed to be controlled, or when technology/equipment was unreliable. Tools and technology that could immediately either confirm or refute subjective respiratory assessment findings such as stethoscopes and capnography were underutilized.

4.3.4.1 Mismatching

Contributing to nurses' mistrust were technology-related readings/assessments that did not match with immediate physical/manual assessments. Participants described their expectations that physical assessments should match technology-generated data. For example, they expected manual respiratory rates to mirror the monitors calculated RR and for ($Sp0_2$) to reflect visual assessments of color. P (7) described the respiratory rate module:

> *I don't know that it's that accurate to be honest with you* [emphasis added], I find it will bounce around, so you will see its reading 8, where I can do a respiratory count through listening and I get a different number... I don't know how accurate it is.

A mismatch precipitated a lack of trust in the technology. Physical assessments came first and technology had to match them as P (1) alludes, "I don't find that what I physically see, matches necessarily what is being shown on the screen." P (9) similarly described the importance of her manual respiratory count lining up with using the displayed rate and respiratory wave form, and only considered the technology accurate if it mirrored the manual assessment,

> The rate [from the waveform] if I feel it's accurate, so I will be watching my patient and making sure it's accurate to lining up with what my patient is doing, definitely the waveform too to make sure I am getting an accurate reading as well.

P (7) highlighted the significance and priority visual assessment continued to play over the technological data, and mistrust of the technology when the two didn't match, "*it's more about*

how the patient looks [emphasis added], so if they are nice and pink and you know the pulse ox is 82%, *you know the wave form is off* [emphasis added]."

It was common for nurses to default to an assumption of inaccurate technology when the two did not match. P 5 rationalized this mismatch between continuous apnea monitoring technology and intermittent manual observations as reflecting inaccurate equipment:

> *apnea, ahhh* [emphasis added] ... and then you look and their breathing perfectly fine ...*uhhmmm, you get lots of apnea ummm alarms* [emphasis added] and you know that they're not accurate. *They are talking to you and their apneic* [laughs].

When apnea alarms occurred, it was common for nurses to make assumptions that patients were breathing based on frequent issues with factors triggering the apnea alarms. P (6) described being certain the patient was breathing, and attributed the alarm to the alarm leads:

> The apnea alarm seems to ring a lot, and that usually one might say, is due to the positioning of the leads ...umm so that usually goes off pretty well right away and your fairly certain that that patient is breathing.

When the apnea sensor was triggered, even though it was sometimes believed, it was still redefined as 'an apneic period,' that downplayed its significance as P (3) stated:

> With the apnea monitoring too, like it will say apnea a lot, *it's an 'apneic period' it's not you know... like they are not breathing for an entire minute* [emphasis added], so that's when we usually do our manual resp's, and then I usually write that on our reporting form what their manual resp's were with apnea.

Again, P (3) stated when an apnea alarm occurred; they would confirm the apnea alarm as accurate by undertaking their own manual assessment, but eventually resorting to ($Sp0_2$) technology to indicate if apnea had occurred. She stated,

> I would probably just do more manual resp rates and make sure, because they are not having apneic periods, and it's not 9 right now, and then 30 second of apnea. Just maybe why it's alarming, umm and then if their Sat's were dipping down kind of thing.

It was not until the periods of apnea were accompanied by desaturation, that participants became concerned. Desaturation appeared to be the trigger for intervention, not apnea that was the primary respiratory dysfunction causing it,

> ...Continue to monitor them and then if ...well, figure out if they do or don't have a history, and if they are de-sating, we let the doctor know, and say... "Ok they are having apneic periods"; "I am not feeling too comfortable about sending them to the floor without monitoring can we either get some monitoring on the floor?"... Or you know like most of the time if they don't have a history and its mostly narcotic related, they need to wake up a little bit, we will hold them wait until they are a little bit more awake.

To summarize, rationalized mistrust was seen to contribute to nurses' distrust of technology particularly where technology-related readings/assessments did not match with immediate physical/manual assessments. A mismatch precipitated a lack of trust in the technology. Nurses had expectations that the technology and their physical assessments should align in real time, as they watched them. Once opinions had been formed, participants expressed holding strong views regarding their trust or mistrust in the technology generally.

4.3.4.2 Personal Beliefs about Respiratory Alarm Parameters

Participants rationalized their mistrust of technology based on their personal beliefs about what were acceptable respiratory data readings. To that end nurses regularly self-defined parameters or rationalized abnormal parameters as normal, in determining acceptable or unacceptable assessment findings, such as minimally acceptable respiratory rates. P (2) used her

understanding of respiratory physiology and acceptable (MRR) alarm limits, to rationalize the lack of need for using the respiratory rate alarm:

> So, they could have been here for an hour and had so many narcotics that they are just sleepy. Or you know they have been here for a couple of hours and they're still just sleepy. *Some people just sleep with a resp rate of 8, so but I don't like that function* [Respiratory rate module] ... [Emphasis added] ... It's... I have never actually put it on one of my patients... I have done break relief for people that have had it on, *but I tend to ignore it* [emphasis added].

Rationalized mistrust was prevalent in relation to PACU alarm management. Participants described silencing alarms, tuning them out, turning the volume down, adjusting them to a higher or lower threshold, etc. Nurse participants tightly managed alarms to prevent unnecessary noise. P (1) described this management so that only acceptable issues triggered alarms, "we only have them going off when there's an issue, so whether it's a desaturation or a low heart rate, I think it's not too bad". P (8) described reducing the alarm volume to avoid peer annoyance:

> If their resp rate was 9 and... I might turn the alarms down then, down a little bit, but no ...ya just turn down the volume a little bit, *so only I can hear it and it's not annoying my colleague's* [Laugh].

Adjusting the threshold of the alarms was a common way nurses managed the alarms to address their frustrations, or to account for technology they did not trust. P (6) described adjusting the threshold to just below the lowest setting: "*I would be like these damn monitors again* [emphasis added], I would probably adjust; go down on my alarm setting, because I think what's our lowest setting, maybe 10, so I think I would go down by 2." Nurses described their adjustments as a highly subjective decision, about what they thought the threshold should be, or

an arbitrary setting that prevented alarm activation. PACU nurses described being comfortable changing alarm settings, to within self-assessed parameters. P (2) felt justified in altering other nurse's alarm settings, and the default settings until they made sense to her:

> I do change alarm settings our monitors are older, and I find every once in a while, whether working on that station or I am having to relieve for breaks, or you know you get a new patient. You know, you clear the monitor and it goes back to a default. *But they don't make sense to me* [emphasis added]. They will have you know a pulse...they will have a low of 90 and a high of 150, so I will change them so... because 90 is I am happy with 90, 90 beats per minute are pretty good. Though I will lower it down to where I want it to alarm... umm and the only time I really change the ECG alarm settings is if they are in known A- fib, I don't ever change the sat alarm.

4.3.4.3 Perceptions of Old, Unreliable Equipment

Rationalized mistrust emerged from beliefs that the equipment currently available was old and of poor quality, from having little understanding or control over equipment settings, or where equipment was not in vogue any longer, or unnecessary in a culture where visual sensory respiratory assessments prevailed. Nurses often used descriptions of inaccurate or technological malfunctions to rationalize their tendency to disbelieve, under assess, or downplay its significance and emphasized physical assessment instead. P (7) described frustration and doubts as to the accuracy of her bedside monitors, because her unit only used a 3-lead cable for data collection, "I don't know if they are completely accurate... we do the three lead ECGs on them... they show things that are not accurate, so they are maybe not sensitive enough." P (1) described her preference for visual assessment over the respiratory module: " You can set it [respiratory module] so that it will count TRR, but *I don't find it extremely accurate* [emphasis added] and

physically I would just rather look at the patient and count it [MRR] , make sure I am seeing." P (2) stated: "I don't use the respiratory wave form and I don't trust it". P (3) described doing manual respirations, because the respiratory rate on the monitors, "*doesn't work just as often as it works* [emphasis added]." Nurses repeatedly spoke of the monitor alarms as inaccurate, unreliable, and they regularly silenced, modified, suppressed or disabled them, and turned to their own trusted manual respiratory assessments. When asked about the respiratory rate module, P (8) identified the likelihood of more alarm triggers and the sensitivity of the module as a factor:

> *That one is a little trickier* [emphasis added]; I find we have issues with that quite a bit just because it always reads if the patient moves. When you get the shakes post anesthetic, especially the spinals, it reads 55, too sensitive for sure. The lower rates tend to be more accurate. So are the apneas, and again unless they are very shallow breathing, it seems like there is less false positives for the lower breathing, than there are for the 55 – 56 and they are chatting away.

Nurses often used equipment malfunction as rationale for managing alarms, and apnea alarm functions. This function was disbelieved, under assessed, or the significance downplayed. P (1) stated:

> I would actually be confirming whether that is true or not, because *monitors malfunction all the time* [emphasis added]...so I would be looking and count for at least a full minute, to see if they have got an adequate chest movement and to make sure that they are actually breathing, I mean because technically they could be apneic, and still have good Sat's, because that will happen for a while.

4.4 Context: Perpetuating a Visual Sensory Respiratory Assessment Focus

Unit culture and lack of training in technology use perpetuated and reinforced nurses' trust in their sensory visual respiratory assessments, and consequent underutilization of the stethoscope and guarded trust/mistrust in technology.

4.4.1 PACU Culture

PACU culture often influenced a nurse participant's technology-related trust and mistrust. Participants described strong cultures that either promoted or discouraged specific tools and technology use and was evident across a range of technologies. Some participants described a unit-wide practice where the respiratory module was not used in early phase 1, and in fact was not even turned on, or only enabled for patients with extended stays. In another PACU, some nurses described using it later in phase 1. In some cases, nurses described the importance of visualization over technology in doing respiratory assessments as an expectation in the PACU unit. P (3) confirmed such an expectation of her PACU: "As far as I know it's never sort of been a standard [use the TRR waveform] for us, normally its visualization of the patient and making sure they are all well."

PACU culture that relied on visualization often prompted nurses to suppress alarms. Despite many participants describing frequent apnea events in phase 1, many turned this technology off completely, as it is part of the larger respiratory module. Peer pressure exerted on perceived noisemakers to suppress such alarms was evident as P (6) described:

> Yes, I find often your apnea alarm is ringing; *even a colleague will just walk up to your alarm and turn it off!* [Laughs] [Emphasis added] *without even mentioning it to you* [Laughs] [Emphasis added]... "Oh they're breathing" .... anyway ya.

PACU nurses, who regularly covered for their colleagues, spoke about stepping into situations in which they inherited technology settings they had not initiated, but others had set-up. Even though their colleagues trusted it, they were mistrusting: P (1) reported she did not use or trust the accuracy of the respiratory module, but found that other nurses did, highlighting some divergent views on the use of the module, "Like often times when we have the respiratory one's going, I find I don't usually have to set it myself, but I might cover for a colleague who has, and *I don't find that they match up* [emphasis added]." Participants dealt with alarms in various ways mainly to reduce the annoyance and avoid disturbing colleagues with alarm noise. In fact, letting alarms go unchecked was considered socially unacceptable, and environmental noise suppression was a priority according to some participants. P (3) described:

> *There are certain people that can have a patient for an hour and their alarms keep going off for the entire hour* [emphasis added], like a heart rate of 52 and it doesn't really matter because the patient's base line is 50...and they will just never change it, so we always have that, but I would say most of us are umm, pretty good at silencing or dealing with the problem, if the Sat's are at 91 you know with deep breathing, you know we put nasal prongs on, everyone is pretty good at that, *a lot of us turn the respiratory alarm off because it's so irritating* [emphasis added].

The only alarms permissible appeared to be the ($Sp0_2$) alarm and heart rate module. However, P (3) also described her growing desensitization to the alarms as she had settled into the PAR "Ya *well I think compared to when I first came there, when I had no clue what I was doing* [Laughs]... um *ya like I just don't, err I don't really listen to the alarms as often* [emphasis added]."

The stethoscope was another piece of equipment that was no longer a significant part of PACU respiratory assessments. Participants frequently described practices where stethoscope use was in decline, removed from the bedside, no longer under personal ownership or rarely used. Field observation confirmed the majority of staff no longer carried a stethoscope at the bedside; in fact, it was hard to spot one at all. Four participants described not using a stethoscope at all in making their assessments. Two participants described using a stethoscope but admitted to it being a rare occurrence. P (3) had less than two years' experience in PACU and a critical care background and described feeling isolated in her use of a stethoscope: "Yes I have one in my pocket all the time. Ya otherwise I am one of the only people that do that [emphasis added] ...." P (6) had a critical care course and two –five years PACU experience, described with some emotion the strong cultural norms conveyed to new staff by other PACU staff: "Where *I work, they also told me to put my stethoscope away* [emphasis added] ... It seems to have phased out." P (6) went on to describe the impact of peer pressure on her stethoscope practice: "Ya I feel like I always have a stethoscope usually like on hand, and *if I feel like I need it, I will use it* [emphasis added], *but it probably should be used a little bit more regularly* [emphasis added]."

If not completely retired, the stethoscope appeared to be on call only. Lack of stethoscope ownership and access to a symbolic stethoscope if needed, appeared to be the norm. Nurses often referred to a symbolic single 'stethoscope that was hanging in the middle of the recovery room' or on the crash cart. P (1) described a change in her practice since settling into her PACU role, and described how stethoscope use had changed for her over time:

> We have a bunch in par, so people usually go grab them where they are hanging...*funnily enough I don't often carry a stethoscope* [emphasis added] ... so that would be the one piece of equipment I don't often have with me. I used to carry one all the time... *I found*

that a lot of times I was carrying it for no reason [emphasis added] ...We have them available, [stethoscopes] we have them on the unit. I don't physically carry one of my own anymore.

In summary, technology was described to be of limited value in relation to participant's own visual sensory respiratory assessments and was heavily dependent on PACU culture. Participants were keen to describe how tools such as the stethoscope were used in very limited ways, less important than their own physical assessment skills. Some actively discouraged stethoscope use. Bedside monitoring technology modules, such as the respiratory module, were significantly underused and actively discouraged in some cases. Alarms were generally controlled and silenced.

4.4.2 Education/Training

Nurses described working with technology for which they had never received training such as P (7) who confessed, "I have actually never been trained on how to use our monitors." PACU nurses did not always have comfortable relationships with even the newer bedside monitors, as P (4) described:

These ... monitors are terrible [emphasis added]; *I* do actually count [MRR] all the time. With our old ones were better, these are over sensitive or not sensitive enough at picking up respiratory rate, so I find with these monitors, I am counting more than I ever did before. They go from apnea to a rate of 30; *it's insane they are really poor quality* [emphasis added].

Recent education, new equipment and an opportunity to give input on programming alarm parameters, had promoted greater trust in the technology. Nurse participants from one of the PACUs that had recently acquired new equipment (e.g., bedside modules) described

receiving education that had engendered greater trust of, and more positive attitudes towards, the technology. These nurses also appeared more likely to use it and adjust the settings to optimize it. Participant (3) described being satisfied with the alarm parameters on the bedside monitors stating: “We had ... [the supplier of new bedside monitors], come in a few weeks ago, and go through the alarms with us, and we changed a couple of things...so we were able to put in what we wanted.” Participant (9) described: “Ya *now* [emphasis added], we just got it all changed, *before it was really annoying* [emphasis added].” Fresh knowledge of alarm parameters allowed nurses to understand and better use the optimizing functions, such as the ‘stars’, indicating signal quality in the saturation probe module. P (8) described her positive response and trust in the equipment readings, “I enjoy that ours has a star for the (0_2) sat, to know whether it’s getting a proper reading.”

Knowledge and experience with advanced respiratory monitoring technology was described as limited and not recent. Most participants described a lack of access to capnography, such as, P (2) who stated, “We don’t use it. We don’t have access to it”. Participants, such as P (6), described not knowing how to access advanced respiratory monitoring equipment for example, “we have no equipment for OSAM patients in PACU... I guess the ($EtC0_2$) if it came down to it”. Other participants described a failed attempt to introduce OSAM monitors in the PACU that had been abandoned a few years earlier as P (3) stated, “We don’t do that [OSAM monitoring] anymore...didn’t seem to work very well from what I remember.” Along with a described lack of experience with advanced respiratory monitoring equipment, participants also expressed limited knowledge of hypercarbia or hypercapnia: P (7) stated: “...That the ($C0_2$) levels in the blood have built up.” P (8) admitted to not knowing altogether “not really.” P (9)

also struggled to describe hypercapnia "... so ...oh ... hypercapnia yes it's ... I am blanking right now... that's too much CO_2 retention isn't it?"

In summary, some nurses described working with technology for which they had never received training, where recent education, newer equipment and an opportunity to give input on programming alarm parameters had occurred, participants described greater trust and utilization of the technology. Advanced respiratory monitoring using OSAM monitors or capnography were not used in PACU for routine monitoring, participants had limited knowledge, no recent education and only remote experiences in the use of advanced respiratory monitoring equipment.

4.5 PACU Nurses' Descriptions of the Challenges in Detecting Respiratory Deterioration

A recurring theme involved the barriers to recognising deteriorating respiratory function in early phase 1 recovery. Nurses experienced limitations in using sensory assessments alone, technology-based assessment alone, or both types of assessments in detecting a problem or when they needed greater reliance on technology. These realizations surfaced during late detection of respiratory distress, involving undetected hypoxia, hypoventilation, and apnea and were heightened during highly memorable adverse event situations.

4.5.1 Adverse Events

PACU nurses often became aware of the limits of their current assessment processes during adverse events. These memorable respiratory difficulties often highlighted the limits of relying on either physical/visual assessments or current technology in detecting patients' status. PACU nurses described incidents that drew attention to the barriers and limits of current monitoring technology to indicate respiratory difficulty. P (7) reflected on an adverse event while caring for a patient overnight in PACU that highlighted the limits of relying on ($Sp0_2$) alone:

> She [patient] plummeted with her Sat's to the 70's at about 4am and a respiratory therapist had been in and she had been on an Optiflow machine. But she still wasn't maintaining her Sat's and it turned out that she had aspirated, and she was intubated and ventilated by ten o'clock in the morning ...I could see there was an issue despite everything looking normal, she would have these sort of drops when everybody just said she does that, but I don't do that, and you don't do that, so clearly something was going on [emphasis added]... We ended up doing a PSLS and PRF on it, you know you do the best you can, but you know darn well that you are not meeting their needs [emphasis added].

In other cases, adverse events heightened awareness of the limitations of sensory assessments alone. P (1), who had taken a PACU course, reflected on an adverse event that demonstrated how her usual visual assessment of color alone was unhelpful in assisting with the identification of hypoxia: "But you do rely on that color indicator a lot [emphasis added]...and it maybe didn't make me realize how much, until I couldn't use it. And then it became a big deal [emphasis added]." P (2), who had also taken a PACU course, similarly described an adverse event with a patient with a pulse ox in the 40s where visual cues were not available:

> We couldn't tell because he was '*So'* [emphasis added] dark, that you could not tell if he was blue or ashen. You didn't have those usual indicators. But his pulse ox was low [40%] and he ended up getting re-intubated.

P (2) also described learning from adverse event experience, when a patient was unable to breathe due to an undetected epidural side effect, and required re-intubation. P (2) described the doctor giving a test dose and leaving right away:

> A few minutes later my patient is saying oh my hands are all warm and tingly, oh that's really nice, then she's... you know, I feel like I can't get enough air, I am not getting any air, and at that time everything looked normal, she looked normal she had Sat's that were 100%, so at first I was like well, no you breathing is ok, your numbers are good, you look good. *Well* [emphasis added] ... the epidural went up instead of down, and paralyzed her diaphragm, and she ended up having to be intubated, and later on ended up in ICU ...*it happened and, ok it was a learning experience* [emphasis added], because I had never had that happen before... umm so now, it's a huge clue to me, so if someone says, hey my hands are really warm they are tingling, I am going to go, *ok let's get on this, how are you feeling how's your breathing feel* [emphasis added]... *so ya* [emphasis added] it was a learning experience.

4.5.2 Undetected Hypoxia and Hypoventilation

Nurses' reliance on sensory assessments of respiration, and a guarded reliance on the ($Sp0_2$) and (0_2) therapy at times delayed the identification of impending problems. This was most evident in nurses' descriptions of situations in which their first indication of respiratory difficulty was a patient de-saturating. Desaturations were viewed as inevitable with patient populations with specific risk factors, such as patients with narcotic tolerance, predisposing factors such as size, or residual drugs from the surgery. P (7) explained the inevitability with narcotic use:

> It depends on their narcotic use at home, if they consume a lot of narcotics or gabapentin or their tolerance is really high, others, you know they can be a big person and they don't ever use anything, so just the slightest bit of narcotic in the operating room, given during the case, can really knock their respiratory drive down.

Respiratory assessment was challenging for PACU nurses when physical, technology-based or both types of assessments failed to detect a problem. When nurses were unable to identify respiratory problems early, patient anxiety and respiratory distress were described. P (9) described a situation in which a patient was having trouble getting an effective breath, the only cue that something was wrong; physical assessments and technology-based assessments of respiratory status, both failed to detect a problem from ineffective reversal of residual neuromuscular blocking drugs post-surgery:

> Today I had a patient they weren't properly reversed, and they felt like they weren't breathing, and they were having anxiety. But when I did listen, it sounded ok, but they felt like they weren't. Their Sat's were fine, so we just gave reversal ...umm different reversals, ... her Sat's never dropped I took her off her (0_2) mask, and she was still feeling that way, and her Sat's were still like 99 throughout. Everything was perfect on my monitor and my assessment but that was just how the patient was feeling I guess.

Early identification of specific patient problems, such as hypoventilation and desaturation caused by residual neuromuscular blocking drug effects and narcotic administration was difficult for participants while relying only on sensory respiratory assessments and ($Sp0_2$) monitoring, with evidence of patient de-saturation occurring.

4.5.3 Undetected Apnea

Manual assessments often failed to identify apnea. At the same time, relying solely on ($Sp0_2$) monitoring contributed to limits and delays in identifying apnea. Some participants made the linkage between their administration of narcotics and subsequent events, however participants viewed it as not particularly concerning, and an inevitability of intravenous narcotic administration in PACU. Participants described patients frequently experiencing depressed

respiration or apnea to the point of desaturation, before they were alerted to a problem. P (2) described seeing desaturation alarms after narcotic administration:

> Desaturation alarms we do, but more often I am finding, we get more after we have given narcotics. So if we give boluses of narcotics, then usually within three minutes they get a little bit sleepy and they will de-sat and you will get them to take a couple of deep breaths, then they will do that, and they will pop back up most of the time.

Participant (6) also described her first indication of desaturation problems, clearly indicating that technology was picking up a problem that manual assessments could not:

> She [patient] came out very obviously OSA ...umm post gosh what did she have done? She was a mastectomy and she came out of the OR on mask, anyway she was apneic for about three hours, so no she's not a very good descriptor, because she would drop her Sat's, [Interviewer] was that the first indication that she wasn't breathing well? Before she dropped her Sat's, did you notice anything? [Participant]: umm to be honest I was quite busy this was just recently. It was a drop in Sat's that led me to believe that I should watch her a little closer, as she became more apneic.

The use of (0_2) therapy made it challenging for PACU nurses to rely on normal ($Sp0_2$) monitoring to detect desaturation. P (9) described a patient on (0_2) that made the saturation unreliable, but where use of physical assessment was able to detect a problem, "Ya we had a patient a few months back that came in with an LMA in, but they had (0_2) ... umm *we couldn't get any air entry* [emphasis added] and ...umm the Sat's looked good (P9)."

Narcotics were a common cause of desaturation and frequently caused depressed respirations or apnea to the point of desaturation, before the nurse was alerted to a problem.

Further delays in identifying a problem were often evident where (0_2) therapy was used and masked the problem for longer.

Some participants described adverse respiratory events that their patients experienced, that pointed to limitations in the usual respiratory assessment process and use of technology. Participants who had taken PACU courses tended to recall adverse events more often than participants with critical care courses. It is unclear if this was related to their discomfort with adverse events, their educational backgrounds, or their maturity in critical reflection. Some participants expressed degrees of moral distress, and some recognized these adverse events as learning experiences. It was clear from the event recollections, that reliance on sensory assessments and current technology particularly ($Sp0_2$) monitoring, in some cases had not assisted in early detection or prevented these events from happening.

4.6 Summary of Findings

In this Chapter I have presented the study's findings. The first major theme to emerge, *The Post Anesthetic Care Unit Visual Sensory Respiratory Assessment process*, has been described. I have demonstrated how the essence of this sensory assessment was characterized by four well defined actions and some adaptations: 1) The Arrival Walk, 2) The Bedside Hookup 3) Confirming Breaths, and 4) Counting Respirations. The adaptations included adjusting to variable (0_2) prescribing, variable respiratory dependence of the patients, and variable preferences of the anesthesiologist for respiratory rate reporting. Theme two described an approach to bedside technology called Guarded *Trust or Rationalized Mistrust*, and Theme three highlighted the context perpetuating a visual sensory respiratory assessment which highlighted the influence of culture, anesthesiologists and educational background affected the participants' approach towards their respiratory assessments. Theme four illustrated nurses' descriptions of

challenges experienced with respiratory assessment process and bedside technology. Nurses described many situations in which their first indications of respiratory difficulty were desaturations. Nurses were unable to detect more subtle deteriorations in respiratory volume or rate, due to the limitations of using only ($Sp0_2$) monitoring and intermittent manual respiratory rate estimates. Respiratory difficulties such as: undetected hypoventilation, hypoxia and apnea and a few situations of delayed rescue measures were described.

Chapter 5: Discussion

Using interpretive description, this study has shown that PACU nurses expressed a profound trust in their visual intuitive sensory assessment of respiration. In fact, PACU nurses expressed a strong sense of expert nursing practice, key to which was an 'intrinsic trust' in a visual sensory approach to respiratory assessment. Nurses could be seen to desire technology to work in harmony and validation with them, and when it did not, with some justification it was rejected.

I will discuss how PACU nurses' respiratory assessment practice, was deeply embedded within, and influenced by, the post anesthetic care unit culture; a culture deeply intertwined with the practices of anesthesiologists. I will discuss current theories of expert practice, and professional culture in the literature and will engage in a discussion around the primary contributions of the current study's findings, locating each contribution within the existing literature.

I will discuss how, within this culture, technology was controlled and its impact limited, notably current bedside technology. I will introduce a term for the positioning of technology within PACU culture, called rationalized desuetude. Within this concept, many factors appeared to influence the limited use of technology including: variable anesthesiologist practices, interruptions and variability during handover, the urgency of interventions required to support breathing in early phase 1 recovery, staffing challenges, education, limitations of current bedside technology, previous nursing experiences, attitudes and orientation processes. I will discuss how PACU nurses validated or rejected respiratory monitoring technology data by matching data with sensory assessments, resulting in either guarded trust or rationalized mistrust. I will discuss how despite PACU nurses' best efforts and diligent attempts to validate their sensory assessment and

technological data, in some situations, the current assessment process and use of technology together, were unable to effect reliable and consistent early detection of respiratory dysfunction in phase 1-recovery patients.

5.1 Intuitive Expertise

In the current study participants described a rapid intuitive assessment of respiration, and conveyed a sense of expert practice in early phase 1 recovery. Participants described their initial respiratory assessment as a well-rehearsed process, which occurred without conscious awareness; they just knew what to do in emergent situations, without thinking about it. I will present the argument that these rapid response intuitive skills may be learned, to some extent, at an unconscious level, which could explain the 'unconscious intuitive' aspects of expertise. I will argue that this intuitive expert practice may be subject to some limitations. I will discuss research evidence from the literature that supported the PACU nurses frustrations with current assessment processes and technology.

5.2.1 Intuition

One ideology in nursing that has been discussed and researched for the past twenty years or more is 'nursing intuition.' Since Benner (1984) declared the expert nurse as 'intuitive,' nursing researchers have tried to elicit what this means in tangible terms, linking intuition and expertise. Other nursing authors in the literature have been more focused on demonstrating the professional, evidence-informed status of nursing. By focusing nursing research on tangible evidence of nursing practice, it could be argued that nurses may have unwittingly suppressed the recognition of the more intangible intuitive aspects of the nursing skill set.

Although elusive and illusive to define, intuition has been described as the hallmark of nursing knowledge, (Rew & Barrow, 2007). In the current study, the term "instinctual" defined

the automatic, unconscious, or immediate cognitive ability of the PACU nurse to identify urgent respiratory needs and act. PACU nurses also seemed to demonstrate an instinctual trust in their experiences and routines, which had developed into their expert practice. Core to this instinctual practice, was trust and confidence in their visual sensory respiratory assessments which included: a rapid visual scan during the arrival walk, a brief visual confirmation of breaths on arrival, a fifteen second count of the manual respiratory rate, and repeated visual checks of breaths and manual respiratory rates throughout the patient's stay in phase 1 recovery [See Figure 4].

Benner (1984) suggested that the expert nurse has an *intuitive grasp* of each situation, and is able to zero in on the accurate region of the problem, *without wasteful consideration* of a large range of unfruitful, alternative diagnoses and solutions. Similarly, the PACU nurses in the current study acted intuitively in their early phase 1 respiratory assessment, describing how they rapidly identified respiratory issues in their patients, and knew immediately what to do. According to Benner (1984) '*The expert nurse*' operates from a *deep understanding* of the total situation, and performs in a fluid, flexible and highly proficient way. Benner recognized the internal ability of the nurse to just know. The expert PACU nurses in the current study, many who were acting as charge nurses, similarly described possessing a total grasp of patients during phase 1 recovery, adapting to patient needs and emergent situations. Resonating with Benner they described an instinctual knowledge, processing information rapidly on the arrival of their patients, and acting immediately to manage and identify respiratory dysfunction.

5.2.2 Expert Intervention

Understanding how nurses come to make the right decisions or choose the right interventions in urgent situations is intriguing. In the current study, PACU nurses used a rapid, intuitive approach, in which their phase 1 recovery actions and assessments had become easier

and more fluid with PACU experience. So automatic was their approach, they expressed difficulty describing it. This is consistent with Benner's suggestion that in familiar situations, cognitive analysis is '*wasteful*.' This concept of 'not wasting time' was clearly conveyed by the current study's participants as important, in early phase 1 recovery respiratory assessments. This concurs with the work of Moulton, Regehr, Mylopoulos, and MacRae (2007), who describe expert practice as an efficient organization of environmental information and intentions, so that experts can carry out their daily activities with minimal demands on cognitive load. Moulton et al. suggested that as the expert gains clinical skills, activities that were once initially effortful, become mundane and routine, leading to greater efficiency than a novice performing the same tasks. Klein et al. (1989) used the term recognition *primed decision-making*' to describe expert-based decisions based on recognition of situations that are typical and familiar to the expert. Acquaviva, Haskell, and Johnson (2013) emphasized subconscious pattern recognition, and experiential learning as important in forming expertise, and suggested that this performance occurs automatically, without conscious thought. Similarly, in the current study PACU nurses described learning a rapid response and an intuitive sensory skill set, based on their visual recognition skills, which defined PACU nurses' expert practice within their early phase 1 respiratory assessment routine.

PACU nurses' intuitive skills and rapid visual assessments and responses were needed during early arrival phase 1 recovery. Rapid visual scans are common, and a recognized method of paramount importance in time sensitive contexts, particularly when identifying urgent respiratory problems in PACU (Barry et al., 2016). Klein et al. (1989) analyzed this form of expert rapid response, where skilled practitioners made a quick assessment of a situation and its requirements and termed it '*situational awareness*.' Similarly, as highlighted by Mushta et al.

(2018) ‘moments of recognition’ are links in a chain of survival. Koster et al. (2010), suggested spending no more than ten seconds in an initial “look, listen, and feel” for respirations, when establishing if a person is breathing. In fact, rapid assessment skills are essential in critical care (Barry et al., 2016), especially in resuscitation science, where quick decisions must be made, often without the availability of technology.

Schon (1987) refers to the experts’ non-cognitive, automatic, responses to learned routinized work as ‘*knowing-in-action’* that also involves the ability to improvise on the spot to unexpected events and surprises or when faced with a different scenario to the routine. PACU nurses in the current study repeatedly described this knowing-in-action as they adapted their practices to anesthesiologists’ variable practices, to their cultural context, and to PACU technology. Similarly, Moulton et al. describe ‘expert’ as a state of extreme organizing of informational process, when “experts” can no longer verbalize the thought processes involved in reaching a decision, or cannot accurately explain details of actions involved in carrying out a procedure” (Moulton et al., 2007, p.109).

5.2.3 The Experienced Non-Expert: Methods for Processing Information

Nurse participants in the current study described a tendency to shift their thought and decision-making processes from cognitive to intuitive and automatic as they acquired experience. Intuitive and rational decision-making are important cognitive processes for nurses when they scrutinize clinical information to make clinical judgments (Mushta, Rush, & Andersen, 2018). However, Mushta et al. (2018) expressed caution in a reliance on intuitive decision-making, because although it allows the nurse to act quickly, it is subject to personal interpretations, and can lead nurses to jump to conclusions, blinded to other possibilities. The tendency for experts to rarely consider more than one option in critical decision-making (Klein, Calderwood, &

Macgregor, 1989) and to develop more automatic thought processes (Moulton et al., 2007) may have limitations. Automatic cognitive processing that reduces cognitive load may limit the expert's ability to manage a novel situation or unusual case appropriately, tending to adapt the presenting problem to known solutions, rather than adopting new, more appropriate, and safer solutions. Moulton et al. calls such a person '*an experienced non-expert*.' Reflecting on participants' descriptions of undetected and delayed detection of adverse respiratory events such as major desaturations, respiratory failure and undetected apnea, this idea of an 'experienced non-expert' resonates.

The ability to avoid limiting themselves to automatic modes of operation, and to stop and reflect in urgent situations to prevent errors is suggested as the difference between experienced non-expert practice and true expert (Moulton et al., 2007; Bereiter & Scardamalia, 1993). Moulton et al (2007) describe this as a combination of the '*effective interfacing'* between cognitively effortful, analytical processes and automatically generated non-analytic resources. Moulton et al (2007) give the example of when a clinical presentation is atypical or a post-operative patient goes off course, questioning if, the clinician who is in automatic mode, would recognize the intricacies and complexities of the case and be able to step out of 'automatic mode.' Many of the participants in the current study described the automaticity of their assessments and their struggle to explain their intuitive practices. This raises some concerns and flags the dangers of automaticity or intuition in practice.

Many authors consider expert recognition to be a learned visual recognition process (Bandura, 1986; Buccino & Amore, 2008; Lave & Wenger, 1991; Kelly & Frinzi, 2011; Klein et al., 1989). An example from the current study can be used to demonstrate how the expert nurse visualized a pattern of breathing, that indicated the patient needed a jaw thrust, and initiated it

without consciously deliberating or decision-making, or relying on any kind of technology to inform the decision. This instinctual but ‘expert recognition’ of the needed rapid actions, could be argued to be organic and learned behavior. Similarly, Bandura’s social cognitive theory (Bandura, 1986) discussed role-modeling behaviors, and suggested watching and mimicking others is foundational to learning a skill. Interestingly this concept is also shared in neuroscience. Buccino & Amore (2008) and Kelly & Frinzi (2011) described how mirror learning may also explain the rapid response aspect of expert practice; mirror learning is described to be deeply imprinted on everyone from birth, a subconscious process that takes place in everyday interactions and goes unnoticed. There are many more theories to explain the idea of a learned skill response such as recognition primed decision-making (Klein et al., 1989) and situated learning theory (Lave & Wenger, 1991). The current study’s findings, in which nurses conducted only a brief 15 second manual respiratory rate recording in PACU, could be interpreted as an example of the dilution of expert practice and over-developed confidence in clinical skills. In the current study, nurse participants relied on rapid spot checks for manual respiratory counts, and some described even estimating initial rates for documentation purposes only. Similar concerns were expressed by Philip et al. (2015) who found high levels of inaccuracy with both formal methods of counting respiration and ‘spot’ assessments of respiration. Philip et al. (2015) concluded that the current unreliable methods used by doctors to establish respiratory baselines may also apply to the rapid respiratory rate assessments nurses performed. Mushta et al. (2018), in a concept analysis of nurse indicators in failure to rescue events, suggested that reasons for inadequate surveillance and monitoring are multifactorial and included: nurse inexperience, high workloads, and deficits in the ability to analyze clinical data. These issues were believed to be most prevalent at the novice skill level on Benner’s scale of novice to expert and identified a lack

of experiential knowledge. However, in the findings of this current study, the nurses were not novices, and had considerable experience and confidence; their rationale for limiting their assessments of respiratory rate had to come from other influences.

5.2.4 Communities of Practice in the Influence of Expertise

The influence of communities of practice on practitioner's performance in critical situations and urgent responses appears to be a significant factor in learning skilled practice (Lave & Wenger 1991). Lave (2019) highlighted the importance of identity and membership of a community of practice, in its effect on motivating, shaping, and giving meaning to practice performance. Holmes, Harris, Schwartz, and Regehr (2015) suggested that the professional practices students learn are strongly influenced by a desire to emulate the behaviors of strong clinical mentors, who may or may not model desired professional behavior. The desire to emulate mentors' behaviors suggested that the power and control of the mentor or role model within a practice community is significant. Not only does it convey both efficient practice and attitudes on new staff, but highlights the power and influence of observing others, which could include colleagues, other professionals or patients and how it can affect PACU nurses' decision making. Examples of how nurses were influenced in their use or disuse of the stethoscope appeared to be heavily influenced by the community of practice in the current study. Alternatively, learning socially congruent behaviors in a practice setting could be interpreted as processing information 'off line,' unconsciously forming intentions, and may explain the socializing effects of PACU interaction, on an unconscious observing level with other nurses and anesthesiologist colleagues.

The current study findings suggested that role model learning had a significant impact on PACU nurse behaviors, how staff orientated in the PACU, and how nurses developed automatic

or intuitive expertise, within this community of practice. Similarly, nursing intuition may occur at an unconscious organic level, with PACU nurses forming their perceptions and guiding their expert practice, and trusted assessment processes through an organic unconscious recognition and rehearsal process. This could apply to symptom recognition, nonverbal signs of patient distress; subtle changes that are beyond the PACU nurse's cognitive awareness but deeply programmed within them to rapidly identify. There may therefore be a neurological basis to nursing intuition and nursing work cultures or communities of practice. This would give credence and a scientific explanation to the concept of *expert nurse intuition*, where the nurse develops experience and forms patterns of recognition over time, which results in sophisticated rapid responses to recognizable urgent patient problems, such as the PACU early phase 1 respiratory assessment. Obviously, it would be a stretch to explain the vast cumulative experience of an expert nurse purely thorough this method of non-cognitive processing. However, this theory does validate Benner's concept of the expert nurse (Benner, 1984). Benner describes the rapid efficient actions undertaken by an expert nurse, similar to the PACU nurses in the current study, who described difficult airway assessment without cognitive awareness.

In the PACU, the expert participants displayed a level of experience, in which they relied on expert perception through rapid scans or spot checks. However, a note of caution is presented, as to how reliable this *situational awareness, perceptual motor response-based* expertise really is. Questions should be asked about the possibility of pitfalls in practicing at this intuitive level of confident practice. Rapid scans are common practice with nurses and physicians; however, they have been criticized. Recent research (Philip et al., 2015) found accuracy in rapid assessments decreased as experience or *perceptions* of expert practice increased. Philip et al. (2015) concluded that the variability in physician expertise and higher accuracy of (MRR)

recording found in junior doctors, related to the more recent clinical practice of junior doctors (Philip et al., 2015). However, the reduced accuracy of senior doctors may also indicate that self-perception of expertise may negatively affect the expert's diligence in their approach to the task, or it could imply that the expert relies on their automatic learned responses rather than slowing down their assessment and applying cognitive skills.

5.2.5 Defining 'True' Expertise

In defining true expertise, the literature is less than clear. Certainly a definition of true expertise is less common in the literature than the perception of expert practice.

True expert practice would seem to require more than the visual recognition emphasized by the participants in the PACU's studied, but also the ability to ask the difficult question, expect the unexpected, and remain vigilant, with cognitive skills required at this level. In the examples, participants recalled of unexpected or unusual respiratory events and memorable situations, it was clear that the unfamiliar, non-routine event was often more challenging to identify, but also recognized for its learning opportunities. Similarly, Bereiter and Scardamalia (1993) insightfully suggested that expertise is not a permanent state or level of practice; experts maintain an explicit awareness, identify subtle complexity of situations and maintain creativity in finding solutions to ill–defined or unusual situations. It would seem essential for nurses in PACU to aspire to this level of expert practice, given the acuity and wide variety of potential adverse respiratory events that have been described in this study's findings. The need to be cognizant of and constantly watching for the unexpected would appear to be expected at the level of expert PACU nurse performance. Bereiter and Scardamalia (1993) do not view expertise as a static state but subject to burnout disillusionment and complacency. PACU nurses can learn from this awareness by remaining engaged with the assessment process and consciously avoiding complacent

routinization of practice. Essential for Bereiter and Scardamalia (1993), expertise is a state of constant intentional engagement with exemplary practice and failing to do so represents a loss of expert status.

To summarize, the term 'instinctual' defined the more intangible aspects of the nursing skill set. The automatic, unconscious or 'immediate' ability of the PACU nurse, to focus on an intuitive rapid response to the patient's presentation on arrival, fits with Benner's concept of 'not wasting time." The participants in the current study described the intuitive nature of their practice and demonstrated difficulty in describing its processes. Core to PACU nursing practice was a strong trust and confidence in their visual sensory respiratory assessments. Educational theories and role modeling processes and unconsciously learned behaviors may play a significant role in rapid response skills.

However, these perceptions of expert practice were attenuated by other findings. Some evidence suggested that 'experts' have been shown to rarely report considering more than one option, which can result in high levels of inaccuracy in respiratory rate assessment (Philip et al. 2015; Klein et al., 1989). Questions were raised about how reliable situational awareness; perceptual motor response or intuitive expert grasp really are. Situations where this became an apparent problem will be discussed in the next section. Bereiter and Scardamalia (1993) described expert practice as "a state of constant intentional engagement with exemplary practice" and failing to do so represents a loss of expert status. Consequently, it can be seen that some levels of rapid response perceived expertise, are in-the-moment engagement with full utilization of all attained knowledge and skill. However, if this knowledge and skill rests exclusively on intuitively learned skills, or lapses from full engagement into routine, it can be liable to error. Expertise is therefore not an accolade but a performance.

5.3 Relationships with Technology

In the current study nurses could be seen to desire technology to work in harmony and validation with them, and when it did not, it was rejected. In this section I will discuss the findings of guarded trust or rationalized mistrust in monitoring technology, in relation to current views of nurses and technology in the literature, and the future visions of technology in nursing. I will discuss the current study's finding of a guarded trust in ($Sp0_2$) and a rationalized desuetude of other technology. Many factors appeared to influence the limited use of technology including: variable anesthesiologist practices, interruptions and variability during handover, the urgency of interventions required to support breathing in early phase 1 recovery, staffing challenges, education, limitations of current bedside technology, previous nursing experiences, attitudes and orientation processes.

5.3.1 Limitations of Technology

Participants in the current study described frustrations with the limitations of technology. One area of distress was delayed detection of hypoventilation. Nurse's reliance on sensory visual assessments challenged their ability to detect hypoventilation that occurred with no recognizable visual indicators, from issues such as epidural respiratory muscle paralysis, RNMB, apnea and aspiration. Similar issues identifying respiratory complications after surgery are reflected in the literature (Beaumont, Luettel, & Thomson, 2008; Hochhausen, Barbosa-Pereira, Leonhardt, Rossaint, & Czaplik, 2018). Beaumont, Luettel, & Thomson (2008) found that most deaths resulted from a lack of recognition or response to patient deterioration. More recently Bruins, Leong, and Ng (2017), in a retrospective review of critical incidences reported by the nursing staff in a PACU, there were 155 respiratory-related critical incidents in the PACU. Hypoxia (n = 103, 66.5%) and CO_2 retention (n = 41, 26.5%) were the most common respiratory incidents.

Siddiqui et al. (2013) stated that the incidence of complications in the PACU ranges from 6% to 30%.

PACU nurses in the current study generally trusted and relied on ($Sp0_2$), applying it immediately upon patient arrival to PACU. However, PACU nurses described examples confirming the limitations of ($Sp0_2$) as a responsive technology in detecting respiratory deterioration in early phase 1. Given the rapidly changing status of emergence from anaesthesia, ($Sp0_2$) monitoring may not be responsive or timely enough to give nurses the reliable information needed to detect respiratory deterioration in phase 1-recovery patients.

Pulse oximetry is still controversial according to the literature and reported to be an unreliable indicator of respiratory depression, particularly in the presence of supplemental (0_2) (Langhan et al., 2017). Pedersen et al., (2014) found no evidence that pulse oximetry affected the outcomes of anaesthesia for patients. These findings may stem from the delayed presentation of (0_2) desaturation, following a period of hypoxia. This lack of evidence for pulse oximetry efficacy suggests the need for a more rapid detection of hypoventilation in post anaesthesia care and may indicate one reason for the difficulty PACU nurses had in identifying patient's respiratory deterioration with the current technology available to them. Nurses may also have inadvertently substituted pulse oximetry for RR monitoring (Mok et al., 2015).

In the current study, participants prioritized the nurse-patient interaction and emphasized manual assessments, suggesting that the respiratory module inaccuracies may compromise patient assessment. Yet, continuous monitoring has been advocated (Mok et al. 2015). Hochhausen et al. (2018) stated how important breath rate monitoring is after anesthesia and recommended that it should be assessed continuously in PACU. Moulton et al. (2007) stated,

"At any moment in time, attention needs to be allocated to monitoring for unexpected and unanticipated cues, as well as for assessing results of actions already taken (p.113)."

5.3.1.1 Consequences of Current Alarm Suppression Practices

PACU nurses' trust and confidence in their clinical judgment contrasted with their mistrust of technology. This mistrust was often manifested in inattention to technology and alarms during early phase 1 and was reinforced by a PACU culture in which it was acceptable to suppress or turn off alarms (respiratory module).

This study's findings suggest that PACU nurses' legitimate concerns regarding the accuracy of the bedside technology to monitor respiration, combined with limited understanding of the operation and function of bedside monitoring technology, led to nurses developing ways to silence and minimise its use, discredit it, remove it, or turn it off. Ongoing monitoring of Phase 1 patients was limited to reliance on intermittent manual assessments and individual PACU nurse's self-defined assessment parameters and alarm suppression. Where technology was not trusted, it was not used, particularly the respiratory module, which in some cases was turned off.

5.3.1.2 Technology Utilization and Rationalized Behaviors

Guarded Trust or Rationalized Mistrust in technology emerged as participants engaged in a process of 'Matching.' PACU nurse participants of all levels of experience described an expectation that technical data should match and validate sensory assessment findings, and when they aligned, they trusted the technology. Some participants rationalized, justified and redefined self-defined parameters, when technical data was abnormal, such as accepting a respiratory rate alarm of as low as 8 breaths per minute. Technology and tools that could refute or bring into question the validity of this sensory assessment routine was '*rationalized into desuetude'*.

According to the Merriam-Webster dictionary (2018) 'Desuetude' derived from the reverse of the Latin verb. '*Suescere*' means, 'to accustom.' '*Rationalized desuetude'* describes a cultural process of rationalizing the reasons for becoming 'unaccustomed' to something. This concept fits as an explanation of how nurses in the PACU appeared to have become unaccustomed to the stethoscope and to respiratory monitoring technology.

This view of tools and technology became more entrenched as PACU experience grew. This *technological neglect* or *rationalized desuetude* was sustained by an enculturation process with an expectation of conformity, enforced through routine practices. Beliefs about technology and respiratory assessments were consciously conveyed in some cases and perhaps *unconsciously* mirrored by newcomers, anxious to develop rapport with their colleagues.

In summary, trust in bedside respiratory technology was limited, knowledge of bedside respiratory technology was limited, clinical judgment was highly valued, with limited attention to continuous monitoring in respiratory assessment. Despite the importance of abnormal RR as an early predictor of deterioration, it was underemphasized. No evidence in the literature has been found to support ($Sp0_2$) positively affecting the outcomes of anaesthesia for patients. PACU nurse participants frequently described an expectation of technological data matching their subjective assessment findings. PACU nurses became unaccustomed to using tools and technology that failed to validate their trusted sensory assessment findings. Participants described examples of where they confidently normalized abnormal technical findings, for ($Sp0_2$), respiratory rates and apneic periods, justifying these adjustments based on their expert knowledge of phase 1 recovery.

PACU nurses in the current study described and presented a well-controlled environment where the technology was controlled, and noises effectively suppressed. The nurses appeared to

be in control of their environment. In the current study technical alarms were kept to a minimum, stethoscopes were actively discouraged and, in some cases, symbolically retired to a wall hanging somewhere, ($Sp0_2$) monitoring was treated with guarded trust and the respiratory module was frequently treated with rationalized desuetude.

5.4 A Culture of Practice

Rajmohan and Mohandas (2007) have a scientific explanation for the concept of a culture of practice. They explain that science has demonstrated that the more people tend to imitate each other, the more they are able to develop an empathic relationship. In the current study, participants emphasized the importance of relationships with colleagues including anesthesiologist colleagues. '*Social mirroring'* is said to involve the interaction of the core mirror neuron system and the limbic system (Rajmohan & Mohandas, 2007). It is suggested that the findings of the current study, including a desire for matched technical data and behavior, could suggest spectrums of social mirroring.

In the current study, there appear to be contextual factors influencing nurse's intuitive practices, including strong influences of culture and custom despite participant's references to clinical practice guidelines. It could be argued that the clinical guidelines did not meet the specialist needs of these expert nurses and their assessment processes. For example, applying standardized expectations, in terms of normal respiratory rate parameters in the first fifteen minutes of phase 1 recovery, may detract from allowing expert PACU nurses to interpret and focus on the special needs of their client group such as assessing for PACU nurse initiated extubation, supporting advanced airways and other multisystem critical care requirements. PACU nurses were maintaining respiratory support in highly dependent patients, with rapidly changing levels of consciousness, and a respiratory rate that was changing minute to minute,

directed their support towards moving the patient to breathing independence.

Part of the cultural process described in the current study revolved around how the nurses were expected to use and treat monitoring technology, either using the technology with guarded trust or rationalizing their mistrust in it and not utilizing it. These findings resonate with the findings of Flenady, Dwyer, and Applegarth (2017) who described the theory '*Rationalizing Transgression*,' to explain how, despite feeling professionally conflicted, nurses often erroneously recorded respiratory rate observations, and then rationalized the behavior by employing strategies that adjusted the significance of the organizational requirement. According to Flenady et al. (2017) the strategies nurses used included: *Compensating*, when nurses believe they are compensating for errant behavior by enhancing the patient's outcome; *Minimalizing*, when nurses believe that the patient's outcome would be no different if they recorded an accurate respiratory rate or not and; *Trivializing*, a strategy that sanctions negligent behavior and occurs when nurses 'cut corners' to get the job done. Nurses use these strategies to titrate the level of emotional discomfort associated with erroneous behavior, thereby rationalizing transgression.

Certainly, participants in the current study described how they had changed their approach and learned to increasingly discount technology as their experience in PACU progressed. Nurses in the current study tended to initially experience emotional discomfort, but it decreased as they changed their perspectives and practices with experience in PACU. This finding resonated with similar concepts in the literature. New staff is a particularly vulnerable group in a community of practice. Holmes et al. (2015) described the 'hidden curriculum' to be a powerful hidden culture that perpetuates not only desired attitudes and behaviors, but also undesirable unprofessional practices. Impressionable students or new staff can adopt these undesirable practices after they see such practices modeled by supervisors and mentors in the

clinical environment. Holmes et al. (2015) suggested deference to authority may be more than simply a survival strategy in a new community of practice, but part of developing a uniform identity with their adopted community. Consequently, conformity of expectations gains the approval of others. Holmes et al. (2015) highlighted that an important contextual factor in professionalism is respecting authority and maintaining order, and this exerts a massive influence on the community of practice. This strong influence from a community may make it highly unlikely that new staff with fresh training and good practice skills will challenge that community of practice. Holmes et al. (2015) suggested that a new staff member's values and standards erode when confronted by the realities of practice in the clinical context. This was evident in the current study, where new staff described their difficulties and adjustments to put away their stethoscopes and turn off the technical alarms they had initially been attentive to, and circumventing conflicts with anesthesiologists by avoiding questioning their practices, preferring to preserve relationships.

5.5 Respiration on Emergence from Anesthesia a time of 'Physiological flux'

Siddiqui et al. (2013) suggested that recovery from anesthesia is a time of significant 'physiologic flux,' when conditions can change, drug effects develop, (0_2) levels can, and often do, diminish and complications (e.g., hypoxemia and desaturation) can arise. Review of the literature revealed little written or known about respiratory assessment during emergence from anesthesia and recovery in the PACU. In the current study, expert PACU nurses did not always see the expected routine recording of a respiratory rate on arrival to PACU as practical or consistent with their priorities for the patients' care. Understandably the PACU nurse was more concerned with the priority of maintaining advanced airways and troubleshooting respiratory dysfunction, while preparing for safe extubations. Kayne et al. (2013) and Ward, Karan, &

Panjit, (2011) suggested that during emergence from anesthesia, respiration is far from normal, and there are considerable risks for insidious complications to develop. Kayne et al. (2013) point out that the risks inherent from anesthesia, related to deregulation of the sympathetic nervous system, may mask acidosis from hypoventilation, and blunt the normal indicators of hypoxemia such as tachycardia, hypertension, and agitation (Kaye et al., 2013), thus making the challenge of hypoxia detection difficult for PACU nurses who rely on sensory assessments. The lack of normal indicators of insidious and hidden respiratory dysfunction (e.g., respiratory depression) may put early phase 1 postoperative patients at increased and unique danger.

Participants described examples of where they confidently normalized abnormal technical findings, for ($Sp0_2$), respiratory rates and apneic periods, justifying these adjustments based on their expert knowledge of phase 1 recovery. The comparison of technical findings to established norms is common nursing practice regardless of practice setting but may not be appropriate for the very unstable phase 1 recovery period. This tendency for PACU nurses to normalize abnormal technological vital signs may be necessary in managing the fluctuations occurring in patient status during emergence from anesthesia.

PACU nurses described commonly observing abnormal respiratory function as patients recovered from anesthesia and analgesic administration, which did not concern them. One of the challenges with briefly counting and assessing respirations immediately following anesthesia and surgery is that respiration follows an irregular pattern; yet charting and bedside technical monitoring parameters were based on ‘normal’ vital signs, which were described as frustrating to the participants, creating some conflict between the realities of patient assessment and organizational expectations for recording data. Barry et al. (2016) described weaning post anesthesia to be quite unique. Barry et al. (2016) suggested that given the residual effects of

anesthetic agents, combined with the physiologic stress imposed by surgical procedures, deterioration in function and *slower irregular breathing patterns* are likely to be frequent in the post anesthesia care unit (PACU). From the literature reviewed, such hidden respiratory dysfunction changes are unlikely to be detected by reliance on a sensory assessment or ($Sp0_2$) monitoring. This may also make traditional Early Warning Detection System criteria potentially ineffective in this environment, as Early Warning System (EWS) risk scoring systems, are designed for early detection of physiological deterioration from 'normal vital signs.' The vital signs of a patient during emergence from anesthesia have been described as commonly, far from normal (Kayne et al., 2013; Ward, Karan, & Panjit, 2011; & Barry et al., 2016). The components of an 'EWS' risk score includes systolic blood pressure, heart rate, breathing frequency, temperature and level of consciousness (Mussa, Al-Raimi, & Becker, 2019; Ludikhuize, Smorenburg, de Rooji, & de Jonge, 2012), all of which can be significantly altered in early phase 1 recovery. The PACU nurses in the current study often expressed a lack of concern for this phenomenon of transient abnormality, based on the expected recovery patterns of patients awakening from anesthesia,

5.5.1 Barriers to Recognising Clinical Deterioration

Two factors found to contribute to undetected patient deterioration in the literature are inconsistent monitoring of vital signs, and a lack of understanding regarding the significance of physiological changes patients' exhibit preceding clinical decline (Australian Commission on Safety and Quality in Health Care [ACSQHC], 2012; Flenady et al., 2017). In the current study, nurse participants described early signs of respiratory compromise/deterioration (hypoxemia, hypoventilation and decreased breathing rates and apnea) they attributed as common in early phase 1 recovery and resolved with stimulation or as drug effects wore off. Early detection of

respiratory deterioration was challenging, perhaps because PACU nurses were desensitized by the regularity of mild respiratory dysfunction or the 'Physiological flux' in early phase 1. The current study's findings regarding vital sign monitoring resonated with the qualitative observational study by Cardona-Morrell et al. (2016), which found appropriate attention to vital signs appeared to rely on nurses' clinical judgment, or time availability, rather than on policy-mandated frequency. Cardona-Morrell et al. (2016), argued for the importance of a continuous monitoring approach to counter the effect of depending solely on clinical judgment, suggesting some caution in placing so much trust in clinical judgment.

In parallel, participants in the current study described a fifteen second count of the MRR, as routine. This is unlikely to result in an accurate estimate of a slower irregular breathing pattern post anesthesia. Mok et al. (2015), in an integrative literature review, concluded that a myriad of factors was found to surround vital signs monitoring, detecting and reporting of deterioration. They found that nurses often overlook the significance of vital signs in detecting deterioration, and that despite the importance of abnormal RR as an early sign of deterioration, this predictor has been largely underemphasized.

Findings from the current study suggest that nurse's early respiratory rate assessments did not always follow expected protocols. Unlike routine recording of vital signs in most areas of hospital nursing, the vital signs recorded in early phase 1 recovery, are essentially abnormal (Kayne et al., 2013; Ward, Karan, & Panjit, 2011), and so need to be monitored every five minutes until stabilized as per PACU protocol. As suggested by Flenady et al. (2017), despite gold standard guidelines that require recording vs. estimation of respiratory rate, suboptimal practice of simply estimating respiratory rates continues. They note that four breaths outside of the normal range could be indicative of impending clinical deterioration. This is significant in

patients expected to be stable and although it does but that is not the case with the patient in phase 1 recovery. Estimating a respiratory rate, as in the current study, may reflect a shift in the culture of practice, but it could also indicate the expectation that abnormal vital signs are expected during for the first fifteen minutes in recovery and the PACU nurses may have focused on seeing trends improve as opposed to individual abnormal numbers. Flenady et al. (2017) suggested that to optimize data collection, nurses need to understand the relationship between the regular collection of accurate respiratory rate observations and optimal patient outcomes. As suggested in the literature, nurses' critical thinking patterns are described as foundational to recognizing and interpreting patient changes but are less well understood (Mushta et al., 2018). PACU nurses may have been critically interpreting respiratory data consistent with this unstable period when comparison to norms is not viable.

Participants felt the need to rely on sensory assessments and found technology limited in supporting their assessments; this led to an emphasis on the importance of color in their initial assessments. However, more than one participant described the potential pitfall of a reliance on color, with the variable skin tones of their clients. PACU nurses in the current study had experienced adverse patient events when they relied on skin color assessment to recognize hypoxia and this reliance had failed to assist them. Further, use of ($Sp0_2$) as a backup has been highlighted as unreliable, due to the fact that that life-threatening hypercarbia can exist in the presence of normal O_2 saturation (Oswald et al., 2016), due to the delayed nature of (0_2) desaturation, particularly in the presence of (0_2) therapy.

PACU nurses' propensity to rely on visual sensory assessments may be strongly influenced by their anesthesiologist colleagues, who have also been found to engage in similar practices. Brull and Kokpman (2017) found that 10 – 20% of anesthesiologists rely on visual

sensory assessments. Siddiqui et al. (2013) found that very few physicians were capable of detecting mild degrees of arterial blood desaturation by the perception of "surface blueness," and recognizing hypoxemia. Siddiqui et al. (2013) found that many of their study patients had low SpO_2 values on arrival at the PACU, indicating that most of the episodes of desaturation during transport went unnoticed. Brull and Kokpan (2017) also highlighted that the literature is replete with studies documenting the inadequacies of subjective assessment and clinical criteria. Brull and Kokpman (2017) suggest that anesthesiologists have spent entire careers relying on subjective assessment of clinical signs, to assess recovery from anesthesia drugs, and that clinical practice is extremely difficult to change. This emphasis on sensory subjective assessment skills perpetuated by anesthesiologists' is congruent with the PACU nurses' practices in the current study and may be a strong influence.

Cultural influences in the PACU appeared to support and sustain the sensory visual assessment process. Langan, Li, and Lichtor (2017) in a study which looked at hypoxemia, apnea and hypoventilation in PACU, found that although 56% of patients experienced hypoxemia detected by pulse oximetry, very few patients received nursing interventions for these events. Langan et al. (2016) concluded that more education was needed to encourage interventions, for nurses to appreciate the significance of these events. The impact of cultural change was demonstrated by Xu, Huang, Bai, and Varughese (2019), who evaluated a quality improvement project focusing on standardised anaesthesia handover protocols and a PACU risk prediction tool for the PACU nurses. They found that they were able to reduce the percentage of respiratory adverse events in PACU by focusing on establishing a culture of safety.

5.5.2 The Case For and Against More Advanced Respiratory Monitoring

Participants in the current study did not have access to capnography to detect ($EtC0_2$) or train of 4 (TOF) to detect RNMB. They described frustrating experiences in getting assistance when they suspected these symptoms in their patients, which resulted in some described delays in patients receiving treatment for more subtle signs and symptoms. Participants described patients often arriving from the operating room without (0_2), and without ($Sp0_2$) monitoring. Participants described receiving patients from the operating room, who were experiencing desaturations. Berg et al. (1997) suggested that TOF technology is the definitive way to identify hypoxia from RNMB and should be used to test a suspected case in the PACU. Participants in this study had to rely purely on a sensory assessment, patients self-report and ($Sp0_2$) to detect symptoms of RNMB, which was described as a common complication in the PACU.

Participants described PACU nurses and anesthesiologists sometimes expressing surprise, confusion, disbelief, and disagreement about unexpected technical data, such as unexpected desaturations and RNMB symptoms, tending to rely on their usual sensory assessment skills first, when unsure if the data was accurate. Nurse's expressed frustration with the perception of inaccurate technology and frequent interference from superficial technical sensors and troubleshooting frequent false alarms. This is supported by other findings in which a high incidence of false alarms (up to 77%) decreased nurse's motivation to attend to alarms (Cardona-Morrell et al., 2016). In the current study, nurses' mistrust of technology and rationalization of alarms during early phase 1 appeared to be explained by their greater trust and confidence in clinical skills.

In summary this discussion has explored the main findings of the current study that PACU nurses conveyed a strong sense of expert nursing practice, key to which was an 'intrinsic

trust' in a visual sensory approach to respiratory assessment, with guarded trust in ($Sp0_2$) technology. Sometimes this approach was not sensitive enough to detect all respiratory issues in phase 1 recovery. I have explored the literature related to concepts of defining expertise and described the theory of the 'experienced non expert,' and methods for managing cognitive load in rapid assessment situations such as PACU phase 1 recovery. I have discussed the idea of transitioning to expert practice, and how communities of practice are believed to influence, for better or worse, the development of expertise in individual practitioners. I have discussed the relationship between nurses and technology and the development of relationships of trust and rationalized desuetude with technology. I have discussed how nurses frustrated with the accuracy of bedside technology, used rationalization and mistrust of technological data to achieve alarm suppression. I have highlighted how these factors can have implications for patient care.

5.6 Marshal McLuhan's Theory and the Tetrad of Media Effects

McLuhan's philosophy and his tool 'the tetrad of media effects' (McLuhan & McLuhan, 2007), has been utilized here as an alternative lens to traditional nursing models and theories to analyze the findings of the current study and consider alternative ways technology could be shaping the PACU environment and the respiratory assessment practices and behavior of nurses.

In this section I will apply the tetrad of media effects to the current study's findings in the PACU environment. McLuhan aimed to provide a causative link between technology and the nature of society. He has been credited with developing the theoretical building block concepts for media ecology (Postman 2012). Media ecology is the study of media, technology and communication, and their effects on human environments. Because of McLuhan's ontological background, he had a strong motivation to preserve human agency. McLuhan (1969) described himself as a humanist. Humanism is a philosophical and ethical stance, which emphasizes the

value and agency of human beings individually and collectively. Essentially, he wanted us to be aware of the subliminal effects of all forms of technology on humans.

McLuhan believed we are inextricably altered and 'unconsciously overwhelmed' by the sensorium of technology. Mouton et al. (2007) similarly described the contextual issues involved in how professionals may or may not pay attention to the information around them and how this affects understanding of the situation. Mouton et al (2007) suggested that it is a basic premise in cognitive psychology that the human cognitive 'space' available for mental activity is limited. Paying attention itself is described as 'an effortful activity' (Kahneman, 1973). It is not surprising therefore that some technical stimuli such as technical alarms may be filtered out to make room for the priorities of our cognitive functioning.

5.6.1 Technical Complexity in PACU

McLuhan saw the invisible effects of the technical sensorium as affecting a "closure of human perception" (McLuhan, 1964). This analogy of closure of perception is useful in interpreting the results of the current study within the '*ground*' effects of the 'Tetrad.' McLuhan's use of '*figure*' described the visible elements of perception, and '*ground*' as the much greater 'contextual' hidden effects. This concept came from Gestalt theories. McLuhan and McLuhan (2007) used the principle of '*figure*' and '*ground*' in the development of the Tetrad of Media Effects, a tool for analyzing media [see Figure 1 & 2] used here to analyze the potential for a closure of nurse's perception to the invisible effects of the technology within the PACU. 'Media' in McLuhan's terms included tools and any technology that altered our environment, from a hand wrench to a system computer, or in modern PACU terms, a stethoscope to a digital capnography machine.

McLuhan's approach was purely focused on media and technology; McLuhan suggested that humans form associations with the technology they interpret. Technical complexity in the PACU environment is certainly vast, with technical equipment and patients' vital signs externalized and displayed on big screens, audible alarms, which follow and converge with other patient's alarms, where-ever the nurse happens to be situated; the potential for a chaotic environment is real. However, PACU nurses in the current study described and presented a well-controlled environment where the technology was controlled and noises effectively suppressed, the nurses appeared to be in control of their environment. In the current study technical alarms were kept to a minimum, stethoscopes (considered technical tools in McLuhan's definition) were actively discouraged in some cases and ($Sp0_2$) monitoring was treated with guarded trust and the respiratory module was frequently treated with rationalized desuetude, similar to McLuhan's 'obsolescence'.

5.6.2 Tetrad of Media Effects in the PACU

Contextual elements were clearly captured in the current findings with *ground* based contextual issues indeed much larger than the '*figure'* section. [See Figure 2]. According to McLuhan and McLuhan (2007) four main criteria need to be isolated for inclusion of a finding: What does the medium enhance? (Amplify or intensify) What does it make obsolete? What does it retrieve that had been obsolesced earlier? And what does it flip into when pushed to extremes?

5.6.2.1 '*Figure*' 1: What does Technology Enhance or Amplify in PACU

Obvious elements within the tetrad are the '*figure*' elements. In the current study the '*figure*' elements that stood out or, in McLuhan's terms, were enhanced, amplified or intensified, included the strongly emphasized trust expressed by PACU nurses, in their *sensory visual manual respiratory assessments*, and their *strong sense of expert nursing practice*. This is

interesting as it is the direct opposite of a strong trust and reliance on technology. This trend suggested a revolution or rejection of technology and included PACU nurses' *desire for matching data* to their sensory assessment of respiration and *using ($Sp0_2$) as a validation* of their sensory assessments.

Technical complexity and super stimulation according to McLuhan, causes humans to form associations with the technology they interpret. Within the current study the PACU culture had formed clearly defined associations for how they managed technology, or expectation of technology performance and these included controlling elements of the technology. One amplified phenomenon described by the participants was the expression of trust in technological data that was perceived to match or validate the PACU nurse's trusted sensory assessments. This trust was based on perceptions rather than any scientific validation process. Illustrations of this included: validating technical respiratory rates with a brief fifteen second evaluation of manual respiration, assessing apnea alarms, based on visual checks of chest movement after the event had occurred, or basing significance of apnea alarms on the degree of desaturation observed irrespective of (0_2) therapy in use. This propensity of the nurses to express a need for trust in technology was clearly important to participants in the study, yet generally participants expressed a significant degree of mistrust of technology.

The PACU culture appeared to sustain these associations with orientation of new staff to the culture. The newer PACU nurses described how their practices, including their approach to technology, had been heavily influenced, and in fact changed, by the culture to conform to the standard approach to respiratory assessment and to control and minimize technological alarms in the PACU, thus as McLuhan predicted forming self-imposed 'associations' or self-rationalized relationships with technology and its data.

PACU nurses could be seen to form of an association with ($Sp0_2$); nurses appeared to have an intensified dependence and reliance on this specific technology as their backup or validation for their manual assessments. If considered as the least alarm fatigue generating module within the bedside technologies, it does fit, as a technology that was used in substitute (amplified) instead of the more invasive alarms perceived to be generated from the respiratory module.

5.6.2.1.1 Ground Elements 1: What does it make Obsolete

The opposite of this '*figure*' aspect, the *ground*, was again larger as predicted by McLuhan and included what appeared to be *Obsolesced or Driven out of Prominence.* Within this section the lack of a full sixty-second respiratory rate count, lack of stethoscope use, and lack of ownership of a stethoscope, along with limited respiratory assessment using full chest auscultation appeared to be obsolete. These findings appeared to fit very well with McLuhan's theory. The lack of use or limited use of the respiratory module, and alarm suppression fits here. Another finding of obsolescence included the lack of use of capnography modules and OSAM monitors in the PACU.

5.6.2.2 '*Figure*' 2: What is retrieved by Technological Effects

The second aspect of the tetrad included the '*figure* focus' of *what is retrieved by technological effects that was previously lost*. Important to consider is the process of how the newer PACU nurses were grandfathered into the culture, through an unofficial orientation process, sometimes with strongly enforced and expressed expectations by the experienced staff. Described by participants, it emphasized the brief manual respiratory rate counts, the emphasis on trusting sensory manual skills, and creating the calm quiet alarm suppressed recovery room environment. This form of orientation is 'old school', and existed in pre-university based nurse

education systems where learning occurred mostly on the job and through mentorship by clinical staff. The achievement of a calm quiet recovery room re-created the atmosphere in the PACU to the era that predates the bedside monitor and environment that high stimulation alarms can cause. However, the age of the participants reflected a span of several generations, therefore it could be suggested that the community and culture of practice was sustained through more than one generation.

5.6.2.2.1 Ground Elements 2: What is Obsolesced

For McLuhan the opposite of the 'figure or easily apparent aspects of technological effects retrieved, were the '*ground or reverse effect'*, '*the aspects of human's being pushed to their limits, flipping into the opposite'*. In McLuhan's tetrad model the contextual *ground* paradigm is always larger. This was certainly true in analysis of the opposite of the figure 1 aspects discussed above. These relatively undetected or less obvious hidden effects included the descriptions from participants of undetected adverse respiratory events as a result of limiting technology or mistrusting it. The general mistrust of technological data was significant. It was also found that in this environment, conflicts and questioning practices with colleagues and coworkers were suppressed and relationships were prioritized over disputed practices, creating undercurrents of frustration, confusion regarding best practice, and sometimes resistance. The participants also demonstrated and expressed limited technical knowledge of bedside technology, suggesting its value was limited, and less prominent in their practice, with attention to its potential discouraged.

Nurses in the current study could be seen to desire the technology to work in harmony and validation with them and when it did not, it was rejected. This phenomenon could be associated with McLuhan's description of the social and psychic extensions or utterings of the

human body or senses, in which technology altered the environment and became an extension of our biology; a diseased process that we attempt to humanize (Kroker, 1995).

To summarize, Marshal McLuhan's insight into the effects of technology was prescient and demonstrates how a technology can interact with the human element to create positive and negative changes in the PACU environment. Davie (2010) describes the discourse presented by Marshal McLuhan as the theory that a society's technology determines its cultural values, social structure, and history as opposed to the more commonly held theory of social constructionism, that society itself shapes the consequences of technology.

From this study's findings it can be interpreted that certainly there are many contextual factors at play in the complexities of PACU culture and its relationship with bedside technology. However, some elements in the community of practice, including the strong opinions and practices of anaesthesia, largely influenced how technology was utilized. It appeared that PACU culture was in fact deeply complex and significantly affected by technology and anaesthesiologist practice. PACU nurses certainly attempted to control technology but did not seem to be aware of the way technology was changing them.

This discussion has shown that, consistent with McLuhan's theory of technical complexity and super stimulation, technology can have negative consequences on humans. The result may be cultural rejection of technology, and efforts to limit its overwhelming effects on the brain to reduce the perceived negativity. I have discussed how the current study's findings show, that there was evidence of technological negative effects, where PACU nurses rejected certain elements of the technology, and made significant efforts to control its overwhelming effects. I have discussed the merger of technology and biology, which McLuhan saw as silent effects. (See Figure 2).

Chapter 6: Recommendations

This study has highlighted nurses' experiences with respiratory assessment and use of technology to assist with respiratory assessment during phase 1 recovery. Based on the findings, the following section presents implications and recommendations for practice, education and future research.

6.1 Practice

Theme 1 described PACU nurses' confidence and trust in a visual sensory respiratory assessment process. Nurses' well-developed sensory respiratory assessments in phase 1 recovery, could be enhanced by integration of reliable assessment tools and advanced respiratory monitoring technology to optimize safe assessments and the detection of respiratory complications. PACU nurses had justifiable concerns regarding the accuracy of their current bedside technological data during the unstable physiological flux phase 1 recovery. It may be advisable to focus on trends, as opposed to single numbers in the rapidly changing phase 1 patient during this period when comparison norms are not useful. Placing value on continuous monitoring trends provides data that informs care and alerts to deteriorating vital signs. Using scoring systems and discharge criteria are suggested in the literature to enhance recognition, response and support the reporting process for patients with clinical deterioration (Street, Philips, Mohebbi, & Kent, 2017).

Theme two described PACU nurses' approach to technology, which included guardedly trusting elements of the technology or rationalizing mistrust of technology. Investment in reliable continuous advanced respiratory monitoring technology, such as a capnography module, may assist the PACU nurses' efforts by significantly improving bedside detection of respiratory dysfunction. Capnography provides reliable continuous respiratory rate, waveform and apnea

event data, as well as continuous end tidal $C0_2$ measurements, to confirm not only increasing $C0_{2,}$ but also effective expiration, and breath-patterns. There is a need to promote methods and protocols for monitoring respiration in early phase 1 that are effective, practical, and support nursing care.

Theme three highlighted the contextual influences, which sustained the visual sensory approach to respiratory assessment. This study's findings suggest that culture and relationships in the community of practice play a significant role in clinical decision-making, and that rapid cognitive decision-making may be replaced by intuitive automatic perceptions of expert practices. The implications of this should be considered in the design of safety and risk management prevention strategies. By involving PACU staff in adverse event reviews and improvement planning following adverse events, undesirable outcomes can be turned into positive catalysts for practice improvements. Sharing such information between PACU's could enhance understanding of the reasons for and value of, safety measures such as accurate continuous monitoring, and ultimately capnography. Critical incident reviews would also enable nurses to share their learned experiences, developing a community of practice with anesthesiologist colleagues, which encourages learning and overcomes the potential for moral distress.

Theme four illustrated PACU nurse's descriptions of adverse events and the barriers to recognising deteriorating respiratory function, using their current respiratory assessment process and technology. Participants in the current study described sometimes scrambling for answers, when their usual routine of relying on sensory assessments resulted in delayed detection of adverse respiratory events. In response to these kinds of concerns, to enhance recognition and response to patients who experienced clinical deterioration, nurses might use a structured

observation response and discharge chart in PACU, such as the Post -Anaesthetic Care Tool (PACT) developed by (Street, Philips, Mohebbi, & Kent, 2017). It was found to reduce rates of clinical deterioration and cardiac events following discharge from PACU, to reduce length of stay and costs. Further, the quality of the observations, accuracy of the continuous technology used, and quality of the communication with anaesthesia colleagues would also appear to be crucial to the success of pre-empting respiratory deterioration.

The current study suggested that variable anesthesiologist practices resulted in confusion and frustration for PACU nurses and in some cases left the PACU nurses feeling unsupported. The variable routine, and lack of a standardized process during OR handover generated some of the frustrations. Integration of anesthesiologist and nursing practice standards, and handover procedures between anesthesiologist and PACU nurses is essential. The current handover procedure appears disjointed, poorly followed, and should be reviewed. For clinical change to occur the deeply intertwined relationship between anesthesiologist and PACU nursing should be recognized, and both professional groups need to meet at the clinical level. Bedside PACU nurses need a platform to engage and learn with their anesthesia colleagues, to develop a better understanding of each other's needs, such as regular joint late start meetings, quality review meetings, advanced life support training, and training in communication and clinical developments.

Reporting manual respiratory rates to the anesthesiologist during the initial handover for documentation purposes is of questionable relevance, accuracy and benefit to the patient. On arrival in phase 1, the emphasis should be on establishing effective airflow and expiration of gases rather than focusing on a manual respiratory rate.

The current study findings suggest that there were limits to the sensory assessment, which in some cases failed to support the PACU nurse with adequate information. These findings highlight the importance of close patient monitoring in the immediate postoperative period, and less reliance on intuitive practice. A more objective and responsive continuous monitoring approach, using advanced respiratory monitoring such as capnography, would give PACU nurses an alternative objective tool to counter the subjective nature of other forms of assessment currently available.

6.2 Education

Findings have several implications for education. Educators, anesthesiologists' and nurse leaders can influence access to, and understanding of, respiratory monitoring technology, in supporting patient's respiratory care and safety during phase 1 recovery, by providing staff development education on equipment and practice standards. PACU nurses' lack of trust in technology indicated that PACU nurses have received limited ongoing education in the optimization of current bedside technology settings and limited access to advanced respiratory monitoring technology such as capnography or OSAM monitors.

Findings revealed a lack of communication between nurses and anesthesiologist about consistent implementation of best practice guidelines and practice standards for the transition from OR to phase 1 care. Communication could be improved with more collaboration, such as PACU nurses' understanding of current evidence-based (0_2) prescribing which is limited and confused by variable anesthesiologist practices with (0_2) in early phase 1. Knowledge sharing between anesthesiologist and nursing could be enhanced thorough more joint educational initiative, such conferences and grand rounds lectures, and development of protocols for (0_2) prescribing in phase 1 recovery. Understanding the culture and community of practice in the

PACU is important for educators and has implications for learning theory. Staff development strategies that enhance mentorship for new staff are recommended with awareness of the significant impact of effective role models, and investment in staff development education and maintenance of engagement and skill development in established staff, to promote true expertise. In clinical practice, understanding social dynamics that affect patient safety and human factors is of utmost importance, in preventing development of alarm fatigue and disregard for alarms, and the value of continuous monitoring which can affect patient safety. Recognition of the existence of the experienced non-expert stage of practice is useful for understanding the level of skill that most nurses achieve in a clinical career.

Findings suggested that although the PACU nurses were aware of the risks of hypercarbia in theory, in practice they lacked knowledge of the significance of low respiratory rates, and frequent periods of apnea, in both rapid onset respiratory dysfunction and the development of insidious hypoventilation and hypercarbia. Educators need to target knowledge of respiratory risk factors in phase 1 recovery and teach methods to optimize the use of continuous monitoring.

6.3 Research

Further work on identifying and defining, concrete practice examples of PACU expert practice and on the benefits of intuitive sensory visual assessments, would be beneficial for rapid response education strategies, and for patient safety initiatives. Research on PACU nurses perceptions of the benefits and potential disadvantages of using capnography in phase 1 recovery would assist its development, in light of the difficulties expressed by participants with current technology. It seems important for future research and practice to identify the frequency of apnea; hypoventilation and hypoxia in phase 1 recovery comparing detection using intermittent manual assessment, and continuous technological monitoring using capnography in PACU.

Further study on the outcomes of brief apnea hypoventilation and hypoxia events during phase 1 recovery would be helpful in clarifying the need for advanced monitoring to detect such events and prevent them.

Repeating a similar study with anesthesiologists would be interesting to evaluate communication with nurses during phase 1 monitoring and the use of technology in phase 1 recovery. It would also be beneficial to research handover practices between the Operating room and PACU.

6.4 Limitations

This study was limited by the interpretations of one field researcher undertaking interviews, with only nine participants, evenly distributed between three Canadian hospitals, two regional centers and one tertiary referral center, all within one health region. This study therefore is most applicable to the region within which the study occurred. As a convenience sample of volunteer participants, it is acknowledged that these participants may have had individual unknown motivations in responding to the study (Kandola, Banner, O'Keefe-McCarthy, & Jassal, 2014), and may therefore not represent the larger population of PACU nurses within the three centers under study. Motivations for participants responding were purposefully not elicited during interviews and therefore remain largely unknown. The findings are specific to this region and the hospitals concerned and should not be generalized to other PACUs, without consideration of local practices and local technology.

As a practicing PACU nurse, working in the same health region, although with no collegial relationship with the participants, the researcher had insider knowledge of the participant’s professional language and held acknowledged bias in understanding the role of the PACU nurse without the participants needing to explain in detail. It was therefore challenging to

step back and take on the role of the researcher and reinterpret participant's accounts with full appreciation for what they were saying, without making assumptions. To counter this risk of insider bias, detailed verbatim transcriptions of the digital recordings were taken and double-checked by the research team for transcription accuracy, and thematic interpretation. Detailed coding and recoding by the research team, to verify interpretations and delete duplications before any analysis was undertaken, followed this. As suggested by Klein et al. (1989) verbal reports or interviews are not a direct window into people's cognitive processes and the interviewees can misrepresent their own decision-making strategies and goals. They suggested minimizing this type of bias by asking for uninterrupted descriptions and refraining from asking why certain actions were taken. In our study, efforts were made to allow a more organic interview, with gentle cues to illicit more detail in some situations. In order to ensure participant comfort, where participant's descriptions remained brief, after gentle probes, further rationale for decision-making was not actively pursued. This was a voluntary interview process not an interrogation.

6.5 Conclusion

PACU nurses' experiences of technology assisted respiratory assessment during phase 1 recovery were investigated using Interpretive Descriptive qualitative methodology. The tetrad of media effects by Marshall McLuhan provided an objective tool for analyzing the findings and situating the findings, the use and control of bedside technology within this PACU culture. The most significant clinical theme to emerge in this study, were PACU nurses' descriptions of delayed detection of adverse respiratory vital signs and their frustrations and barriers to recognising deteriorating respiratory function, using their sensory respiratory assessment process and current technology. This was a concern supported by other researchers and contributors to the literature. Nurses in PACU expressed frustration in their technological resources for

evaluating respiratory volumes or confirming effective expiration. PACU nurses reported being hampered in their inability to detect apnea, hypoventilation and increasing $C0_2$. This often left the nurses feeling that they were making do with inferior technology.

Despite this, and as a compensation for this feeling of inadequate resources, PACU nurses expressed a profound trust and strong emphasis in their manual skills and projected a strong sense of expert nursing practice and a tenuous relationship with current bedside technology. Perceptions of expert practice, the concept of learned expertise, the experienced non-expert, and true expertise have been discussed. Modified procedures and alarm fatigue appear to be threats to expert practice.

An adapted assessment process sustained PACU respiratory assessment culture, this included a method of dealing with bedside technology called guarded trust or rationalized desuetude, and cultural community practices. Technology was rationalized into desuetude, with both stethoscopes and the respiratory module being significantly underused and actively discouraged in some cases. Nurses' guarded trust in technology led to non-evidence based validating behaviors for matching sensory findings to the available technical data and discounting or 'normalizing' abnormal technical data, which did not match expert opinion.

Contextual factors including the nurses' perceptions of inconsistent practices and processes of individual anesthesiologists, sustained a culture where evidence-led advancement in practice with (0_2) administration and effective handover communication were often compromised by prioritizing relationships over best practice.

Final Recommendations of this study will address the four themes that were identified.

1. *Nurses' confidence and trust in a visual sensory respiratory assessment process*

   Mentorship by more experienced and specifically trained nurses to promote and reinforce expert and best practices could be incorporated in the PACU.

2. *PACU nurses' approach to technology, which included guardedly trusting elements of the technology or rationalizing mistrust of technology*

   Addressing this aspect of the culture of the PACU could entail specifically prioritizing education and promoting a questioning environment in a way that doesn't threaten or diminish the importance of relationships. Introducing multi-disciplinary rounds that include respiratory therapists, anesthesia assistants and anesthesiologists could lead to a more shared understanding of the benefits and limits of the technology.

3. *The contextual influences, which sustained the visual sensory approach to respiratory assessment.*

   Development of consistent handover protocol between the OR anesthesiologists and PACU nurses is important for enhanced patient safety. This protocol could include a prioritized assessment of key aspects of respiratory function in early arrival phase 1. The handover protocol could also include clinically relevant assessments of respiratory function on emergence from anesthesia and be patient specific rather than routine. This effort could be supported by interdisciplinary quality improvement initiatives.

4. *PACU nurses' descriptions of the technical challenges recognising deteriorating phase 1 recovery respiratory function, using their current respiratory assessment process and technology.*

This theme highlights the importance of one-on-one education, and case-based learning rounds, where participants feel the environment is safe and their concerns are heard and addressed.

Interestingly, this study of the use of technology in the PACU unearthed findings that can only be addressed through mentorship, education, attention to workplace culture and further research.

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Appendices

Appendix A: Research Introduction

Communication Draft Letter

Dear Colleague

I am writing with a request for your help in disseminating an invitation to your PACU staff about a research study I am conducting as part of a requirement for completion of the MSN program at the University of British Columbia Okanagan. I am seeking to recruit 6 – 10 recovery room nurse volunteers to participate in a research interview (30-40 minutes) regarding their experiences with technology assisted respiratory assessment. I will ensure work sites and patient care are not impacted in any way by this process.

My hope is to make recommendations for practice that will enhance patient safety in Recovery Room Nursing. Results and final papers will be shared with the organisations involved. All participants and organisations will be kept confidential and protected by ethical guidelines approved by both UBCO and Interior health.

Please let me know if you are able to disseminate the attached poster to your recovery room staff. Please feel free to contact me with any questions you may have.

Many thanks

Helen Shannon RN

Graduate Student UBCO and full time PAR Nurse at Interior health.

Appendix B: Consent and Information Form

Title: An Interpretive Descriptive Study 'How Post Anesthetic Recovery Room Registered Nurses'Nurses, Experience Technology Assisted Respiratory Assessment During Phase 1 Recovery'

Principle Investigator:

Kathy L. Rush, PhD, RN

Associate Professor

School of Nursing, University of British Columbia Okanagan

Email: Kathy.Rush@ubc.ca

Co- Investigators:

Contact Person:

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Study Information and Purpose

This research will explore the respiratory assessment experiences of Post Anesthetic Care Nurses in Mid-Western Canadian Hospitals. The purpose of the research is to better understand how recovery room nurses experience and practice respiratory assessment for post anesthesia patients. This study is part of a Master's Thesis in the Faculty of Nursing at the University of British Columbia Okanagan.

Who can participate?

To participate in this research study you must be a registered nurse with a minimum of six months working in a post anesthetic recovery room. There will be six to ten nurses participating in this study.

What does the study involve?

You will participate in an interview where I will ask you open ended questions regarding your experiences, practices, preferences, techniques and perceptions of respiratory assessment in phase 1 recovery. You will be encouraged to give you honest opinions, experiences, perceptions and ideas, and allowed time to expand on your responses. The discussion is planned to take a maximum of an hour . I will be flexible to fit in with work requirements, and to minimize any inconvenience. I will record the interview and take notes. Interviews will be transcribed later as recorded and checked for accuracy in transcription by co-researchers.

Results will be shared through publications and presentations. No identifying information regarding participants will be shared.

Risks

There is obviously a commitment to giving your time, and sharing your experiences, which may potentially raise personal emotional recollections of any particularly poignant or traumatic work experiences you may have had with respiratory complications in PAR. If you are currently experiencing any kind of posttraumatic stress or emotional response to work related experiences you may choose not to participate. Participation is entirely voluntary.

Benefits

One of the benefits of participating in the study may be to increase your awareness of the topic of respiratory assessment; final research will be shared with participants. You will also receive a coffee card in appreciation of your participation in this study.

Confidentiality

A number of measures are in place to keep your identity confidential. The audio recordings and printed discussions will be kept in a locked cabinet and made available only to members of the research committee as listed on the front page of this consent. Once the audio digital recordings are transcribed, the recordings will be double deleted from the digital recorder. The transcriptions will be stored in a password-protected format and will be backed up by a flash drive, kept in a locked cabinet where they will remain for the expected standard time frame of five years. In September 2023 double shredding the paper data, double deleting data from electronic data -bases and burning the flash drive will destroy them.

The printed discussions will use code numbers so no participants can be identified. All documents will be identified only by a code number and kept in a locked filing cabinet. The code book will be kept in a separate locked drawer. The findings of the collected data will be shared with others who study and work with similar areas of practice in healthcare, and will be communicated in written papers and oral presentations.

Short quotes from your interview may be used to provide context to the findings but all identifying information will be removed. We are asking your permission to communicate the findings in this way without personally identifying you. It is anticipated that results from the study will be used to guide future research in this area. If you would like a copy of the report of the findings please include your mailing address in the space provided at the end of this form. You will also be provided with a copy of the signed consent form.

Withdrawal from the Study

Your participation in this study is entirely voluntary and you may choose to withdraw from the study at any time during the course of the study. There is no impact on your employment if you choose not to participate or withdraw. If you decide to withdraw after the interview you may choose to have your data withdrawn from the study, the data will be immediately destroyed if you request it to be. Once the data analysis is complete, contributed data will no longer be able to be withdrawn.

Contact for Information about the Study

If you have any concerns, questions or would like further information about the study, please contact Dr. Kathy Rush at (250) 807-9561 or by e-mail:.

Or Helen Shannon (778) 214-4662 or by e-mail: helen.shannon@interiorhealth.ca

Contact for Concerns about the Rights of Research Participants

You have the right to ask questions, and have those questions answered. If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Services at 1-877-822-8598 or the UBC Okanagan Research Services Office at 250-807-8832. It is also possible to contact the Research Participant Complaint Line by email (RSIL@ors.ubc.ca). You may also contact the Chair of the Interior Health Research Ethics Board through the Research Office at (250) 870-4602 or researchethics@interiorhealth.ca.

Research Introduction

Dear colleague the interview process is designed to allow you to freely respond to the researcher. You responses are highly valued and totally confidential, feel free to add any further thoughts at the end of the interview if you feel you have anything to share, or that you would like to highlight or thoughts to express on the subject of respiratory assessment.

The aim of this research is to explore PAR/Recovery/PACU nurses experiences of respiratory assessment in phase 1 recovery in PAR/Recovery/PACU and identify themes and commonalities in the responses in order to make recommendations for practice generally. No hospital, PAR/Recovery/PACU Nurse will be identified in the process of this research. The response process will not identify you to the researcher or to any organization. Your responses will be literally transcribed in their entirety and data will be kept confidential, no individuals, or organizations will be named or otherwise identified.

Appendix B: Consent

Consent

Your signature below indicates you have received a copy of this consent form for your own records and have read the preceding information on the research and your participation.

Permission to record interviews **(initial)**

Do you agree to have short quotes used in disseminating the information gathered from the study? [ ]

YES [ ] NO

Your signature indicated that you consent to participate in the study

Participants Signature Date

Printed Name of the Participant

Witness Signature

Printed Name of the Witness

Address or email of Participant (*Optional if you would like a copy of the Study Results*

Thank you for your participation

Keep Carbonated Copy **Original to Participant**

Appendix C: Participant Demographics

Participant Demographics **Participant Code**

1) Highest level of Education in Nursing

[ ] Certificate in Nursing

[ ] Diploma in Nursing or Associate Degree in Nursing

[ ] Bachelor's Degree in Nursing

[ ] Masters in Nursing

[ ] Other please clarify

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2) Specialty Education?

[ ] YES [ ] NO if yes please explain;

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3) Years of Experience in Nursing:

[ ] < 2 [ ] 11 – 15

[ ] 2- 5 [ ] 16- 20 years

[ ] 6 – 10 [ ] > 20

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4) Years of experience in Post Anesthetic Nursing

[ ] < 2 [ ] 11 – 15

[ ] 2- 5 [ ] 16- 20 years

[ ] 6 – 10 [ ] > 20

5) 8) How often do you care for an adult patient in early phase 1 recovery after the anesthesiologist leaves the bedside, that is unconscious with an LMA or Endotracheal airway in situ, [ ] never, [ ] daily, [ ] more than daily, [ ] weekly, [ ] less than weekly

6) If you have a patient in early phase 1 with an LMA or ET tube in situ how long can they take to wake and be ready to extubate in your experience, for example a few minutes [ ] , ten minutes, [ ] fifteen minutes,[ ] sometimes longer?[ ]

7) How often do you find you need to provide airway support such as a jaw thrust or chin lift, or t- piece (02) to an LMA in the early phase 1 recovery for example daily, [ ] more than once a day [ ] , once a week [ ] , rarely,[ ] never [ ].

8) How frequently do you count a respiratory rate manually during phase 1?.....

9) How Many Recovery Rooms have you worked in?

Appendix D: Interview Template

10 Question Interview Template.

1) Perceptions of Respiratory Assessment by Nurses in Phase 1 Recovery

Tell me about your experiences of what it is like doing a respiratory assessment when your patient arrives in the recovery room during phase 1 recovery?

- Probe: **What** have been some of the challenges? **What** assists you? Does the use of technology enhance your assessment? **Does** the use of technology impede your assessment in any way? **Has** your approach changed over time for any reason? Are there any skills or techniques or equipment you used to use that you no longer use for any reason?

2. Use of Technology or not during Current Respiratory Rate Assessment PACU

Describe how you obtain a respiratory Rate assessment when receiving an adult patient from the operating room?

- Probes: Tell me step-by-step your process for obtaining a respiratory rate? **Do** you ***manually*** calculate respiratory rate while receiving your adult patient from the operating room? If so…. how many seconds do you manage to manually count a respiratory rate for to calculate the rate per minute? ***What*** do you prefer to count during the count? **For** example chest movement, abdominal movement, condensation on the (02) mask? ***How*** do you count? Visual? Your hand? A stethoscope?

3). Influence of Technological Alarms on Nursing Practice in PACU

What are your thoughts on bedside monitor alarms in phase 1 recovery?

- Probes: **what** have been some of the more common causes of the alarms you've experienced? **Can** you talk about the (02) desaturation alarm (Sp02) during a typical day in the recovery room? **Talk** about how your use of the bedside monitors respiratory alarm settings (e.g., use preset default or change any settings)? **When** would you change the settings? **Are** there unit expectations for the using and setting the alarms**? Do** you or your colleagues ever choose to turn off respiratory related alarms on your patient's bedside monitor for any reason?

4. Use of (02) in the PACU

What is your experience with the use of (02) for an adult patient in phase 1 recovery?

- Probe: **Talk** about when and why it has been used? **Is** there a consistent practice? Has anything changed? **When** do you typically apply (02) in phase 1? **Why** do you think this is?

5. Confidence in detecting hypoventilation and hypoxemia in PACU

Can you describe a situation that sticks in you mind where you may have felt unsure if your adult patient in phase 1 recovery was breathing effectively enough, despite normal parameters including adequate colour, respiratory rate and (Sp02) on the bedside monitor?

- **Probes: Did** you feel any anxiety in attempting to assess respiratory function? **What** interventions do you use in this situation? **Did** you find technology helped in this situation? Did you find technology hindered in any way in this situation? What are the ways you find most reliable to detect and confirm hypoventilation?

6. Awareness of the latency of Sp02 technology in detecting hypoxemia, and the transient effect of stimulation on the respiratory rate of someone with medication induced respiratory depression or OSA.

If you are busy admitting your second phase 1 adult patient. What would you think or do if your other patient, a resting later phase 1 patient has an (Sp02) of 98% with o2 at 3 liters via nasal cannula and the respiratory wave form on the monitor is repeatedly alarming apnea. Each time you respond to the alarm you observe that they appear roused and breathing, and the monitor shows a rate of > 9 Breaths per minute with a visible respiratory waveform on the monitor?

7. Current Practice with Technology assisted OSA Prevention in PACU

If an adult patient has a postoperative anesthetic or surgical order for sleep apnea (OSA) monitoring do you need to take any additional measures or precautions during phase 1 recovery according to your hospital protocols, or is this something that only happens on phase 2 ward transfer please describe. Do you use any special equipment for OSAM patients? Are OSAM patients flagged on arrival in PACU/PAR? Are OSAM patients seen frequently?

8. Adoption of New Technology: Capnography in the PACU

Talk about your experiences, if any with using capnography monitoring in non vented adult patients in phase 1 recovery.

- Probe: **Can** you describe a specific situation, where you have used Capnography? Does capnography assist you in monitoring phase 1 adult patients? **And** if so how? **Do** you consider that you have easy access to Capnography equipment in PAR/ Recovery for monitoring capnography in non-vented patients? **Do** you have a recovery room practice standard or policy for use of capnography?

9. Knowledge of Respiratory Complications in PACU

Describe what you understand by the terms hypercarbia? or hypercapnea?

10. Current satisfaction with Technology in the PACU

If we could grant you a wish, is there any part or functions of the bedside monitoring technology that you would change?

- Probe: For respiratory assessment in PACU, **how** do you think bedside monitoring technology could be improved to make your role easier in phase 1 recovery?

Thank you

Appendix E: Research Poster

Your Experience as a PAR/PACU Nurse is Very Valuable

Do you have six months experience as a PAR/PACU Nurse? Would you like to contribute to nursing research? We would love to hear from you!

This research will explore the respiratory assessment experiences of Post Anesthetic Care Nurses The purpose of the research is to better understand how recovery room nurses experience and practice respiratory assessment for post anesthesia patients.

How Post Anesthetic Recovery Room Nurses Experience Technology Assisted Respiratory Assessment During Phase 1 Recovery

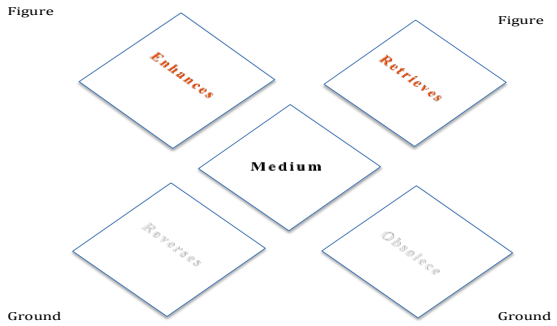
By Helen Elizabeth Shannon

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER OF SCIENCE IN NURSING in The college of Graduate Studies THE UNIVERSITY OF BRITISH COLUMBIA (OKANAGAN)

If you wish to participate Email me the researcher at **helen.shannon2@interiorhealth.ca** to arrange a 1 hr. max interview, the researcher will visit you at your convenience. Interview times will be flexible to fit in with work requirements and will be conducted on evenings, weekends or night shifts. All data collected will remain 100% confidential; no personal identifiers will be used to describe participants, units or hospitals.

An honorarium in the form of a coffee card will be provided for your time and efforts.

Figure 1: Tetrad of Media Effects Defined



Tetrad of media effects

1) What does the medium enhance? (amplify or intensify) - ***figure*.**
2) What does the medium make obsolete? (drives out of prominence) ***-Ground*.**
3) What does the medium retrieve that had been obsolesced earlier? (what is recovered which was previously lost) ***-Figure***
4) What does the medium reverse or flip into when pushed to its limits? ***Ground*.**

***Figure*:** Something that grabs our attention, is focused on, engages us, or a perception.

Ground: Something that supports or contextualizes a situation and is usually an area of inattention, unintentionally ignored, blocked out, disregarded, environment, or background.

Adapted by the author from: https://en.wikipedia.org/wiki/Tetrad_of_media_effects.

and http://collectionscanada.gc.ca/innis-mcluhan/030003-2030-e.html retrieved 2018-01-24

Figure 2: The Use and effects of Technology in the Post Anesthetic Respiratory Assessment Applying The Findings to McLuhan's Tetrad of Media Effects.

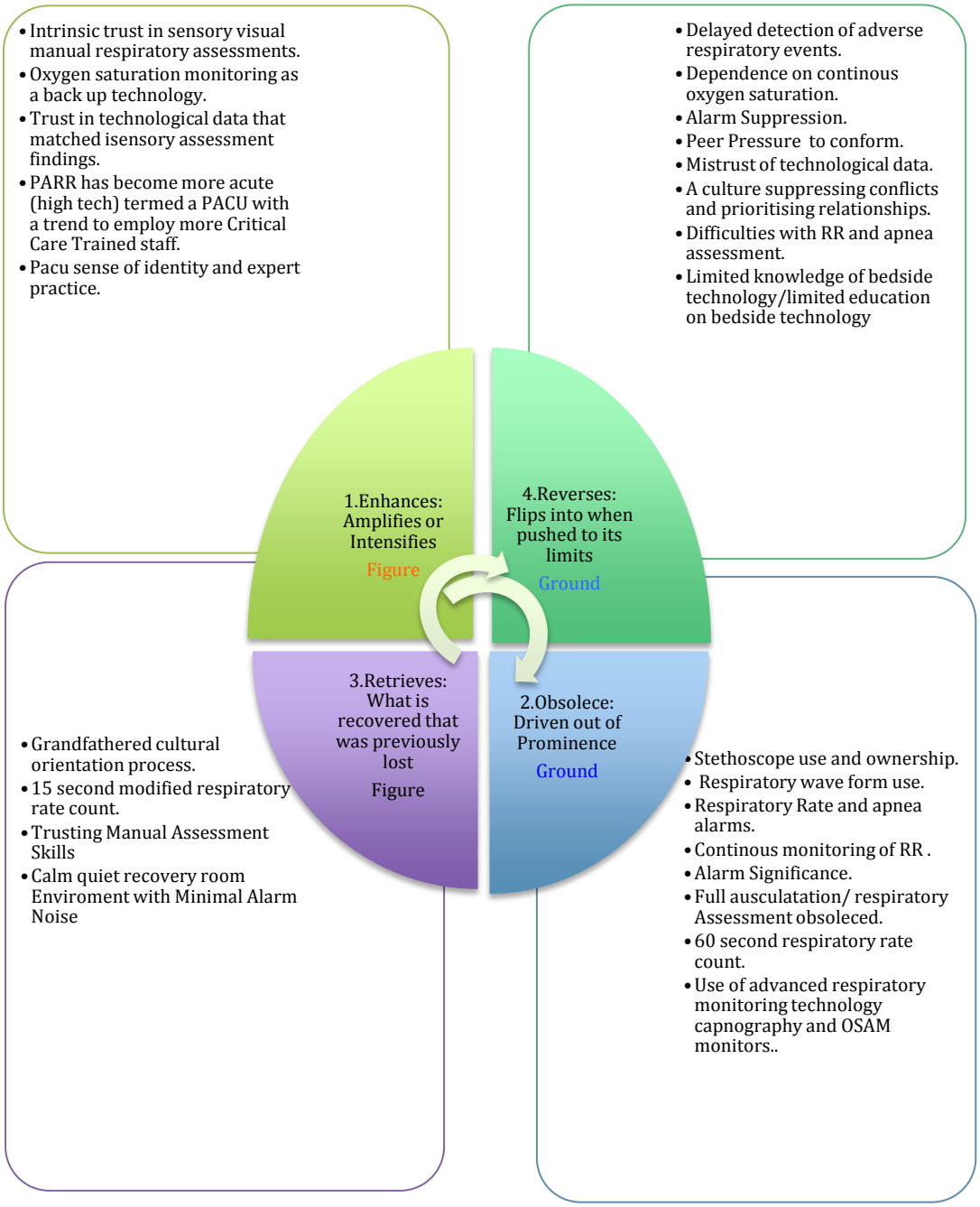


Figure 3: Demographic Characteristics of Study Participants

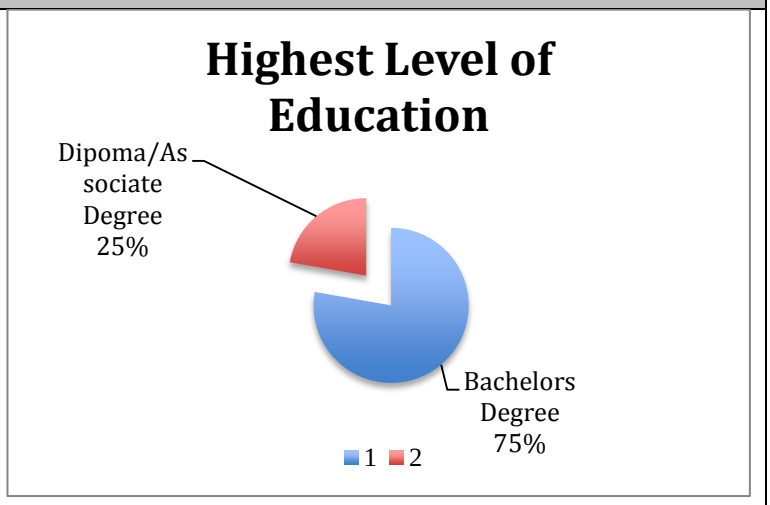
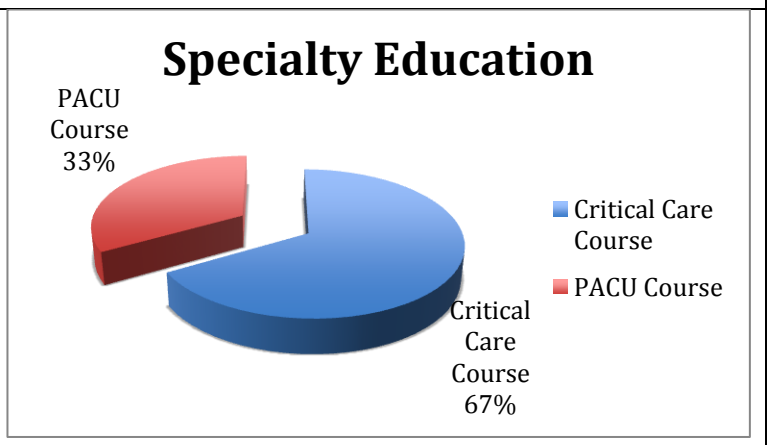
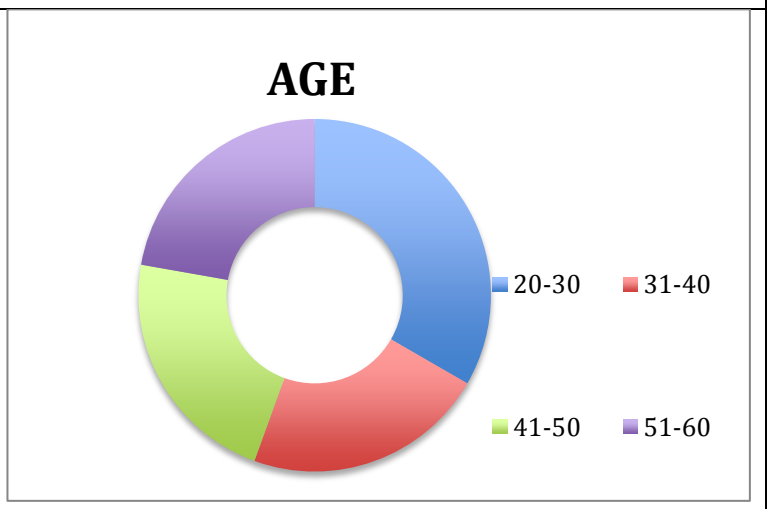
Characteristics	Participant (n)	Finding
Highest Level of Education Certificate in Nursing Diploma in Nursing or Associate Degree in Nursing Bachelor's Degree in Nursing Master's in nursing Other please clarify	2(Dip) 7(BSN)	
Specialty Education **Critical Care Course** **Post Anesthetic Care Unit Course** **Other** **None**	6 (Critical Care Course) 3 (PACU Course)	
Age	20- 30=3 31-40 =2 41-50 =2 51-60 =2	

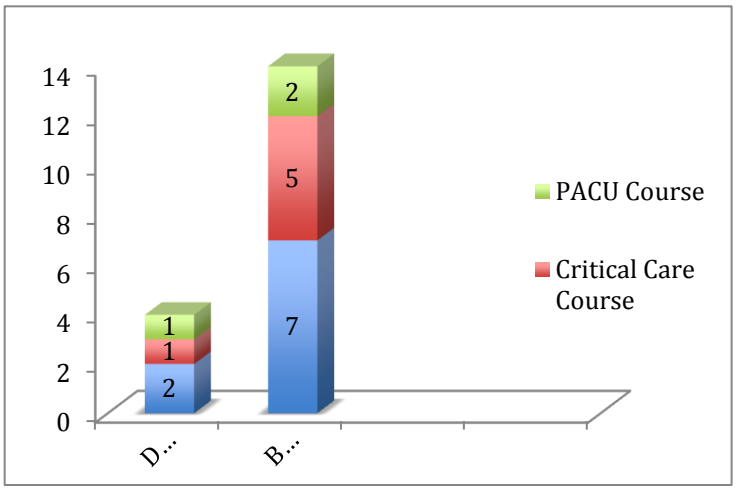
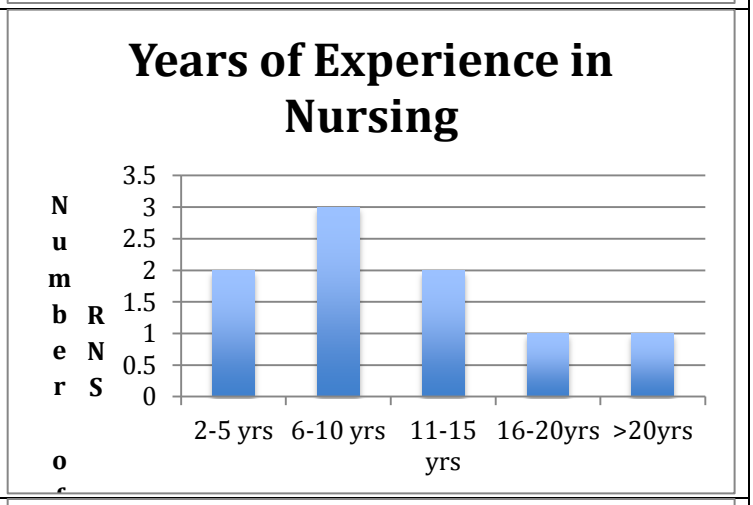
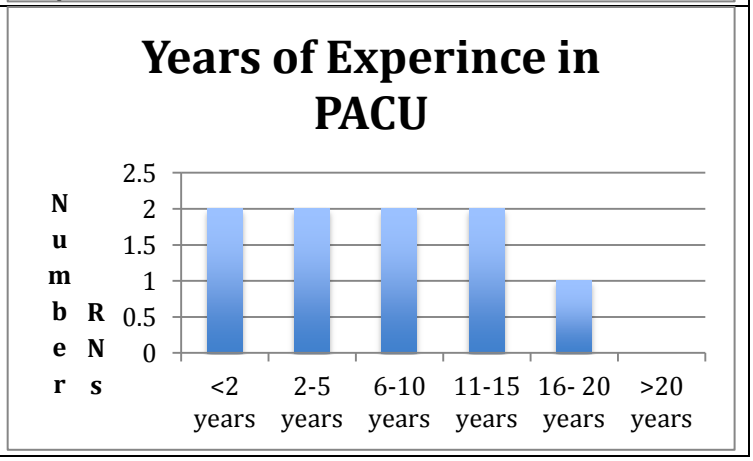
Figure 3: Continued		Demographic Characteristics of Study Participants
Characteristics	**Participant (n)**	**Finding**
Highest level of General Nursing education compared with Nurses Level of Specialty Education	Diploma with Critical Care Courses= 1 Diploma with PACU Courses=1 Bachelors with Critical Care Course= 5 Bachelors with PACU Course= 2	
Years of Experience in Nursing **2-5** **6-10** **11-15** **16- 20** **>20yrs**	2 (2-5yrs) 3 (6-10Yrs) 2 (11-15Yrs) 1 (16-20yrs) 1 (>20yrs)	
Years of Experience in Post Anesthetic Nursing **<2** **6-10** **11-15** **16-20**	2<2 1(2.5yrs) 2(6-10) 2(11-15) 1(16-20yrs)	

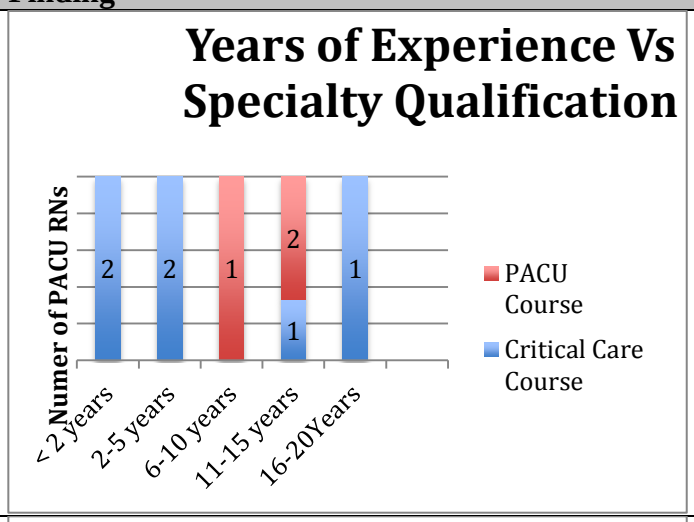
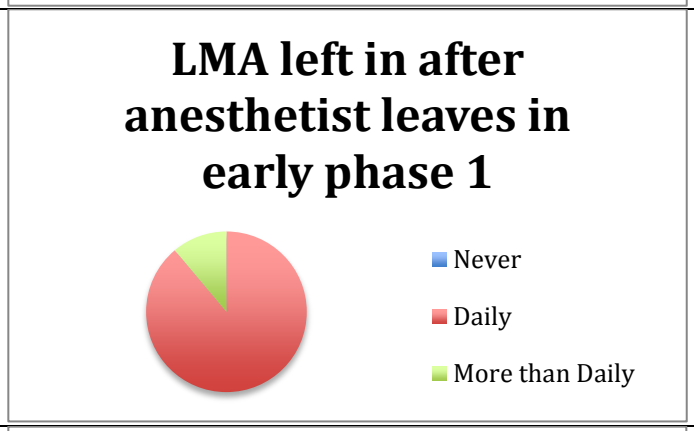
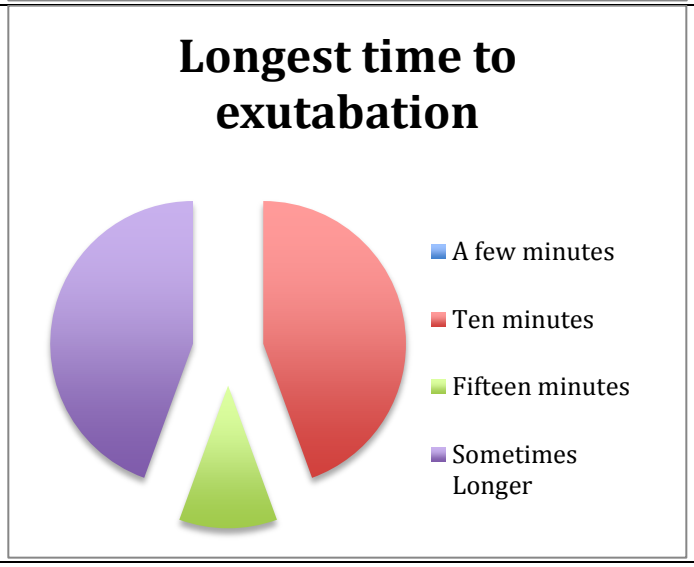
Figure 3: Continued		**Demographic Characteristics of Study Participants**
Characteristics	**Participant (n)**	**Finding**
Years of experience in PACU nursing compared with Specialty education	<2 years With Critical Care Certificate = 2 2-5 years with Critical care Certificate = 2 6 -10 with a PACU Certificate =1 11-15 with a PACU Certificate =2 11- 15 with Critical Care Certificate =1 16 – 20 years with Critical Care Certificate =1	
How often do you care for an adult in early phase 1 recovery after the anesthesiologist leaves the bedside, that is unconscious with an LMA or Endotracheal Airway in Situ: **Never** **Daily** **More than daily** **Weekly** **Less than Weekly**	8 (daily) 1 (More than daily)	
If you have a patient in early phase 1 with an LMA or ET tube in situ how long can they take to wake and be ready to extubate in your experience, for example **A few minutes:** **Ten minutes:** **Fifteen minutes:** **Sometimes longer:**	4 (ten mins) 1 (15 minutes) 4 (sometimes longer)	

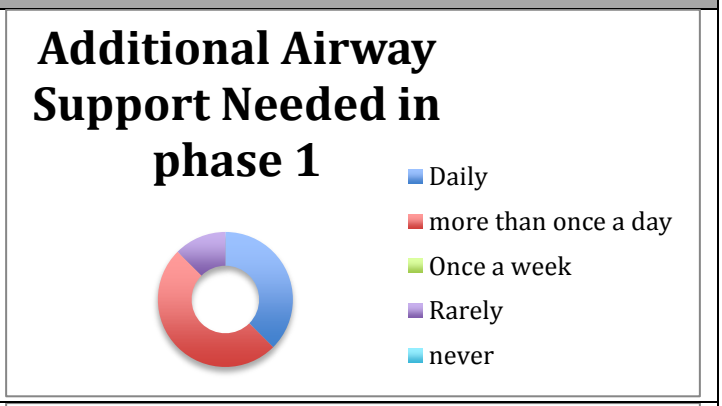
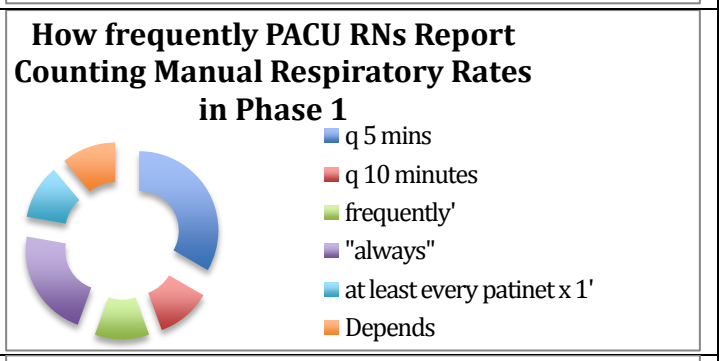
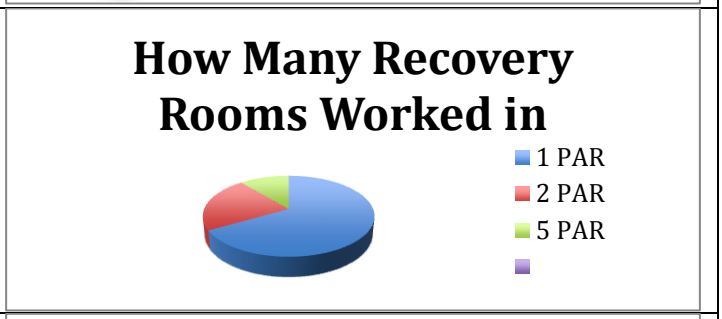
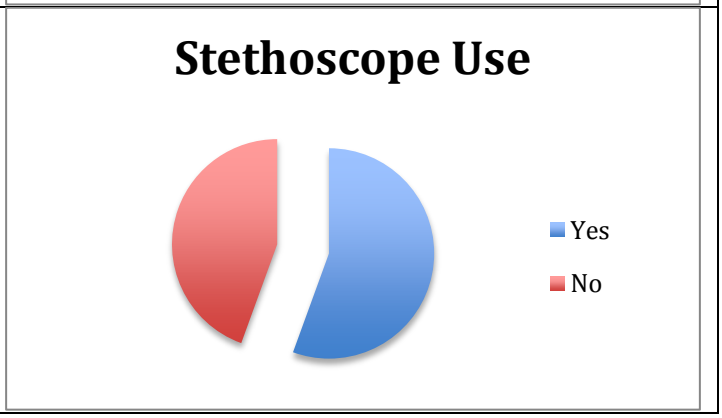
Figure 3: Continued		**Demographic Characteristics of Study Participants**
Characteristics	**Participant (n)**	**Finding**
How often do you find you need to provide airway support such as a jaw thrust or chin lift, or t-piece (02) to an LMA in the early phase 1 recovery for example: **Daily** **More than once a day** **Once a week** **Rarely** **Never**	3 (daily) 0 (once a week) 1 (rarely *('x 1 month')* 4 (more than once a day)	
How frequently do you count a respiratory rate manually during phase 1? **Q 5 min**	1 *("frequently")* 2 ("*always"*) 3 ("q5 min's") 1 ("q10 min's") 1 ("*at least every patient x1"*) 1 ("this *depends on patients' respiratory status. Q minute if there are problems. Q 5 minutes until aware. Then Q 10 minutes or more frequently if there are problems*	
How many recovery rooms have you worked in? **1** **2** **3**	6 (1 PACU's) 2 (2 PACU's) 1 (5 PACU's)	
Use of a Stethoscope	P 1 = No P 2 = Yes P 3 = Yes P 4 = No P 5 = No P 6 = No P 7 = Yes P 8 = Yes P 9 = Yes	

Figure 3: Continued		**Demographic Characteristics of Study Participants**
Characteristics	**Participant (n)**	**Finding**
Participants Demographics	P (1)	P (1) Diploma in Nursing or associate degree. Specialty Education PACU Course 16-20 years experience in Nursing 11-15 years in Post Anesthetic Nursing Age 42 .....Has worked in 2 recovery rooms
	P (2)	P (2) Bachelors Degree in Nursing Specialty Education: PACU Course Years of Experience in Nursing 11-15 years Years of Experience in Post Anesthetic Nursing 11-15 Age 43 Has worked in 2 recovery rooms
Participant Demographics	P (3)	P (3) Bachelors Degree in Nursing Specialty Education: Critical Care Course Years of Experience in Nursing 2 – 5 Years of Experience in Post Anesthetic Nursing < 2 Age 28 Has worked in 1 Recovery Room
	P (4)	P (4) Diploma in Nursing Or Associate Degree Specialty Education: Critical Care Course Years of Experience In Nursing > 20 Years of Experience in Post Anesthetic Nursing 16-20 Age 56 Has Worked in 1 Recovery Room
	P (5)	P (5) Bachelors Degree in Nursing Specialty Education: Critical Care Course Years of Experince in Nursing 11- 15 Years of Experience in Post Anesthetic Nursing 11-15 Age 35 Has worked in 2 Recovery Rooms
	P (6)	P (6) Bachelors Degree in Nursing Specialty Education: Critical Care Course Years of Experience in Nursing 6-10 Years of Experience in Post Anesthetic Nursing 2-5 Age 32 Has worked in 5 Recovery Rooms
	P (7)	P (7) Bachelors Degree in Nursing Specialty Education: PACU Course Years if Experience in Nursing 6-10 Years of Experience in Post Anesthetic Nursing 6-10 Age 51 Has Worked in 1 recovery room
	P (8)	P (8) Bachelors Degree in Nursing Specialty Education: Critical Care Course Years of Experience in Nursing 6-10 Years of Experince in Post Anesthetic Nursing <2 Age 25 Has worked in 1 Recovery Room
	P (9)	P (9) Bachelors Degree in Nursing Specialty Education: Critical Care Course Years of Experience in Nursing 2-5 Years of Experience in Post Anesthetic Nursing 2-5 Age 26 Has worked in 1 Recovery Room

Figure 4: Respiratory Assessment Process Flow Diagram