Medication & Ventilation Errors during Respiratory Therapy in Intensive care

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Research abstract

Patient safety is a core goal of health care. ICU patients are more prone to medical errors than other patients due to their critical condition, the use of high-tech devices like mechanical ventilation, and the fast-paced decision-making environment (Valentin 2007). Medical errors have been studied by a variety of specialties' point of views including anesthesiologists, pharmacists and nurses, however medical errors in the area of Respiratory Therapists' practice have not been investigated. To my knowledge, this is the first research to study ICU medical errors from the respiratory therapy perspective.

The aims of this study are:

1. To observe and investigate the prevalence of medical errors in the ICU setting from the respiratory therapy viewpoint.
2. To gain the perception of ICU staff and respiratory therapists of safety culture, medical errors, causes, and solutions through a qualitative study.

The research was conducted in two phases: in phase I, a cross-sectional a safety attitude study was used. Followed by a prospective, observational study conducted in two ICUs with total capacity of 50 beds, and 22 semi-structured interviews with respiratory staff from the observed ICUs. In phase II, a qualitative (In-depth interview & job satisfaction) study of ICU staffs' perceptions of medical errors, causes, and solutions was conducted.

To establish a baseline for safety culture in the studied ICUs, a Safety Attitude Questionnaire (SAQ) was used. The overall participants SAQ score was 52.8%, which is considered negative. In addition, the findings showed that 79.2% of the respondents had not reported any incidents in the last 12 months. The result of the study showed unsatisfactory levels of safety culture among healthcare staff in these two ICUs. The importance of this study is to establish a baseline for

safety climate in these hospitals and specifically in ICUs. In addition, by exposing system weaknesses it helps the administration strengthen and improve patient care.

To identify the types and prevalence of common incidents that occur during respiratory therapy in ICU and its relation to patients' characteristics, an observational study was conducted in two adult ICUs in two main hospitals in the Eastern Region of Saudi Arabia. The two main hospitals have a total capacity of 759 beds and a total of 50 adult ICU beds. Most ICU admissions were for medical and surgical reasons. Data were collected over a period of 65 days between April and June 2019. Out of a total of 341 ICU admission, *n=58* (17%) patients were exposed to respiratory-related medical incidents. The total rate of incidents per 1000 patient-days was 118.9 incidents. The total number of incidents during the observation period was 289 incidents. Among these incidents, 42.9% were related to infection control and documentation errors (Miscellaneous errors), and 38.4% were airway related. The most common incidents that occurred during respiratory therapy were documentation errors 27.3%, followed by infection control 11.8%, then 11.4 % of incidents were due to inappropriate pressure of endotracheal tube (ETT) cuff. The findings of this study will help the respiratory therapy management understand the types of medical errors that occur during respiratory therapy in ICU and therefore develop a targeted approach for preventing further errors with the same nature from happening in the future.

22 Semi-structured interviews were conducted to explore further the most common errors that occur during respiratory therapy in ICU, participants' understanding of these medical incidents, the contributing factors, and patient safety. Interviews were conducted on-site during a convenient time for each of the participants. Interviews were conducted between May and June 2019 and lasted between 15 to 25 minutes. The findings of this study showed an existing level of job dissatisfaction among respiratory therapists. In addition, the lack of proper supervision was the main reason for the decrease in work quality and poor safety culture. Participants avoided

reporting incidents due to the fear of consequences. Results suggest the need for customized safety approach and feedback to respiratory therapists around the processes of reducing medical errors to ensure improvement in patient care within the ICU.

The semi-structured interviews data also indicated that staff's lack of motivation and not following hospital policies were a keys factors in staff committing errors. To further investigate this statement, job satisfaction was measured by using the Minnesota Satisfaction Questionnaire (MSQ) to evaluate the satisfaction level among the staff of the respiratory care department in both hospitals. Over half of the respiratory therapists (65%) had an average level of overall job satisfaction. Furthermore, staff's years of experience, gender, and age didn't affect job satisfaction. However, there is a difference in job satisfaction between respiratory therapists and respiratory administrators; managers and supervisors scored a higher level of job satisfaction than respiratory staff, especially with regard to extrinsic job satisfaction and general job satisfaction. These findings generate the need for further investigation into the level of extrinsic, intrinsic, and general job satisfaction among respiratory therapy departments. This study will help the administration understand the department's staff needs and resources they require to provide better practice.

Finally, to obtain a better understanding of ICU working conditions, safety culture, medical incidents, contributing factors, and how to improve the system, 20 in-depth interviews were carried out, with 6 physicians, 6 nurses, and 12 respiratory therapists. The interview schedule was developed from the findings of the studies in phase 1, focusing in-depth on errors during respiratory therapy in ICU. Various barriers and issues were identified by the participants which they believed had led to these incidents such as lack of training /education, lack of supervision, lack of future job development and the absence of job recognition, and poor teamwork in ICU. In this study, we found that Improving Intra departments communications, better supervision, clear protocols, supportive management, staff recognition, continuous education and training sessions,

non-punitive reporting system, and establishing a reward system for the reporting staff, would increase the quality of patient care and improve staff attitude towards safety culture.

The data from these studies shows multiple challenges to improve safety culture such as lack of incidents reporting, lack of management support and planning, and teamwork and communication difficulties. To improve safety and quality of services in healthcare organizations, periodical assessment of safety culture is considered an essential element for this process. Achieving better outcomes and improving quality after applying an improvement plan is expected. However, maintaining high levels of quality and safety require continuous monitoring, better supervision, frequent assessment, and annual reports and recommendations. Inter and intra department communications should be encouraged and more open. Teamwork and leadership should be strengthened and supported.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification.

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"*Praise be to Allah, the Cherisher and Sustainer of the worlds; Most Gracious, Most Merciful; Master of the Day of Judgment. Thee do we worship, and Thine aid we seek. Show us the straight way, the way of those on whom Thou hast bestowed Thy Grace, those whose (portion) is not wrath, and who go not astray*" Holy Quran: chapter 1 verse 1-7

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Scientific participations and publications during my study at the University of Nottingham

- Hot Topics in Pediatrics conference, March 2019, Saudi Arabia
- Airbase hospital Research symposium, April 2019, Saudi Arabia
- ePoster presentation, June 2020, CHEST Virtual Congress 2020
- ePoster presentation, August 2020, ERS Virtual Congress
- Division of Clinical Neuroscience Research Day 30th of Oct 2020 at university of Nottingham

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List of abbreviations

Abbreviation	Meaning
A/C	Assist Control Mode
AARC	American Association for Respiratory Care
AC/PC	Assisted-Controlled/Pressure-Controlled ventilation
ACSNI	Advisory Committee on the Safety of Nuclear Installations
AHRQ	Agency of Health Care Research and Quality
CBAHI	Central Board for Accreditation of Healthcare Institutions
CT	Computerized Tomography
CVC	Central Venous Catheter
ER	Emergency Room
ETT	Endotracheal Tube
HME	Heat and Moisture Exchanger
HSC	Health and Safety Commission
ICU	Intensive care units
JCI	Joint Commission International
LOS	Length of Stay
MD	Doctor of Medicine/physicians
MDI	Meter Dose Inhaler
MSQ	Minnesota Satisfaction Questionnaire
MV	Invasive Mechanical Ventilation
NCC MERP	*National Coordinating Council for Medication Error Reporting and Prevention*
NHS	National Health Service
NIV	Non-Invasive Ventilation
NRLS	National Reporting and Learning Systems
OR	Operating Room
PRVC	Pressure Regulated Volume Control
PVA	Patient-Ventilator Asynchrony
QuIC	Quality Interagency Coordination Task Force
RN	Registered Nurse
RT	Respiratory Therapist
RTA	Road Traffic Accidents
SAQ	Safety Attitude Questionnaire
SEE	Sentinel Events Evaluation
SIMV/PC	Synchronized-Intermittent-Mandatory-Ventilation/Pressure-Controlled
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
US	United States
VAP	Ventilator-Associated Pneumonia
Vt	Tidal Volume
WHO	World Health Organization

Chapter 1: Literature review

Introduction

Patient safety, prevention of medical error, and quality of care are important aspects of health care. The importance of these fields has led to an expansion in literature and research in recent years. As in any other profession or industry such as engineering, aviation, or nuclear plants, human factors play an important role in the generation of medical errors (J. Reason 2000). One of the earliest studies that addressed medical error by highlighting the incidence of adverse events and negligence was the Harvard Medical Practice Study. In this study, around 28 percent of the adverse events were due to negligence and around 70 percent of adverse events were avoidable (Brennan et al. 1991). Furthermore, it was estimated that a minimum of 44,000 deaths in the United States was the result of medical errors that could have been prevented (Kohn, Corrigan, and Molla 1999). Moreover, in a more recent study done at Johns Hopkins University, it was estimated that more than 250,000 people in the U.S. die every year from medical errors. This high number of deaths makes medical errors the third leading cause of deaths in the United States (Makary and Daniel 2016). In addition, it was estimated that the annual costs of medical errors were between $17 billion to $29 billion (Kohn, Corrigan, and Molla 1999). These publications raised awareness among the general public, health care practitioners, and hospitals about the quality of health care that was being provided, and encouraged health care providers to develop tools to measure the quality of health care (Garrouste-Orgeas et al. 2012; Weingart et al. 2000).

To reduce medical error and improve patient safety, a clear definition of medical error was necessary to establish. Several definitions have been applied to patient safety incident and medical errors. The literature doesn't provide distinct difference between medical errors and medical incident definitions, moreover, they used these terms interchangeably. The World Health Organization (WHO) defined patient safety as the prevention of harm and avoidable adverse effects on patient's health care (World Health Organization 2012). National Reporting and Learning Systems (NRLS) define patient safety incident as " any unintended or unexpected

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incident, which could have or did lead to harm for one or more patients receiving care" (Great Britain. National Audit Office 2005). On the other hand, in *To Err is Human*, the Institute of Medicine defined medical error as: "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (Kohn, Corrigan, and Molla 1999). The Quality Interagency Coordination Task Force (QuIC) report further expanded the medical error definition as: "the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Errors can include problems in practice, products, procedures, and systems."(Schulman and Kim 2000). In summary, incident could be described as the comprehensive result of what happened, i.e. the patient airway was blocked with mucus plugs. Error is the specific mistake i.e. the respiratory therapist didn't check or suction the patient airways. Throughout our study, we will be using the terms error and incident based on the above definitions.

Medical error as a definition explains the failure of planned action in the medical field but it does not fully express their consequences. These consequences are divided and subdivided into various scenarios. One of these divisions can be described as a medical error that occurs and leads to no harm to the patient either by chance or because it was prevented by someone. This event is called a near miss (Great Britain. National Audit Office 2005), and if the medical error resulted in harm or injury to the patient that could have been prevented it would be labeled as an adverse event (Ahmed et al. 2015). However, if an adverse event led to death, permanent harm, or severe temporary harm, it would be called a sentinel event (**Figure 1**) (Joint Commission 2018).
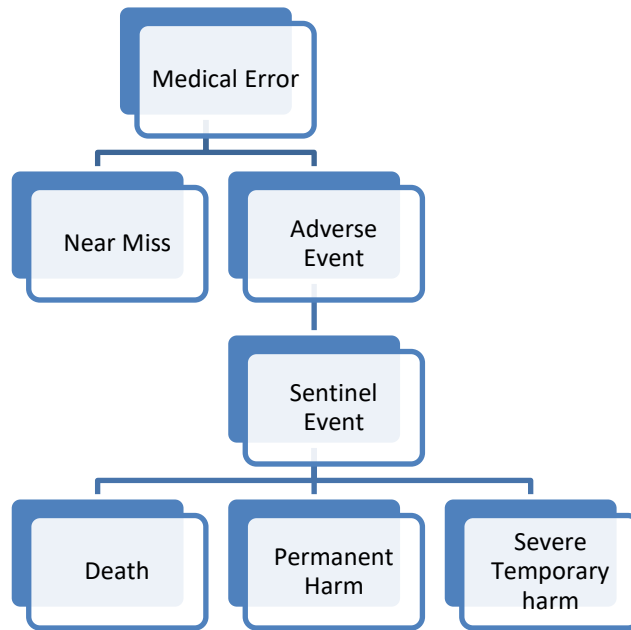
Figure 1: Medical error consequences.

Classification of medical errors

Whenever a medical error is mentioned, many healthcare providers focus on medication-related errors such as wrong medication, incorrect dosage, or incorrect administration of medication. However, medication related errors are only one type of medical error. There are many other types of medical errors which can be further categorized based on severity, setting, or by types of individuals involved (Vozikis and Riga 2006). In 1993 a proposed classification by Leape suggested to categorize medical errors into four major categories: Diagnostic such as misdiagnoses, Treatment such as an error in administration or dose, Preventive such as inadequate monitoring or follow up treatment, and Others such as equipment failure (L. L. Leape et al. 1993). In 1998, the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) categorized medication errors based on severity to four main sections which could be divided to nine categories as summarized in **Figure 2** (National Coordinating

Council for Medication Error Reporting and Prevention 1998).


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                          ┌─────────────────────┐
                          │  Medication Error   │
                          └─────────────────────┘
        ┌──────────────┬───────────┴──────────┬──────────────┐
  ┌──────────┐  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐
  │ No Error │  │ Error, No Harm│  │ Error, Harm  │  │ Error, Death │
  └──────────┘  └──────────────┘  └──────────────┘  └──────────────┘
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Category A: events that have the capacity to cause error.

Category B: error occurred but didn't reach the patient.

Category C: error occurred and reached the patient but didn't cause harm.

Category D: error occurred and reached the patient but required monitoring to confirm that there was no harm.

Category E : temporary harm required intervention

Category F: temporary harm required prolonged intervention.

Category G: perminent harm.

Category H: harm required intervention to sustain life.

category I: error occurred and resulted in patient's death.

Figure 2: Classification of medication errors.

Medical error epidemiology

A medical error could happen on any site, either inside the hospital facility like wards or Intensive care units (ICU) or outside the hospital like a physician's office or nursing home. However, the stressful environment of taking care of severely ill patients increases the risk of medical error incidence. In addition to the severity of illness, the complexity of treatments, fast pace decision making, and critical procedures elevate the odds of medical error exposure in ICU (Bucknall

2010). All of these factors have made researchers focus on medical error prevalence in ICU settings. Rothschild and colleagues who conducted an observational study in two ICUs, reported that during 189 observational days there were 120 adverse events (80.5 adverse events per 1000 patient's day), 45 percent of adverse events were preventable and 13 percent were fatal (Rothschild et al. 2005). Moreover, a study reported that 1.2% of ICU patients were admitted to the ICU as a result of medical error (Lehmann et al. 2005). Nevertheless, Brennan and colleagues reported that the largest numbers of adverse events were reported in the operating room (OR) (41%) and in-hospital patient rooms (27%). In addition, approximately 3% incidence of medical error was seen in each of the following areas: The emergency room (ER), intensive care units, and labor and delivery rooms, **Table 1** lists the distribution of adverse events per site (Lucian L Leape et al. 1991). However, a study claims that in 2009, the number of reported paid malpractice claims to the National Practitioner Data Bank in the United States (US) for events in the outpatient setting was similar to inpatient events number (Bishop 2011). Moreover, in the *Harvard Study II*, about 9% of adverse events occurred in a physician's office, and 2% in nursing homes (Lucian L Leape et al. 1991). The prevalence of the variation in the reported medical errors between the studies could be weighed on the method used in the study or the used definitions of errors. Observational studies have been found to catch more medical errors compared to other methods (Rothschild et al. 2005).

Table 1: Sites of care that resulted in Adverse Events in Harvard study II.

Location	Adverse events %	Due negligence %	Resulted serious injury
Operating room	41.0	13.7	22.0
Patient's room	26.5	41.1	30.4
Emergency room	2.9	70.4	24.8
Labor & delivery room	2.8	27.7	9.8
intensive care unit	2.7	30.2	50.4
Radiology	2.0	36.9	35.8
Cardiac catheterization laboratory	0.9	-	-
Ambulatory care unit	0.8	-	-
Other	1.7	-	-

A medical error could happen anywhere and involve any healthcare worker. Although anesthesiologists were the first to research into the safety of patients (J. B. Cooper, Newbower, and Kitz 1984), every specialty is susceptible to error. However, some specialties are more susceptible to error than others. For instance, mistakes are common when the caregiver is inexperienced, and when advanced techniques or new medical equipment are introduced. In a survey among new interns in internal medicine about medical error incidence, 45% admitted to at least one medical error (Wu et al. 2003). A multicenter observational study investigated the prevalence of medical errors during cardiopulmonary resuscitation and claimed that 37% of patients experienced medical errors (Heyland et al. 2016). In Greece, a study claimed that surgeons and obstetricians are the most high-risk specialties involved in the medical error (Vozikis and Riga 2006), while another study suggested that medication error is generally related to nurses (Küçük Alemdar and Yaman Aktaş 2013).

Seriously injured patients are at a higher risk of experiencing an adverse event. This is because, for these patients, more complex and intense procedures are required for treatment, which increases the risk of error (Weingart et al. 2000; Meurer et al. 2006). These findings were supported by Marbella and colleagues, in a hospital-based case-control study conducted in 268 cases. They found that high severities of illness and length of hospitalization were significantly related to the increased occurrence of medical injuries. Furthermore among these cases, 47.8% were procedure-related errors, and 44.8% were medication-related errors (Marbella et al. 2011). Valentin and colleagues reported that there is a correlation between patient length of hospitalization and the exposure to medical error (Valentin et al. 2006). Another study found that there is a relationship between preventable adverse events and patients with illnesses that require urgent care (Wilson et al. 1995).

In conclusion, the more that provided patient care was researched, the more errors were found. All patients are at risk of an adverse event regardless of their illness or demographic data. Every

healthcare specialty is susceptible to error whether treatment is done in a hospital setting or an outpatient setting.

ICU setting and medical error

Even though the ICU is designed to be a closed and controlled environment to treat critically ill patients, the medical error still has a high chance of occurring. The advanced technological equipment, critical decision making, and complex treatments make the ICU a high-risk site for medical error (Valentin 2007). In Europe, it was reported that 26.8% of 1369 studied ICU patients were exposed to at least one medical error. And the rate of patients exposed to a second error was 55.3%. Consequently, having more than two medical errors was an independent risk factor for ICU mortality (Garrouste-Orgeas et al. 2010). In this study, Garrouste-Orgeas and colleagues reported that errors related to insulin administration were the most frequently committed errors with a rate of 185.9/1000 days. **Table 2** is a listed summary of the most commonly reported medical errors from their study (Garrouste-Orgeas et al. 2010). Subsequently, in this study, the medical errors related to mechanical ventilation were the second most commonly occurring errors in the ICU, which is consistent with the findings of the multinational Sentinel Events Evaluation (SEE) study (Valentin et al. 2006). The studied mechanical ventilation related errors included the following: overinflating of endotracheal tube (ETT) balloon, failure to repositioning the patient on semi-recumbent position, accidental extubation (Including self-extubation), suction failure, and laryngoscope dysfunction. These errors and more will be covered in the Respiratory Therapy Related Medical Errors in the ICU section later on.

Domain of care	Medical error	Number of medical errors	Patients with domain of care
Error administering Medication	Error administering insulin	630	801
Error administering Medication	Error administering vasoactive drugs	29	428
Errors related to mechanical ventilation	Overinflation of intubation catheter balloon	261	805
Errors related to mechanical ventilation	Failure to place patient in a semi-recumbent position	121	805
Errors related to mechanical ventilation	Accidental extubation	35	805

In addition to the Garrouste-Orgeas and colleagues' study, several other studies also confirmed that medication error is the most common medical error in the critical care units (Bucknall 2010; J. K. Ward and Armitage 2012; Camire, Moyen, and Stelfox 2009; Rothschild et al. 2005). For instance, an observational study conducted in critical care units found that medication error has the highest incidence rate (127.8/1000 bed days). Notably, different types of medication were involved in these errors, such as preventive, monitoring, and even diagnostic like IV contrast (Rothschild et al. 2005). Moreover, it is reported that most of the medication errors occur due to incorrect dosage (Wahr et al. 2017; Rothschild et al. 2005). Errors could happen in any step of the medication phases which include prescription, transcription, preparation, dispensation, and administration. However, most medication error incidences happen during the administration phase (Camire, Moyen, and Stelfox 2009; Wahr et al. 2017).

In addition to medication error, it was reported that failure to wash hands and sterile field violations were common 51% and 17%, respectively (Rothschild et al. 2005). Failing to follow universal safe practice standards lead to an elevated chance of hospital-acquired infections or nosocomial infection which is responsible for a 30% increase in morbidity and mortality rate in ICU (J. L. Vincent 2003). In the Rothschild et al study, two fatal adverse events were the result of catheter-

related bloodstream infections. Also, it was reported that up to 15% of ICU patients experienced arterial cannula adverse events and up to 26% central venous catheter (CVC) adverse events (Bucknall 2010).

Medical device-related errors is a topic that has not yet been investigated in depth. In 2000 the FDA received around 90,000 reports regarding medical device-related errors (J. R. Ward and Clarkson 2004). However, device-related errors could be connected to human error rather than device failure. A study done to examine the characteristic of human error and equipment failure in an anesthetic practice found that 82% of preventable medical device errors incidents were human errors and 14% were a result of device failure (J. B. Cooper et al. 1978). The multinational Sentinel Events Evaluation study found 9.2 events (per 100 patient-days) were related to equipment failure. The most common equipment failures were infusion devices, then mechanical ventilators (1.9% of patients receiving mechanical ventilation) (Valentin et al. 2006).

Role of Respiratory Therapists in ICU

As new complex respiratory procedures and advanced technologies such as compressed therapeutic gases and computerized mechanical ventilation are introduced to the health care system, newly specialized and well-trained care practitioners become a necessity.

As part of the ICU medical team and under the ICU medical supervision the respiratory therapist is focused on assessing, monitoring, and treating patients with cardiopulmonary diseases or any patient with breathing or pulmonary difficulties (Keenan et al. 1998). The respiratory care profession started to appear and progress in the 1940s in the United States. It started with hospital-based training personnel who were responsible for providing and monitoring oxygen therapy. These workers were identified as inhalation therapists (West and Dipph 2014).

Over the years, this profession progressed from a hospital-based program to a well-educated college-based program and became an important part of the interdisciplinary medical team in

critical and sub-acute care units (West and Dipph 2014). In Saudi Arabia, respiratory therapy could be traced back to 1975 in the capital city Riyadh, where an American-operated hospital founded the first respiratory therapy department. In the following year, a hospital-based training program was established. Since then, respiratory therapy grew greatly and paralleled the huge dramatic growth in population and health services. Nowadays, more than 11 college programs are teaching respiratory therapy in Saudi Arabia (Al-Otaibi and AlAhmari 2016).

The respiratory therapist is actively involved in critical care units, emergency rooms, wards, pulmonary rehabilitation, and home care. In the following table (**Table 3**), a sample of the duties that the respiratory therapist in a tertiary hospital is responsible for is outlined. Adapted from: (AARC n.d.; UW n.d.).

Table 3: Respiratory therapist duties may include, but are not limited to the following:
Administering and monitoring oxygen therapy via different delivering devices such as a nasal cannula, face mask, and non-rebreathing mask.
Performs pulmonary and cardiac diagnostic tests such as Pulmonary function tests, EKGs, and stress tests.
Planning, preparing, and administering respiratory therapy treatments including aerosolized medication therapy, chest physical therapy, lung expansion therapy, in accordance with hospital policies and procedures.
Monitoring patient's post physiological responses to therapy, such as vital signs, breathing sounds, and arterial blood gases.
Setting up, Applying, modifying, and monitoring patients on invasive and noninvasive mechanical ventilation.
Providing direct assistance to the physician during cardiac resuscitation, Advanced Airway Management, and Bronchoscopy procedures.
Performing arterial punctures to obtain arterial blood samples for blood gas analysis, and understanding the possible complications and contraindications associated with the procedure.
Inspects, calibrate, and tests respiratory therapy equipment such as mechanical ventilation and arterial blood gases analysis machine, to ensure that it is functioning safely and efficiently.

The respiratory therapist's duties in ICU range from simple oxygen administrations to management of sophisticated microprocessor mechanical ventilation machines. A respiratory therapist is responsible for maintaining a secure and patent patient airway. In addition, they are responsible for oral, nasal, nasopharyngeal, and endotracheal suctioning which are also considered sharing responsibilities with nursing (Leddy and Wilkinson 2015). Therefore, with this wide range of duties and responsibilities comes a higher chance of errors and mistakes. The following section will cover respiratory therapy related medical errors in ICU settings.

Respiratory therapy-related medical errors in ICU

A typical ICU patient is critically ill and requires high-intensity medical care. Patient illness severity and the use of high-intensity care and advanced equipment increase the chances of medical errors in ICU (Garrouste-Orgeas et al. 2010). ICU patients usually need airway protection and require the use of temporary respiratory support either through invasive or noninvasive mechanical ventilation (Wunsch et al. 2010). Moreover, Rothschild et al stated that 19% of common adverse events were respiratory (Rothschild et al. 2005). In addition, respiratory tract infection is the most common nosocomial infection in ICU, and 83% of nosocomial pneumonia was associated with mechanical ventilation (J. L. Vincent 2003) . For all of the above reasons, the respiratory therapist has a major role in preventing ICU medical errors. Therefore, we will focus in this section on the most common respiratory therapy related medical errors in ICU.

As mentioned earlier, the respiratory care roles in ICU include the use of invasive mechanical ventilation. Mechanical ventilation machines have gone through dramatic technological advances in recent years, and due to these advancements, the need for skilled and well-trained staff is increased. Without proper in-service training on machines, the chances of errors are more likely to increase. An example of these errors may include inappropriate calibration of the ventilator or the misuse of ventilation mode which leads to the mismanagement of ventilation of the lungs (Buckley et al. 1997). Lack of training and inappropriate ventilator maintenance will affect the

accuracy of the ventilator sensors and may lead to ventilation errors (Govoni et al. 2012). Patient-ventilator asynchrony is another common error that happens frequently in the ICU. In a prospective descriptive study conducted in three critical ICUs (surgical trauma, cardiac surgery, and medical respiratory ICUs) with a total of 983 beds, twenty-five percent of ICU ventilated patients experience patient-ventilator asynchrony episodes. These patient-ventilator asynchrony episodes may happen because of either inadequate sedation or poor management of ventilator settings (Mellott et al. 2014). The poor management of patients on ventilators could lead to prolonged use of ventilation and increased length of ICU days. This poor management could include inappropriate ventilator settings for a patient's case such as low tidal volume (Vt) or pressure, insufficient flow, or inappropriate alarm settings (Buckley et al. 1997; Govoni et al. 2012). Another error related to mechanical ventilation is equipment dysfunction, which the SSE study reports as the second most common type of equipment failure (Valentin et al. 2006).

In addition to invasive mechanical ventilation, noninvasive ventilation errors are common too. The most common errors related to noninvasive ventilation is interface errors. Interface errors include the inappropriate size of the face mask or mouthpiece which promotes air leaks. These errors will decrease noninvasive ventilation efficiency and reduce patient tolerance (Hess 2011).

Another common area for respiratory medical errors with a strong impact on patient safety is the management of patient artificial airways as shown in **Table** 4 (Valentin et al. 2006). Lipshutz et al reported that 50% of near-miss errors were airway-related (Lipshutz et al. 2015). Unplanned extubation is the most common error related to the artificial airway (Buckley et al. 1997). Unplanned extubation is associated with increased ICU days and prolongs the use of mechanical ventilation (Valentin et al. 2006). Unplanned extubation could be a result of an unsecured airway or a inappropriately high ETT level. ETT levels should be measured on a daily basis by lip-level monitoring and chest x-ray (Hardcastle, Faurie, and Muckart 2016). Another airway related error

is inappropriate ETT cuff pressure. A study reported that only 23% of ETT cuff pressure was within the optimum range (Hardcastle, Faurie, and Muckart 2016).

Table 4: Common errors related to patient artificial airway
Unplanned extubation
Failed Intubation attempt
Inappropriate ETT cuff pressure
Unsecure airway
Unsafe ETT level
Artificial airway obstruction

During intubation, it is important to have functional and tested equipment and adequate assistance. A study showed that half of the intubation incidents were due to the lack of functional equipment (Antony N. Thomas and McGrath 2009). Dysfunctional laryngoscope, either no or low light or inappropriate blade size could lead to failed intubation. In addition, not having a functional suction catheter with efficient pressure to remove secretion will lead to a failed intubation attempt and increase the risk of adverse events (Garrouste-Orgeas et al. 2012). In Japan, an observational multicenter study conducted in 11 emergency departments found that 11% of 2,616 patients (receiving emergency tracheal intubation) required multiple intubation attempts (more than or equal to three intubation attempts). The most commonly observed adverse event was esophageal intubation. Moreover, they found a significant association between multiple intubation attempts and the increased risk of adverse events (Hasegawa et al. 2012).

The following **Table 5** summarizes the most common ICU errors related to respiratory therapy in literature with a brief definition.

Table 5: Definitions of respiratory therapy related medical errors in ICU settings.

Medical Error	Definition
Suction failure.	The suction system does not work properly: The pressure is not sufficient to ensure the removal of pharyngeal and/or bronchial secretions (Garrouste-Orgeas et al. 2010).
Laryngoscope dysfunction	The laryngoscope does not work properly: The light is not strong enough or does not turn on, assembly of the blades on the handle is difficult, or blade size is not available(Garrouste-Orgeas et al. 2010).
Accidental extubation	Unplanned extubation or self-extubation of ETT or tracheostomy tube (Garrouste-Orgeas et al. 2010) (T. W. Lee et al. 2015)
Airway unsecure/ displaced ETT	Incorrectly secured tube, totally displaced from patient, displaced from trachea into soft tissues, displaced from trachea into pharynx, displaced from trachea into esophagus, or displaced from trachea into bronchus. Ventilator-patient circuit disconnects or leak (Antony N. Thomas and McGrath 2009; Lipshutz et al. 2015).
Artificial airway obstruction	ETT or tracheostomy blockage (Antony N. Thomas and McGrath 2009).
Unsafe ETT level	Either their ETT level is too low or too high (optimal ETT level is 2-3cm above the carina and it could be assessed through chest X-ray) (Hardcastle, Faurie, and Muckart 2016).
Arterial blood gas error	Wrong technique (e.g. not performing Allen test to avoid complication), sample error (e.g. veins sample, or air bubble) (Dev, Hillmer, and Ferri 2011).
Failed Intubation attempt	Includes: Failure to intubate, Delay in intubation, Endobronchial intubation, Esophageal intubation, and Aspiration of gastric contents (H. E. Wang et al. 2009; Antony N. Thomas and McGrath 2009)
Inappropriate ETT cuff pressure	Either the mean pressure in the endotracheal cuff pressure is over (over-inflation) or below (leak) the recommended pressure, which is measured with an optimal range 20-30 cm H2O (Sole et al. 2009)
Heat and moisture exchanger (HME) failure	Either failure because the respiratory therapist didn't change it as instructed (every 48 hours) or failure due to secretion block (Restrepo and Walsh 2012)
Mechanical ventilator and accessories dysfunction	lack of cleaning, or faulty equipment. (A. N. Thomas and Galvin 2008) or bad performance (Govoni et al. 2012)
Inappropriate patient settings on mechanical ventilator	Patient settings are not optimal or updated for patient prognosis or auto cycling breathing (Buckley et al. 1997)

Patient Ventilator asynchrony	No sedation, not using the ventilator graphs to identify issues (Mellott et al. 2014).
Alarm failure	Inappropriate settings of alarms or alarms are turned off including pulse oximetry and end-tidal CO_2 monitoring alarms (Buckley et al. 1997)
Noninvasive ventilation (NIV)	Delay or absence of NIV, inappropriate Noninvasive interface size, or leak (Hess 2011).
Failure to follow infection control protocol	Including Hand hygiene, Use of personal protective equipment (e.g., gloves, gowns, and masks), Safe injection practices, and safe handling of potentially contaminated equipment or surfaces (J. L. Vincent 2003).
Respiratory medication error	Either by administering medication to the wrong patient, wrong dose, or delayed or wrong time (Stoller, Orens, and Kester 2003).
Documentation error	Absence, incomplete, or wrong documentation. Including the use of unapproved abbreviation (de Feijter et al. 2012).
Failure of Transport ventilator	No charge or low charged battery (A. N. Thomas and Galvin 2008)
Electrical power failure	No backup power or battery, unaware staff with outage (A. N. Thomas and Galvin 2008).
Behavioral incidences	Rude, miscommunication, member inactive of teamwork (T. Reader et al. 2006)

In conclusion, patients in ICU settings may require the use of mechanical ventilation and airway devices to provide respiratory support. Respiratory therapy plays a major role in operating, assessing, and managing patients on mechanical ventilation in ICU. With great power comes great responsibility. The use of complex therapies and high severity levels of patient illness increases the risk of medical errors and adverse events that respiratory therapists have a hand in preventing with proper training, honest effort, continued education, and quality monitoring.

Contributing factors for medical errors

To design a risk-based approach to prevent further medical errors with the same origin or nature, we need to understand the contributing causes of these errors. However, it is expected that some of these medical errors will not be reported to the system. In England, The National Patient Safety

Agency estimated that 22% of incidents and 39% of near-miss goes unreported (House of Commons 2006). On the other hand, an empirical study conducted on 42 obstetricians and 156 midwives at two different units, reported that staff reported more serious incidents compared to moderate and minor ones (Vincent C, Stanhope N 1999). Reasons for not reporting an incident could be due to the fear of consequences, blame, or unawareness of the importance of reporting an incident (Vincent C, Stanhope N 1999). In a national study in England and Wales called "*Characterizing the nature of primary care patient safety incident reports,*" 34% of reports were excluded because the nature of the incidents were either not described or related to health care. In addition, two-thirds of the included reports did not include a sufficient description of the reasons why the incidents happened. The reasons for these findings are mainly due to the lack of knowledge and understanding of the incidents reporting system (Carson-Stevens et al. 2016). Lack of reports on sentinel events or errors will make the prevention of these errors difficult. To reduce medical errors, there needs to be more of a focus on the reasons why medical errors happen rather than by whom. Using this approach will make ICU staff more involved in the solutions and will increase the incidence report rate. In September 2019, the Saudi Patients Safety Centre and DATIX, a patient safety software company, established a nationwide reporting system called SAWTAK. It is not available nationally as of yet, however there is currently a seven year implementation plan in process (Health Matrix 2019). This is definitely a step in the right direction.

In most of the medical error incidences in the ICU settings, there is more than one contributing factor for the incidences (Wu et al. 2003). Ineffective or poor communication played a major role in 60% of errors (World Health Organisation, 2008). Human errors are responsible for about 55% of medical errors (Buckley et al. 1997). In further studies with a broader definition of human error, human errors ranged from 31% to 82% (Kothari et al. 2010; J. B. Cooper et al. 1978; Bracco et al. 2001).

Contributing factors to medical errors could be divided into active failure and latent failure. Active failure can be defined as errors performed by health care providers in the front line "sharp end," for example when the respiratory therapist sets the ventilator incorrectly (J. T. Reason 1995). On the other hand, latent failure can be defined as errors related to system or organization conditions. For instance when the respiratory therapist sets the ventilator incorrectly because he used varied types of ventilators in the ICU which may have caused confusion (J. T. Reason 1990).

Human error can be defined as an incident occurring as a result of the human factor, which could be a result from failure of execution (slips and lapses) or failure of intention (mistakes). Slips and lapses occur when there is an adequate plan, but the execution action does not go as intended. Slips could be a result of attention failure, such as the failure of the respiratory therapist to notice the low tidal volume alarm on mechanical ventilation. Lapses errors occur as a result of memory failure, for example when a respiratory therapist forgets to reduce the oxygen concentration after suctioning the patient (J. T. Reason 1990; Bucknall 2010). Slips and lapses are typically skill-based errors (Senders et al. 1991; Diller et al. 2014). Mistakes are failure of planning (e.g. failing to identify disconnected breathing circuits for a long period of time) which include knowledge and rule-based errors (Carthey, De Leval, and Reason 2001). The other types of active failures are violations that break department or organization rules or policies. These violations could be a result of intentional or pure negligence and include any routine that utilizes "bending the rules" even if it were a common practice in the institution (J. R. Ward and Clarkson 2004). Active failure is summarized in **Figure 3** (Adopted from (J. T. Reason 1995).)

Rothschild and colleagues conducted a one-year observational study to observe incidents and the nature of adverse events and serious medical errors in ICU. In their study, it was reported that the most common human errors were skilled based errors at 53%, then knowledge-based

errors at 26%, and finally rule-based errors with 14% occurrence (Rothschild et al. 2005).
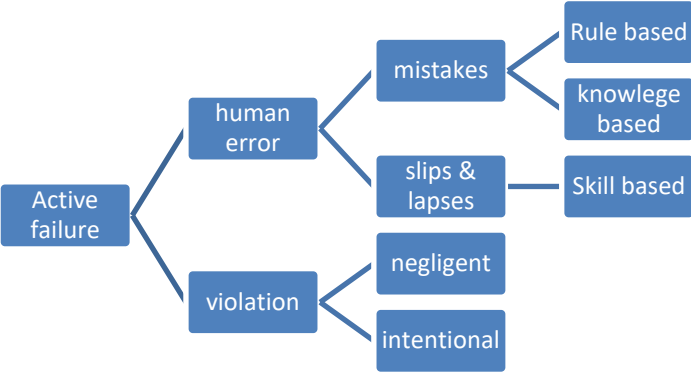
Latent errors happen as a result of the wrong decision of management, department, or supervision. These errors are a result of conditions that led to these actions such as inadequate staffing, poor supervision and training, inappropriate maintenance of equipment, and poor communication (Van Beuzekom et al. 2010; Stanhope et al. 1997; J. T. Reason 1990; C. Vincent, Taylor-Adams, and Stanhope 1998). Latent failure risk factors are summarized in **Figure 4** (Van Beuzekom et al. 2010).
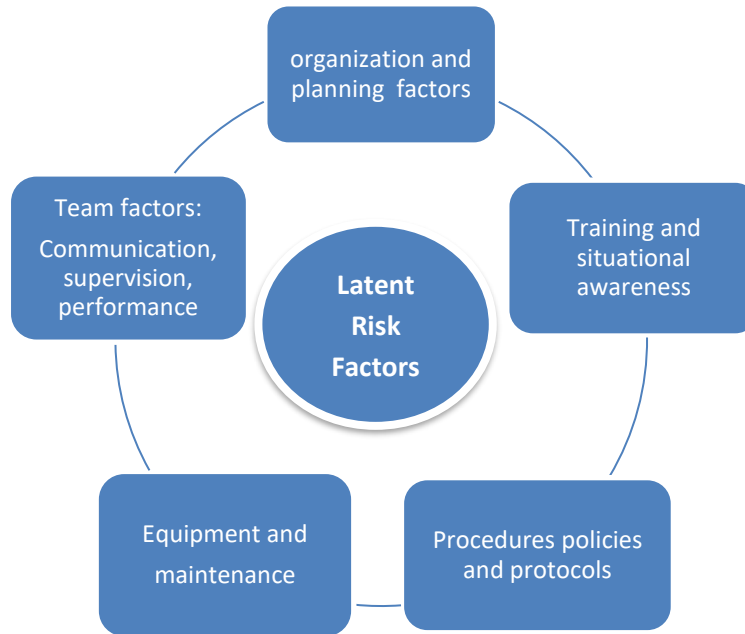
Figure 4: Latent risk factors.

Patients with severe illness, elderly patients, and the use of sophisticated equipment such as mechanical ventilation are considered to be risk factors to medical errors (Valentin et al. 2006; Garrouste-Orgeas et al. 2010; Lori B. Andrews et al. 1997). The critical condition of patients in the ICU, the use of high-tech devices, fast-paced decision-making environment, in addition to complicated procedures and therapies, demands a high level of attentiveness from the health care professionals. This stressful environment leads to various factors such as fatigue, sleepiness, haste, impaired communication, and distraction which are associated with an increased risk of medical errors (J. B. Cooper et al. 1978; Sinha, Singh, and Tewari 2013; Dhawan et al. 2017; Wu et al. 2003; Gorgich et al. 2015). In a study focused on identifying the contributing factors to human errors in anesthesia, Cooper and colleagues reported that the most common factors were inadequate total experience and inadequate familiarity with equipment or device, 77 and 45 incidents, respectively (from a total of 481 incidents) (J. B. Cooper et al. 1978). Furthermore, various studies reported that 31% to 85% of multidisciplinary health care

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professionals failed to correctly demonstrate inhaler therapy administration (e.g. the use of meter dose inhaler MDI). The lack of training is the main reason for these kinds of skill-based human errors (Price et al. 2013; Jackevicius and Chapman 1999).

In the critical care unit, in addition to the mentioned above factors, there are contributing factors related to work schedule and load such as long shifts, burnout, and workload. The long working hours and workload are considered contributing factors. An observational study conducted on 20 interns for a period of 3 weeks in the medical ICU and coronary care unit, reported that interns with less working hours per week had better sleeping patterns and decreased rates of medical errors (Sarani and Alarcon 2005). Likewise, a study reported that reducing interns' working hours were associated with decreased medical errors in the ICU (Landrigan et al. 2004). Furthermore, a study reported that 51% of ICU physicians reported committing a medical error as a result of high-level tasks and workload (Wu et al. 2003). A retrospective study of the frequency and risk factors for medication errors by pharmacists found that the increased workload (number of medication orders per shift) were associated with increased rates of errors (Gorbach et al. 2015). Burnout and extended working shifts have a significant association with the increase of human errors (Caruso and Hitchcock R. Russo. J. Schimt, J., E Dick 2004; Berryman, Lukes, and Keller 2009; Ahola et al. 2009). In a cross-sectional study conducted on nurses to investigate the causes of medication errors, 97% reported high workload as a contributing factor, as well as, ICU environmental conditions and the low ratio of staff to patients, 70% and 74%, respectively (Gorgich et al. 2015). The result of a very stressful working environment has an effect on health care mental health. Depression is reported as another independent contributing factor to medical errors (Garrouste-Orgeas et al. 2015). What is more, Fahrenkopf et al conducted a prospective cohort study to discover the prevalence of depression among residents and the relationship to medical errors. One hundred twenty-three residents from three pediatric programs participated in the study. The study found that depressed residents (20% of 123 residents) made six times the

errors compared to non-depressed residents (Fahrenkopf et al. 2008). Depression is a common problem among health care workers, with the study claiming that approximately one of every four ICU physicians suffers from it (Embriaco et al. 2012).

Safety and Incidents of Preventive strategies

"When you make a mistake, there are only three things you should ever do about it: admit it, learn from it, and don't repeat it" Paul Bear Bryant.

Safety as a concept was formulated in industries as a result of major accidents such as Chernobyl reactor meltdown, crash of Air Ontario Flight 1363 and the Exxon Valdez oil spill (ARPANSA n.d.). The safety was managed as a reactive management to an incident.

Safety could be described as finding ways of preventing the occurrence of incidents. This definition is the concept of safety I, an approach that focuses on incidents and risk management. Eventually a newer approach called Safety II was developed which was used in applying guidelines and regulations to ensure work is done correctly. It is more proactive and focuses on the right practice rather than incidents investigation (Hollnagel 2012). With the advancement of new technologies in healthcare and new skills and techniques, safety I & safety II are being used in conjunction with each other to improve healthcare quality and patient safety (Smith and Valenta 2018; Hollnagel 2012). The recent trend in healthcare management is to expand the safety concept in healthcare administration from avoiding wrong practice to corroborate the right practice.

To understand what is done correctly, a close monitoring to current practice is required. One of the methods to understanding current practice is the reporting incident system. If the reporting was done correctly and encouraged, this system would provide a rich source of information to help improve safety. Understanding the chain of events that led to an error is the key to eliminate further errors with the same origin from occurring again (Dhawan et al. 2017). The urging

response from management to blame someone for the incidents is a sign of systemic deficiency (J. Cooper et al. 2017). However, the goal should not just be about making errors blame-free but to create balance between prevention and responsibility by ensuring accountability is still involved.

Risk managers and investigators must look for the root of the incident instead of focusing on the individuals involved. Was it a result of a bad apple and simply an individual human error, or was it a bad barrel maker which is the system failure which led to this incident? Identifying the cause is the path towards fortifying the system from future incidents. The investigator must look at the big picture and see all the elements that led to this event. Thus, the study of the psychological, social, and environmental causes of errors has become a fundamental aspect of the prevention process (D. Cooper 2001).

To identify the underlying factors, an assessment of human reliability would be beneficial. Human reliability assessment is defined as the use of qualitative and quantitative methods such as semi-structured interviews and observational studies to investigate the human contributing factors to incidents (Bell and Holroyd 2009). The use of such assessment methods to assess safety culture within the workplace clarifies the underlying contributing factors. The topic of safety culture and safety climate will be discussed in the following chapters.

Most of medical errors are a result of more than one contributing factor and a combination of human and system errors (Wu et al. 2003; J. Reason 2000). However, the high chance of human errors which range from 31% to 82%, was the reason why early studies were focusing on human error prevention. (J. B. Cooper et al. 1978; Bracco et al. 2001; Giraud et al. 1993). The goal for the human-based prevention approach is to determine the responsible personnel involved and prevent errors from happening again by focusing on educating the staff who have the same chance of committing the same error (J. Reason 2000). For example, if a respiratory therapist

operates mechanical ventilation and commits a mistake, the department will conduct an in-service session for the staff on mechanical ventilation. On the other hand, the system model approach applied for the same earlier issue will focus on identifying the reasons for the errors. For example, it could be that there are various types of mechanical ventilators which could confuse staff. The solution through the system model approach would be to unify the ventilators in the ICU (Garrouste-Orgeas et al. 2012).

Study introduction and aims

Patient safety is a core goal of health care. ICU patients are more prone to medical errors than other patients and that is due to their critical condition, the use of high-tech devices like mechanical ventilation, and the fast-paced decision-making environment (Valentin 2007; Bucknall 2010). Medical errors have been studied by a variety of specialties' point of views such as anesthesiologists, pharmacists, nurses, etc.; however medical errors in the area of Respiratory Therapists' practice have not been investigated (Dhawan et al. 2017; Anderson, Dipnurs, and Anderson 2001; Gorbach et al. 2015; Rothschild et al. 2005). This is maybe because the majority of the countries that have researched in this field, such as Australia, the UK, and other European countries, don't have respiratory therapists as a part of their ICU medical teams. To my knowledge, patient safety in the respiratory care practice has not been investigated before and this is the first research to study ICU medical errors from the respiratory therapy perspective. Moreover, this is first research to study job satisfaction among respiratory therapists in Saudi Arabia. Besides the U.S. and Canada, Saudi Arabia has a strong presence in respiratory therapy specialization. It is a prominent part of the multidisciplinary healthcare team in their hospitals. Unfortunately, studying medical errors in Saudi Arabia either in the ICU setting or non-ICU setting was not introduced until recently. The lack of medical error research in ICU settings in Saudi Arabia increases the value of this research.

The research will include the use of qualitative and quantitative methods to help develop an understanding of the contributing factors and the environment that surround the incidents. Moreover, the research aims to use grounded theory as a qualitative method to explore and allow emerging of new theories from the obtained data (Charmaz 2006).

To gain understanding of the current status of delivered care in the hospitals; to understand the respiratory therapists work environment; and to find ways to improve the delivered care and improve job satisfaction were the motivators behind this research. The results of this study will provide a better understanding of the types of errors that occur and can be prevented during respiratory therapy services in ICU settings. Better understanding will help in building and designing a systematic approach to reducing errors during respiratory therapy services. In addition, ventilators have gone through major changes in recent years and there were no recent studies to report the effect of these developments on the rates of medical error occurrence. Therefore, this research will explore this field from the respiratory therapy aspect through five studies.

The aims of this study are:

1. To observe and investigate the prevalence of medical errors in the ICU setting from the respiratory therapy viewpoint.
2. To gain the perception of ICU staff and respiratory therapists of safety culture, medical errors, causes, and solutions through a qualitative study.

In order to find an answer to address the research goals, it was important not only to count how many incidents occurred or how many treatments are missed, rather understanding the why behind it and get connected with staff in the front line by listening to their feedback, concerns and solutions. Therefore, this research methods included not only observations but semi- structured and in-depth interviews to get deep insight of the problem. The findings of this study will help

respiratory therapy management understand the types of medical errors and therefore develop a targeted approach for preventing further errors with the same nature from happening in the future. Also, the findings should help in customizing training workshops and educational courses based on staff's needs and redesigning respiratory therapy hospital policies, and improve patient safety.

The observed incidents will be analyzed using root cause analysis and human error identification. A hierarchical task analysis was used to categorize predefined tasks into steps and sub-steps based on the American Association for Respiratory Care (AARC) clinical practice guidelines and the hospital's RC department policy and procedures.

Study design

The research will be conducted in two phases: phase I will be a prospective, observational study followed by a semi-structured interview. The study will be conducted in two adult ICUs in two main hospitals in the Eastern Region of Saudi Arabia. The two main hospitals have a total capacity of 759 beds and a total of 50 adult ICU beds. The observational study will be conducted over a period of 65 days, with no national holiday to ensure the maximum staff availability. The primary method of data collection will be the direct observational method and interviews. In addition, self-reported errors will be collected. Medical errors were identified based on **Table 6**. All ICU patients will be included in the study, including chronic patients and readmitted patients. In phase II, a qualitative (In-depth interview) study of ICU staffs' perceptions of medical errors, causes, and solutions will be conducted. The following table is the planned study timeline.

Table 6: Planned study timeline.

	2019											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Study Part I: Data collection												

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Study Part I: Data entry and analysis				■	■	■	■	■				
Study Part I: Writing report									■	■	■	■
2020												
Study Part II: Data collection	■	■										
Study Part II: Data entry and analysis			■	■								
Study Part II: Writing report					■							
Study Part III: Data collection						■	■					
Study Part III: Data entry and analysis								■	■			
Study Part III: Writing report										■	■	■

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Chapter 2: Application of Safety Attitudes Questionnaire (SAQ) in Adult Intensive Care Units: a cross-sectional study

Introduction

Patient safety, prevention of medical error, and quality of care are important aspects of health care. The importance of these fields has led to an expansion in literature and research in recent years. As in any other profession or industry such as engineering, aviation, or nuclear plants, human factors play an important role in the generation of medical incidents (J. Reason 2000). The available literature seems to suggest that a high percentage of medical incidents could be prevented in many cases (Brennan et al. 1991).

To achieve a positive safety culture, first, we must understand the values, perceptions, and patterns of behaviors to determine what the norms are and what is appropriate.

After the Chernobyl disaster in 1986, more attention was given to safety culture in nuclear institutions. In 1993, the Advisory Committee on the Safety of Nuclear Installations (ACSNI) established a definition for safety culture stating that: "*The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.*" (Health and Safety Commission (HSC) 1993).

Safety culture in a unit is a part of the whole organizational culture. Cooper (2000) described safety culture as a sub-facet of a bigger culture: the organizational culture. Moreover, it was also suggested that safety culture affects organization members' attitudes and behavior about the organization's current health and safety performance(M. D. Cooper 2000) and that the administration's perception of safety influences the staff's safety culture (Gadd and Collins 2002). Communication-based on mutual trust, commitment to, and understanding of the importance and

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benefits of following safety protocols are features of positive safety culture (Sorra and Nieva 2004).

In the Cooper framework, safety culture has three aspects: Psychological aspect, Behavioral aspect, and Situational aspect. The psychological aspect (also called "safety climate") represents the individual's attitude, values, and perceptions. It can be measured by the safety climate questionnaire to capture a glimpse of staff attitude and perceptions toward safety at a specific point in time (M. D. Cooper 2000). However, in some studies, the term safety climate has come to be used to refer to the safety culture alternatively (Gabrani et al. 2015; Soh et al. 2016). In some studies, safety climate has been described as the shared perceptions, attitudes, and beliefs of staff about the organization's way of handling and archiving safety (Soh et al. 2016; Flin et al. 2006). To reiterate safety culture is how things are done around here, and safety climate is a glimpse or superficial image of safety culture in a specific time and place. However, throughout this paper, the term safety climate will be used to refer to the psychological aspect of safety culture.

The second aspect, the behavioral aspect, focuses on individuals' actions and can be examined by direct peer observations and self-reports.

The third aspect: the situational aspect, which concerns the organization's policies, procedures, regulations, and organizational system. This aspect could be examined via inspections and surveillance (M. D. Cooper 2000; Health & Safety Executive 2005).

As in different industries such as aviation and nuclear power, the Agency of Health Care Research and Quality (AHRQ) (Sorra et al. 2016), the Joint Commission for the Accreditation of Healthcare Organizations (Joint Commission 2018), and the National Health Service (NHS) (NHS England and NHS Improvement 2019) encourage the regulatory measurement of safety culture, which is necessary for maintaining or improving its quality. Moreover, measuring safety could be

conducted via two different methods, as an active or a reactive response and should be frequently measured to improve or maintain safety culture.

Active measurement is done to monitor safety culture in the organization before an incident occurs; these measurements are done as inspections rather than investigations. On the other hand, reactive measurement is measuring safety culture after an incident took place, investigating the incident or near miss cases, and examining the safety culture at that moment (Gadd and Collins 2002).

There are several active and reactive methods for measuring safety cultures including reporting near-miss occurrence, accidental data collection, behavioral measuring, self-report method, and safety questionnaires. However, the most common method to actively assess safety culture is through safety questionnaires and one of the most internationally used questionnaires is the Safety Attitude Questionnaire (SAQ)(Smits et al. 2017; Gabrani et al. 2015), developed by the University of Texas and partially funded by AHRC. The aim of the SAQ was to fill the demand for healthcare quality regulations required by the Joint Commission for the Accreditation of Healthcare Organizations, the Agency for Health- care Research and Quality, and the U.S. National Quality to measure and monitor safety culture (Sexton et al. 2006b).

The SAQ has many strengths making it a popular choice among researchers and investigators. It also has a shorter questionnaire version compared to others such as The Job Descriptive Index, has been tested and validated in different cultures worldwide, is available in multi-language translations, allows for trend data measurability and monitoring over a specific time span, allows benchmarking, and can be utilized with any unit in the hospital such as ICU and OR. (Gabrani et al. 2015; Smits et al. 2017; Etchegaray and Thomas 2012)

The SAQ ICU Arabic version is the most used validated tool in Arabic culture. SAQ was translated and validated (internal consistency) by Hamdan 2013 (Hamdan 2013). Moreover, a study by Abu-El-Noor et al (2017) confirmed Hamdan's translation, tested the psychometric properties (validity

and reliability) and found good validation. It was then determined that it could be used as a tool to evaluate the safety attitudes in Arabic speaking hospital cultures (Abu-El-Noor et al. 2017).

In this chapter, I describe a study designed to establish a safety climate baseline in two intensive care units in Saudi Arabia and to assess the safety culture attitude among these healthcare professionals. The study involved ICU physicians, nurses, respiratory therapists, and *ICU* dietitians.

Method

A cross-sectional study was conducted using anonymous and random sampling. I surveyed all ICU staff working in every adult ICUs in two of the major hospitals in the eastern province of Saudi Arabia. The short version of the Safety Attitudes Questionnaire was used to assess participants' attitudes towards safety culture. Approval for the Questionnaire was gained from the University of Texas for the English version. Permission was obtained from Dr. Hamdan for the validated Arabic version of the Questionnaire.

The SAQ (**Appendix 1**) has 30 core items representing six scales: teamwork climate, safety climate, job satisfaction, stress recognition, perception of management, and working conditions. Additional items were added to explore the safety culture perception and the attitude toward incident reporting within the unit.

The following items were not part of the original Questionnaire: Item "How you score the intensive care unit in this hospital regarding patient safety", item "describe the quality of communication and collaboration with the following personnel during your experience in this ICU", and item "How many incidents (medical errors) did you report to the management in the last 12 months?".

The questionnaire uses a Likert-type scale, ranging from 5 for strongly agree, 4 slightly agree, 3 neutral, 2 slightly disagree, to 1 for strongly disagree. The overall domain score was calculated by summing all items in each domain then dividing by the number of items.

Data collection

Data collection for the study occurred over a three-week period in March 2019. The respondent criteria required that all healthcare workers in the adult intensive care units had at least one year of experience and have worked in the ICU for at least one month prior to the time of the study.

Statistical Analysis

All data were transferred to an electronic worksheet in Microsoft® Excel on office 365. Then data were then analyzed by using SPSS software (version 25, Chicago, IL). A p-value of less than 5% was considered to be statistically significant. Cronbach's alpha was used to assess the reliability of each domain in the Questionnaire. Descriptive analysis was performed using ANOVA and paired sample t-tests in all demographic data including sex, age, educational level, job title, years of experience, working hours, and working shifts and compared to SAQ mean scores. In each domain, the positive responses (agree and strongly agree) and negative responses (disagree and strongly disagree) were calculated to identify the strengths and areas of improvement. The percent positive scale scores were calculated by averaging the percent positive response on each item within the scale. A score of greater than or equal to 75 on 100 points scale was deemed as a positive safety attitude (W. C. Lee et al. 2010).

Results

A total of 82 completed questionnaires were returned which represented a response rate of 82%. **Table 7** shows the demographics of the questionnaire participants. 49% of the participants used the Arabic version of the Questionnaire versus 51% using the English version. 57% of the participants were male, and 43% were female. Among participants, around 45% were respiratory therapists, 45% were nurses, 9% were physicians, and one participant was an ICU nutrition specialist. Most of the participants were bachelor's degree holders (76%), then diploma (18%), and postgraduates (6%). 63% of participants have a minimum of 5 years of experience. Regarding

working hours, the majority were working full time 40 to 59 hours per week (83%), and 11.7% were the part-time staff. Around 72% of the participants' work schedule is variable and they cover night and day shifts, 22% work only day shifts, and 6% work night shifts.

Table 7: Demographic data of respondents.

Variables	Frequency	Percentage
Sex (n= 79)		
Male	45	57
Female	34	43
Age (n = 75)		
<= 30 Years	40	53.3
> 30 Years	35	46.7
Educational Level (n=79)		
Diploma	14	17.7
Bachelor's degree	60	75.9
Master, PhD, or equivalent	5	6.3
Job Title (n=78)		
Staff Physician	5	6.4
Nurse	32	41.0
Resident Physician	1	1.3
Respiratory Therapist	33	42.3
ICU Head	1	1.3
Nurse In-charge	3	3.8
Respiratory Supervisor	2	2.6
Nutrition Specialist	1	1.3
Years in Profession (n= 79)		
< = 5 Years	29	36.7
> 5 Years	50	63.3
Years in ICU (n= 79)		
< = 5 Years	43	54.4
> 5 Years	36	45.6
Work hours per week (n = 77)		
Less than 39(part-time)	9	11.7
40 to 59 hours	64	83.1
60 to 79 hours	2	2.6
80 hours and more	2	2.6
Work shift (n = 79)		
Day	17	21.5
Night	5	6.3
Variable shifts	57	72.2
Number of incidents reported to the Management (n = 80)		
None	62	77.5
1 – 2 incidents	18	22.5
Language of survey (n=82)		
Arabic	40	48.8
English	42	51.2

The participants overall SAQ score was 52.8%, which is considered negative (Sexton et al. 2006a).The participants' mean scores for each item of the six domains and the percentage of positive responses are presented in **Table 8**. On average, the domain that scored the highest number of positive responses was Job satisfaction with 68.5%, followed by teamwork climate 67.8%, then working conditions 60.1%, 57.1% safety climate, then preparation of management with 53.4%, and finally 46% in Stress recognition. **Figure 5** demonstrates the average percentage of positive responses per SAQ domain.

The Pearson correlation analysis was used to determine the associations between participants' positive response and each SAQ domain. The reliability analysis was done using the Cronbach α method and showed that the Cronbach α values.

Overall, the SAQ had very good internal consistency (Cronbach's α = 0.91). The domains internal consistency showed good results for Job satisfaction (Cronbach's α = 0.86), Safety Climate (Cronbach's α = 0.77), Working conditions (Cronbach's α = 0.84), and Stress recognition (Cronbach's α = 0.71). And acceptable internal consistency was shown in Preparation of Management (Cronbach's α = 0.70), and Teamwork climate (Cronbach's α = 0.68) which fall within the acceptable range (De Vet et al. 2011).

Table 9 shows the mean SAQ score of participants according to their characteristics. A statistically significant difference was found between the mean SAQ score and the educational level of the participants. Participants with bachelor's degrees scored a mean of 50.17 compared to participants hold diploma degrees who scored a mean of 68.81 (P=0.02). Moreover, a significant difference was found between the mean SAQ score and participants' specialties. Attending/Staff Physician mean score was 36.40, Nurse Manager/Charge Nurse scored 39.78, and Respiratory therapist means score was 47.88, compared to mean score of 62.27 for Registered Nurse, and Respiratory supervisor 67.0 (P=0.04).

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Table 10 shows the mean SAQ score of both hospitals in each domain. Perception of management scored a mean of 28.65 in hospital 2 compared to 62.22 in hospital 1. Hospital 2 working condition scored a mean of 29.05, compared to 74.33 in hospital 1. Moreover, the safety climate means score in hospital 2 was 37.22, and hospital 1 was 69.97.

This could be explained by the significant difference in management and working conditions in both hospitals. Firstly, Hospital 1 is a military hospital that is managed by the Ministry of Defense and serves only the Ministry of Defense workers and their families. Whereas Hospital 2 is under the Ministry of Health administration and serves the public residents of the region and is therefore expected to have a higher workload compared to hospital 1. A higher workload, different management could explain the difference results between these hospitals. Secondly, even though the bed capacity of hospital 2 (425 beds) is more than hospital 1 (335 beds), the staffing in hospital 2 is insufficient and therefore shortage of staffing and working conditions and perception of management means the score was immensely negative.

One of the added items to the Questionnaire was the number of incidents reported by the participants in the last 12 months. Based on the responses, **Table 11** shows that 79.2% of the respondents did not report any incidents in the last 12 months, while 20.7% reported one or two incidents in the last 12 months, and no participant has reported more than two incidents (**Figure 6**).
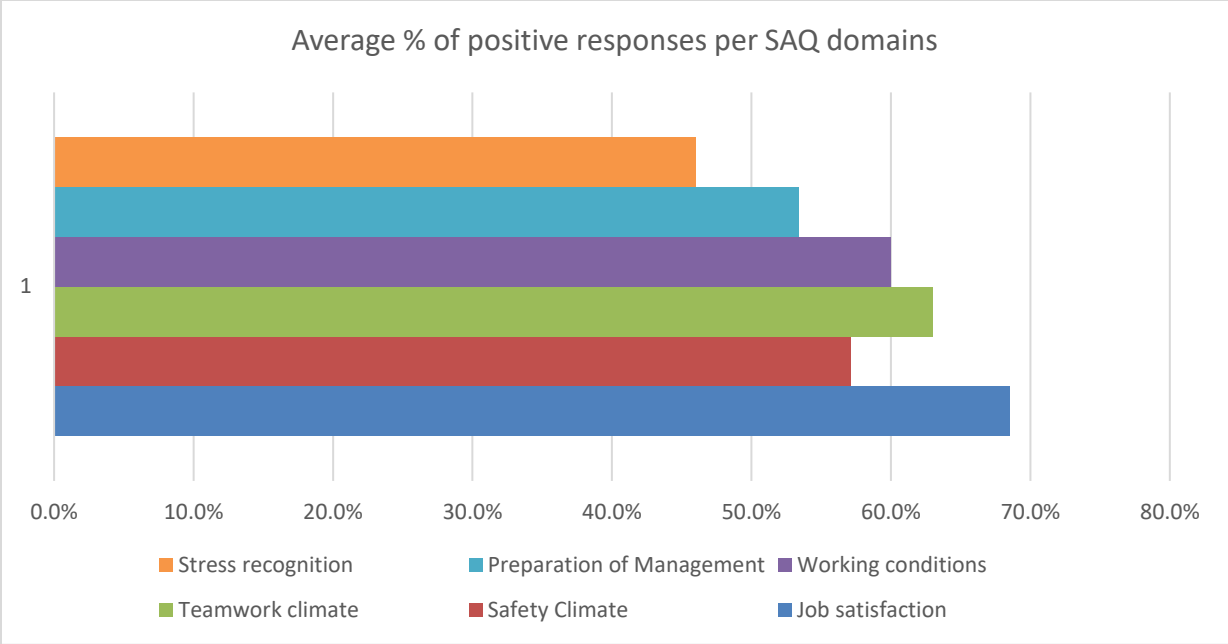
Figure 5: Average of percentage positive responses per SAQ domains.

Table 8: SAQ Domains and items, scales' mean scores, and percentages of positive responses.

	Mean	SD	% of Positive Responses
Job satisfaction (Cronbach's α = 0.86)			
I like my Job	3.56	2.07	75.7
Working here is like being part of a large family	3.07	2.20	67.0
This is a good place to work.	3.04	2.24	65.8
I am proud to work in this clinical area.	3.38	2.10	73.1
Morale in this clinical area is high.	2.72	2.22	60.9
Safety Climate (Cronbach's α = 0.77)			
I would feel safe being treated here as a patient	2.40	2.33	52.5
Medical errors are handled appropriately in this clinical area	2.38	2.36	51.2
I know the proper channels to direct questions regarding patient safety in this clinical area.	3.02	2.17	67.0
I receive appropriate feedback about my performance.	2.99	2.09	68.3
In this clinical area, it is difficult to discuss errors.	1.48	2.02	35.4
I am encouraged by my colleagues to report any patient safety concerns I may have.	2.83	2.14	64.6
The culture in this clinical area makes it easy to learn from the errors of others.	2.68	2.19	61.0
Teamwork climate (Cronbach's α = 0.68)			
Nurse input is well received in this clinical area	3.37	2.09	73.2
In this clinical area, it is difficult to speak up if I perceive a problem with patient care	1.00	1.85	23.2
Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient).	2.65	2.27	58.5
I have the support I need from other personnel to care for patients	3.43	2.07	74.4
It is easy for personnel here to ask questions when there is something that they do not understand.	3.45	2.02	75.6
The physicians and nurses here work together as a well-coordinated team.	3.39	2.11	73.1
Working conditions (Cronbach's α = 0.84)			
Problem personnel are dealt with constructively by our department.	2.09	2.23	47.6
This hospital does a good job of training new personnel.	2.82	2.25	62.2
All the necessary information for diagnostic and therapeutic decisions is routinely available to me.	2.93	2.16	65.9
Trainees in my discipline are adequately supervised.	2.95	2.23	64.6
Preparation of Management (Cronbach's α = 0.70)			
Management supports my daily efforts:	2.24	2.18	52.4
Management doesn't knowingly compromise patient safety.	2.76	2.31	59.8
I get adequate, timely info about events that might affect my work.	2.44	2.20	56.1
The levels of staffing in this clinical area are sufficient to handle the number of patients	1.98	2.22	45.1
Stress recognition (Cronbach's α = 0.71)			
When my workload becomes excessive, my performance is impaired.	2.05	2.24	46.3
I am less effective at work when fatigued.	2.54	2.18	58.5
I am more likely to make errors in tense or hostile situations.	1.71	2.23	37.8
Fatigue impairs my performance during emergency situations (e.g. emergency resuscitation, seizure).	1.85	2.24	41.5
Overall SAQ (Cronbach's α = 0.91)	2.64	1.13	
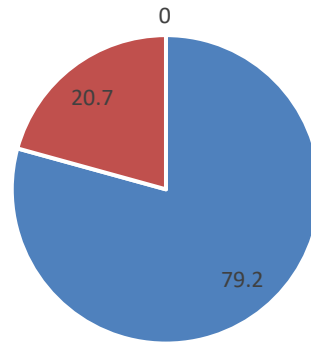
Figure 6: Number of incidents reported by participants in the last 12 months.

Table 9:Association between participant characteristics and overall SAQ scores.

	Mean	SD	P-value
Sex (n= 79)			0.43
Male	55.08	23.23	
Female	52.10	20.70	
Age (n = 75)			0.30
<= 30 Years	51.22	20.94	
> 30 Years	56.42	23.49	
Educational Level (n=79)			0.02
Diploma	68.81	17.26	
bachelor's degree	50.17	22.17	
Master, PhD, or equivalent	55.33	17.48	
Job Title (n=78)			0.04
Attending/Staff Physician	36.40	8.39	
Registered Nurse	62.27	22.30	
Respiratory therapist	47.88	21.09	
Fellow Physician	70.00	nil	
Nurse Manager/Charge Nurse	39.78	13.68	
Unit Head	67.33	nil	
Respiratory supervisor	67	0.47	
Nutrition	78.67	nil	
Years in Profession (n= 79)			0.65
< = 5 Years	55.29	21.62	
> 5 Years	52.93	22.52	

			0.24
Years in ICU (n= 79)			
< = 5 Years	56.50	23.10	
> 5 Years	50.57	20.66	
Work hours per week (n = 77)			0.94
Less than 39(part-time)	53.85	26.24	
40 to 59 hours	53.42	21.98	
60 to 79 hours	43.33	5.66	
80 hours and more	52.00	25.46	
Work shift (n = 79)			0.28
Day	55.61	20.42	
Night	38.53	18.05	
Variable shifts	54.60	22.68	
Number of incidents reported to the Management (n = 80)			0.21
None	52.12		
1 – 2 incidents	59.48		

Table 10: Comparison of the result of both hospitals.

Domain	Hospital 1		Hospital 2	
	Mean	SD	Mean	SD
Job Satisfaction	76.71	30.17	46.49	32.41
Safety Climate	61.97	25.21	37.22	25.93
Teamwork Climate	66.67	21.09	46.58	26.88
Working Conditions	74.33	27.11	29.05	30.66
Perception of management	62.22	25.73	28.65	29.12
Stress recognition	35.44	28.16	47.16	36.22

Table 11:Number of incidents reported by participants per specialty in the last 12 months.

# of incidents reported	All participants		Physicians		Nurses		RT		Others	
	F	%	F	%	F	%	F	%	F	%
1 – 2	17	20.7	3	3.7	7	8.5	6	7.3	1	1.2
None	65	79.2	3	3.7	28	34.1	29	35.4	5	6.1

Discussion

Healthcare accreditation organizations such as Joint Commission International (JCI), United

Kingdom Accreditation Service (UKAS), and the Saudi Central Board for Accreditation of

Healthcare Institutions (CBAHI), encourage hospitals to frequently assess safety culture within the institution. In Saudi Arabia, the safety culture research field is still relatively new and underexplored and has very limited published data in measuring safety culture and the use of SAQ (Alayed, Lööf, and Johansson 2014; Alswat et al. 2017; Alzahrani, Jones, and Abdel-Latif 2018; Algahtani 2015). The findings of this study show similarity to results from other studies (Sexton et al. 2006b; Hamdan 2013; Abu-El-Noor et al. 2017; Vifladt et al. 2016; Gabrani et al. 2015; Zhao et al. 2019).

In this study, our results show a significant difference between nurses and other specialties. Nurses scored a higher positive attitude toward safety culture. The result is in line with the findings from a study done by Abu-El-Noor (Abu-El-Noor et al. 2017). This difference could be related to the fact that most of the nurses were younger and felt more informed toward safety culture. They may also be more resilient and able to cope with stressful working conditions in ICU (Raftopoulos and Pavlakis 2013a). However, other studies reported that physicians scored higher than nurses (Sexton et al. 2006b; Gabrani et al. 2015; E. J. Thomas, Sexton, and Helmreich 2003). The difference in the SAQ score between healthcare specialties could be related to the safety culture of their department, responsibilities, availability of protocols, training, and gender (E. J. Thomas, Sexton, and Helmreich 2003).

Another significant difference was found between staff holding a diploma degree who scored higher in SAQ compared to higher educated staff. This could be related to the fact that the majority of diploma staff have had more ICU experience than others and therefore were more familiar with the unit policies and team. Findings in this study indicate that staff working in night shifts scored lower overall SAQ than the day shift. Various studies found that safety and productivity are compromised during night shifts (Folkard and Tucker 2003; Wagstaff and Lie 2011; Gomez-Garcia et al. 2016).

In this study, job satisfaction scored the highest positive domain among all domains despite the fact that the stress recognition domain scored the lowest at 46%, with more than 55% of participants believing that ICU staffing is insufficient. These results were consistent with findings from other studies (Hamdan 2013; Raftopoulos and Pavlakis 2013b). This could be explained firstly by high working morale since 75.7% of participants answered positively to the item "I like my Job" which was the highest scored item in SAQ. Secondly, it could be explained by the positive teamwork domain, which scored 67.8% positive response (2nd highest domain) which could be a result of ICU staff familiarity with each other. Moreover, it was noticed that some of the younger staff were trained during their internship in these units; therefore, they feel loyal to the team.

The stress recognition domain scored the lowest in both hospitals. This finding is consistent with other studies (Raftopoulos and Pavlakis 2013b). This could be a result of working in a stressful, fast-paced environment resulting in staff burnout. In addition, Item "Problem personnel are dealt with constructively by our department" in the working condition domain, received only 47.6% positive responses. Several studies showed a correlation between high workload, stressful working conditions, and the number of incidents rate (Fahrenkopf et al. 2008; Ahola et al. 2009; Guirardello 2017; Abu-El-Noor et al. 2017).

The results of overall SAQ showed significant differences between both ICUs. However, the variation in overall SAQ score between hospitals is common and expected as a result of different management, financial status, staff level, and types of patients (Raftopoulos and Pavlakis 2013b; Hamdan 2013).

Hospital 1 had recently initiated a safety educational program among their hospital staff, which may explain the relatively positive attitude of their staff towards safety culture. However, both hospitals showed deficiencies in their reporting systems and staff who were unwilling to report incidents (**Table 11**). This could be due to reasons such as lack of staff awareness about the

importance of reporting incidents, or the fear of punishment and liability. In the survey 35.4% of participants had felt that: "In this clinical area, it is difficult to discuss errors" and 23.2% of participants felt that: "In this clinical area, it is difficult to speak up if I perceive a problem with patient care", moreover only 51.2% of participants believes that "Medical errors are handled appropriately in this clinical area". which indicates that the existing culture in the ICUs is not supportive and reliable toward reporting incidents and patient safety culture. Only 52.5% of staff said they felt safe to be treated in their hospitals, which is a strong indicator of poor patient safety.

Several studies showed that safety culture has a strong association with patient safety and incidents rate (Nieva and Sorra 2003; Sexton et al. 2006b; W. C. Lee et al. 2010; Pettker et al. 2011; S. E. Lee et al. 2019; Tear et al. 2020). Moreover, more studies suggest that inability or difficulty for staff to report or to discuss incidents is one of the main reasons for poor patient safety culture (Sexton et al. 2006b; Buljac-Samardzic, Van Wijngaarden, and Dekker-Van Doorn 2016). Therefore, further investigation is needed from each hospital's administration to highlight staff concerns and work in improving the safety culture.

Conclusion

The result of the study shows unsatisfying levels of safety culture among healthcare staff in these two ICUs. The importance of this study is to establish a baseline for safety climate in these hospitals and specifically in ICUs. In addition, by exposing system weaknesses it helps the administration strengthen and improve patient care. By decreasing workload and job stress, studies show they have a positive association with increasing job performance (Raziq and Maulabakhsh 2015). The use of questionnaires should be done periodically to assess safety culture over a period of time and observe the direction of the results.

Limitations

Using questionnaires to evaluate safety culture, or more specifically, safety climate plays an important role in drawing the road map of the institution's safety culture assessment. However, SAQ is not enough, therefore more tools should be used to inspect other aspects of safety culture. SAQ is great at measuring staff beliefs about safety culture but does not measure actual safety behavior which is equally important in determining a more accurate picture of safety culture (Gadd and Collins 2002). Furthermore, the sample size was limited; therefore, the findings should be dealt with caution in regard to transferability. In addition, the participation of specialties such as physicians, clinical pharmacists, and others was poor and needed to be further investigated.

Summary

The use of the questionnaire tool only explores the psychological aspects of safety culture and should not be used as the only assessment tool for improving an institution's safety culture. Additional qualitative and quantitative investigations are needed to truly evaluate the safety culture and to establish a designed safety improvement intervention that tackles the founded issues in these hospitals. Including an observational study will provide a rich amount of data about the actual prevalence and effects of medical incidents during respiratory therapy in ICU.

Chapter 3: Prevalence of medical Incidents during respiratory therapy in Intensive care unit (ICU): a cross-sectional observational study

Introduction

Safety culture and prevention of medical incidents have recently received more attention as surely required. Compared to other industries, such as engineering, aviation, or nuclear plants, hospitals and healthcare institutions were late in applying human factors theories and studies. However, healthcare institutions took advantage of other industries' advancement in ergonomic theories and incidents analysis, which helped the fast growth of healthcare ergonomics.

One of the earliest studies that addressed medical error by highlighting the incidence of adverse events and negligence was the Harvard Medical Practice Study. In this study, around 28 percent of the adverse events were due to negligence and around 70 percent of adverse events were avoidable (Brennan et al. 1991). Furthermore, it was estimated that a minimum of 44,000 deaths in the United States was the result of medical errors that could have been prevented (Kohn, Corrigan, and Molla 1999). Moreover, in a more recent study done at Johns Hopkins University, it was estimated that more than 250,000 people in the U.S. die every year from medical errors. These high numbers of death make the medical error as the third leading cause of deaths in the United States (Makary and Daniel 2016).

Even though the ICU is designed to be a closed and controlled environment to treat critically ill patients, medical errors still have a high chance of occurring., The stressful environment of taking care of severely ill patients increases the risk of medical error incidence. In addition to the severity of illness, the complexity of treatments, advanced technological equipment fast paced decision making, and critical procedures elevate the odds of medical error exposure in ICU (Bucknall 2010; Valentin 2007). A typical ICU patient is critically ill and requires high-intensity medical care. Patient illness severity and the use of high-intensity care and advanced equipment increase the chances of medical errors in ICU (Garrouste-Orgeas et al. 2010). ICU patients usually need airway protection and require the use of temporary respiratory support either through invasive or noninvasive mechanical ventilation (Wunsch et al. 2010).

Respiratory therapy plays a major role in operating, assessing, and managing patients on mechanical ventilation in ICU. The use of complex therapies and high severity level of patient illness increases the risk of medical errors and adverse events that respiratory therapists have a hand in preventing with proper training, honest effort, continued education, and quality monitoring. As part of the ICU medical team and under the ICU medical supervision the respiratory therapist is focused on assessing, monitoring, and treating patients with cardiopulmonary diseases or any patient with breathing or pulmonary difficulties (Keenan et al. 1998). The respiratory therapist duties in ICU range from simple oxygen administrations to management of sophisticated microprocessor mechanical ventilation machines. A respiratory therapist is responsible for maintaining a secure and patent patient airway. In addition, they are responsible for oral, nasal, nasopharyngeal, and endotracheal suctioning which are also considered sharing responsibilities with nursing (Leddy and Wilkinson 2015). Therefore, with this wide range of duties and responsibilities comes a higher chance of errors and mistakes.

Cooper identified in his framework the need for examining the behavioral aspect of safety culture as a cornerstone of evaluating the current ICU safety culture. Methods such as questionnaires only assess the psychological aspect of safety culture. However, using qualitative methods, we can capture the work complexity and staff behaviors in work settings (M. D. Cooper 2000). Non-participant, direct observations of healthcare practice on-site, provide a prolific amount of data that helps understand the safety culture, work process, weaknesses and ways to improve performance (Catchpole et al. 2017). This study aims to observe and investigate the prevalence of medical errors in the ICU setting from the respiratory therapy viewpoint. Understanding the common types of errors that occur during respiratory care in ICU could help in building and designing a systematic approach to reduce errors and prevent recurrence of incidents.

Methods

A cross-sectional observational study was conducted, the quantitative data will help uncover the prevalence of the respiratory therapist incidents and types, and correlate between the variables.

Study settings and design

The data collection was conducted in two adult ICUs in two main hospitals in the Eastern Region of Saudi Arabia. The two main hospitals have a total capacity of 759 beds and a total of 50 adult ICU beds. Most ICU admissions were for medical and surgical reasons. Permission was obtained from the hospital administration and ethical approval was acquired from the hospital research committee (**Appendix 2**). After receiving permission to conduct the study in their ICUs, data were collected over a period of 65 days between April and June 2019. Observations were conducted mainly during day shifts. Night shifts observation were conducted with a minimum of one night shift per week. Few night observations were conducted after a day shift observation by another observer. Total hours of observation are estimated to be around 840 hours. A list of predefined, targeted respiratory-related medical incidents was generated with the core types of incidents to be explored and investigated (**Table 12**). All the predefined incidents were identified and broken down into a hierarchical chart, and each procedural step was identified based on the American Association of Respiratory Care (AARC), hospital policies, and department practices, an example of a procedure steps is outlined in **Appendix 3**. The observation contributing factors protocol was designed based on Vincent's London Protocol which consists of six domains: Organizational and management factors, Work environment factors, Team factors, Individual (staff) factors, Task factors, and Patient factors (C. Vincent, Taylor-Adams, and Stanhope 1998). To minimize the observer effect (Hawthorne Effect), four observers working in the same hospital were recruited, therefore their presence in the ICU is usual and expected. A training workshop for the observers was conducted prior to the study to guarantee that the quality of their observations will be as expected. The list of the predefined targeted respiratory-related medical incidents was discussed

with the observers during the training workshop. Afterwards, two weeks of mock observations were conducted for training and evaluation purposes, and all the noted information and results were discussed, and feedback was given. If serious harm were to occur to the patients, observers were instructed to alert the staff. However, these types of incidents were very rare. After an incident occurred, the patient file was checked away from the patient room, and the involved staff were unaware of the process to avoid any influence on the observational process. Occasionally, we conducted the observation with two observers, rather than one, in the unit at the same time to test reliability. At the end of the observational session, a debriefing meeting was conducted with the observers to discuss the observed events and evaluate the reporting process.

A reporting form (**Appendix 4**) was designed to request information regarding patient demographics, types of respiratory services provided, details of staff involved, incidents details, types of incidents, incidents outcome, contributing factors, and the observer notes. In addition, a self-reporting form was given to the staff to report any incident to occur during night shifts or when observers are not around.

Inclusion criteria

All adult ICU patients aged 16 and older who required respiratory care services were included. The need for written consent was not required since it was only examining the provided care. All collected data were anonymous and confidential.

Data Analysis

Simple descriptive statistics were calculated for patients and incidents characteristics and reported as numbers and percentages. A chi-squared test was used to test the relationship between incidents descriptions and patient characteristics. We used the Pearson correlation analysis to determine the associations between patients' age and length of stay (LOS) in ICU. Each hospital data was analyzed separately, compared side by side for differences, then

calculated as a total to find any correlation with other variables. Rate of incidents per patient days was calculated by dividing the number of incidents per month by the number of occupied ICU bed days for 30 days then multiplied by 1000. All data were transferred to an electronic worksheet in Microsoft® Excel on Office 365. Then data were analyzed using SPSS software (a Statistical Program for Social Sciences, Chicago, IL) version 25. A p-value of less than 5% was considered statistically significant.

Table 12: predefined respiratory-related medical incidents

Medical Error	Definition
Suction failure.	The suction system does not work properly: The pressure is not sufficient to ensure removal of pharyngeal and/or bronchial secretions
Laryngoscope dysfunction	The laryngoscope does not work properly: The light is not strong enough or does not turn on, assembly of the blades on the handle is difficult, or blade size is not available
Accidental extubation	Unplanned extubation or self-extubation of ETT or tracheostomy tube
Airway unsecure/ displaced ETT	Incorrectly secured tube, totally displaced from the patient, displaced from the trachea into soft tissues, displaced from the trachea into the pharynx, displaced from the trachea into the esophagus, or displaced from trachea into the bronchus.
Artificial airway obstruction	ETT or tracheostomy blockage
Unsafe ETT level	Either there ETT level is too low or too high (optimal ETT level is 2-3cm above the carina and it could be assessed through chest X-ray)
Arterial blood gas error	Wrong technique (e.g. not performing Allen test to avoid complication), sample error (e.g. veins sample, or air bubble)
Failed Intubation attempt	Includes: Failure to intubate, Delay in intubation, Endobronchial intubation, Esophageal intubation, and Aspiration of gastric contents
Inappropriate ETT cuff pressure	Either the mean pressure in the ETT cuff pressure is over (over-inflation) or below (leak) the recommended pressure (it could be a result of inappropriate ETT size)., which is measured with an optimal range 20-30 cm H_2O.
HME failure	Either failure because the respiratory therapist did not change it as instructed (every 48 hours based on hospital policy) or failure due to secretion block
MV and accessories dysfunction	Lack of cleaning, or faulty equipment.
Inappropriate mechanical ventilator settings for the patient.	The settings are not optimal (based on ICU policy, e.g.: ARDS protocol) or updated for patient prognosis or auto cycling breathing
Patient Ventilator asynchrony	No sedation, not using the ventilator graphs to identify issues
Alarm failure	Inappropriate settings of alarms or alarms are turned off including pulse oximetry and end-tidal CO2 monitoring alarms
NIV incidents	Delay or absence of NIV, inappropriate Noninvasive interface size, or leak
Failure to follow infection control protocol	Including Hand hygiene, Use of personal protective equipment (e.g., gloves, gowns, and masks), Safe injection practices, and safe handling of potentially contaminated equipment or surfaces
Respiratory medication error	Either by administering medication to the wrong patient, wrong dose, or delayed or wrong time
Documentation error	Absence, incomplete, or wrong documentation. Including the use of an unapproved abbreviation
Failure of Transport ventilator	No charge or low charged battery
Electrical power failure	No backup power or battery, unaware staff with outage
Behavioral incidences	Rude, miscommunication, member inactive of teamwork
Prolong mechanical ventilation	Ventilation for 21 consecutive days for at least 6h/d.
Comorbidities	Defined as: congestive heart failure, coronary artery disease, chronic obstructive pulmonary disease, interstitial lung disease, pulmonary hypertension, end-stage renal disease, liver cirrhosis, diabetes mellitus, acute or chronic encephalopathy, cancer, and immunosuppressant usage.

Results

Patients characteristics

Out of a total of 341 ICU admission, *n=58* (17%) patients were exposed to respiratory-related medical incidents. We identified that 79.3% of ICU patients required invasive mechanical ventilation (MV). The characteristics of the exposed patients are shown in **Table 13**. The majority of patients 70.7% were male. Patients' ages range from 16 to 92 years with an average of 61.3 years. LOS tended to increase with older patients, with a mean of 13.3 ICU days. A significant relationship was observed between patient age and increase in LOS (*P*= 0.007). Patients aged between 66 and 75 years stayed the longest in ICU (21 days). Seventy-nine percent of patients were intubated and required the use of mechanical ventilation. Nearly 34% of respiratory-related medical incidents occurred to patients with comorbidity, and among these patients 40.3% had one comorbidity, 49.2% with two comorbidities, and 6.6% had three comorbidities or more. Among patients aged between 16 and 35, 76.9% were admitted as a result of a road traffic accidents (RTA).

Medical incidents during respiratory therapy

The total rate of incidents per 1000 patient-days was 118.9 incidents. The total number of incidents during the observation period was 289 incidents with rate of 1 incident every 3 observation hours. Among these incidents, 42.9% were related to infection control and documentation errors (Miscellaneous errors), and 38.4% were airway related (**Table 14**).

Most of the incidents occurred in patients aged 55 and older (67.8%) (**Table 15)**. The most common incidents that occurred during respiratory therapy were documentation errors 27.3%, followed by infection control 11.8%, then 11.4 % of incidents were due to inappropriate pressure of ETT cuff. **Table 16** shows the prevalence of respiratory-related medical incidents**.** Heat and Moisture Exchangers (HME) incidents such as HME were plugged or not connected. HME were

associated with patients age 46 and more (*P*=0.02). In addition, there was a significant correlation between the number of patients who developed ventilator-associated pneumonia (VAP) and HME related incidents (*P*=0.03) shown **in Table 17**. Moreover, VAP was associated with inappropriate ETT cuff pressure (*P*=0.03). The results show an increase in incidents related to infection control with an increase in LOS (*P*=0.04).

LOS and incidents related to inappropriate settings on MV were significantly associated (P=0.03). **Table 18** presents the prevalence of MV mode among MV and airway related incidents. During MV related incidents, pressure regulated volume control (PRVC) mode was the most commonly used mode (38.1%). On the other hand, the most commonly used mode during airway related incidents was Assisted-Controlled/Pressure-Controlled ventilation (AC/PC) mode (27%). In MV related incidents, the most common observed incidents were Patient Ventilator Asynchrony (PVA) 40.5% and inappropriate settings for the patient on MV 33.3%. Moreover, 47.4% of PVA incidents occurred during PRVC mode. Fifty percent of inappropriate settings for the patient on MV occurred during Synchronized-Intermittent-Mandatory-Ventilation/Pressure-Controlled (SIMV/PC) mode (**Table 19**).

Incidents outcome

Table 20 demonstrates the outcome of reported incidents. Sixty-seven percent of observed incidents did not require a change in the patient treatment plan. Unfortunately, there was one reported death to a patient who was exposed to an airway related incident. However, that does not mean the patient's death was linked directly as a result of this incident.

Staff characteristics

Eighty percent of the staff involved in the reported incidents worked exclusively in the ICU, with 72% being male. There was no significant relationship found between staff experience and the number of committed incidents (**Table 21**).

Contributing factors

The most common observed contributing factors were: policy and procedure protocol not having been followed (67.1%), failure to check (51.2%), and poor supervision (23.9%). The observed contributing factors to respiratory-related incidents in ICU can be seen in **Table 22.** Moreover, there were 31 incidents which resulted from equipment failure. Suction pump failure was the most common equipment to fail n=19, 61.3%. followed by mechanical ventilator n=7, 22.6%. More data regarding incidents as a result of equipment failure are presented in **Table 23**.

Table 13: Patients characteristics.

Variable	Mean (%)
Patient age (years)	61.3
Number of patients per age group:	
16-35	13 (22.4%)
36-45	6 (10.3%)
46-55	9 (15.5%)
56-65	8 (13.8%)
66-75	11 (19%)
76-85	8 (13.8%)
86-95	3 (5.2%)
Gender:	
Male	41 (70.7%)
Female	17 (29.3%)
Days in ICU	13.3
Days in ICU per age group	
16-35	7.1
36-45	4.7
46-55	9.1
56-65	8.2
66-75	21
76-85	12.9
86-95	5.4
Type of respiratory support	
intubated	46 (79.3%)
NIV	2 (3.4%)
O2	10 (17.2%)
Comorbidities:	
CHF	7 (7.1%)
CAD	11 (11.1%)
COPD	6 (6.1)
ILD	1 (1%)
End-Stage Renal Disease	9 (9.2%)
Liver Cirrhosis	1 (1%)
DM	35 (35.7%)
Encephalopathy (acute or chronic)	7 (7.1%)

Cancer	8 (8.2%)
Immunosuppressant Usage	13 (13.3%)
Patient with:	
1 comorbidity	27 (44.3%)
2 comorbidities	30 (49.2%)
3 and more	4 (6.6%)

Table 14: Prevalence of incidents per domain.

	Number of incidents		
	Mean (%)		
Incident domain	**Hospital 1**	**Hospital 2**	**Total**
Mechanical ventilation related errors	23 (12.9%)	19 (17.1%)	42 (14.5%)
Airway related errors	49 (27.5%)	62 (55.9%)	111 (38.4%)
Equipment related errors	4 (2.2%)	8 (7.2%)	12 (4.2%)
Miscellaneous errors	101 (56.7%)	23 (20.7%)	124 (42.9%)

Table 15: Prevalence of incidents domains per age group

Age group	Mechanical ventilation related incidents	Airway related incidents	Equipment related incidents	Miscellaneous incidents	Total incidents n (%)
16-35	6	15	2	12	35(12.1%)
36-45	3	4	2	9	19(6.6%)
46-55	5	18	3	13	39(13.5%)
56-65	8	11	2	12	33(11.4%)
66-75	8	33	3	40	84(29.1%)
76-85	9	15	-	34	58(20.1%)
86-95	3	14	-	4	21(7.3%)

Table 16: Prevalence of respiratory-related medical incidents

Respiratory care medical incidents in ICU	F	%
Mechanical ventilation related incidents:		
Inappropriate settings for the patient on MV	14	4.8
Patient Ventilator Asynchrony	17	5.9
Alarm failure	5	1.7
Ventilator-Patient circuit disconnect or leak	-	-
Noninvasive ventilation error	6	2.1
Airway related incidents:		
Suction failure	26	9.0
Laryngoscope dysfunction	4	1.4
Accidental extubation	3	1.0
Airway unsecure /displaced ETT	7	2.4
Artificial airway obstruction	8	2.8
Unsafe ETT level	2	0.7
Failed Intubation attempt	6	2.1
Inappropriate ETT cuff pressure	33	11.4
Heat and moisture exchanger (HME) failure	22	7.6
Equipment related incidents:		
Mechanical ventilator and accessories dysfunction	7	2.4
Failure of arterial blood gas machine	2	0.7
Failure of Transport ventilator	1	0.3
Electrical power failure	2	0.7
Miscellaneous incidents:		
Arterial blood gas error	7	2.4
Failure to follow infection control protocol	34	11.8
Respiratory medication error	3	1.0
Documentation error	79	27.3
Behavioral incidences	1	0.3
Total number of incidents during the total observational period	289	

Table 17: Relationship between HME related errors and Patients developing VAP.

	Hospital 1	Hospital 2	Overall	*P*-value
Number of patients developed VAP	13	11	24	0.03
Number of patients developed VAP and exposed to HME related errors	9	8	17	
%	69.2%	72.7%	70.8%	

Table 18: association between MV mode and MV and airway incidents

MV Mode	Incidents related to MV n (%)	Incidents related to Airway n (%)
AC/Pc	5 (11.9)	30 (27)
PRVC	16 (38.1)	27(24.3)
PSV	3 (7.1)	3(2.7)
SIMV/PC	13 (31)	23(20.7)
SIMV/PRVC	1 (2.4)	-

Table 19: MV modes and MV incidents

MV mode	Inappropriate settings for the patient on MV	Patient Ventilator asynchrony
AC/Pc	3 (21.4)	4(21.1)
PRVC	3 (21.4)	9(47.4)
PSV	1(7.1)	2(10.5)
SIMV/PC	7(50)	3(15.8)
SIMV/PRVC	-	1(5.3)

Table 20: Incidents outcome

Incidents outcome	Hospital 1	Hospital 2	total
No harm or self-resolving injury	142	53	195(67.5%)
Minor injury may require adaptation of treatment	23	29	52 (18%)
Serious injury may increase ICU days	12	26	38 (13.1%)
Serious permanent injury	1	2	3 (1%)
Death	-	1	1 (0.3%)

Table 21: Staff characteristics

Variable	Number of errors
	Mean (%)
Staff years of experience:	
1-5 years	122 (42.2%)
6-10 years	153 (52.9%)
11 & more	14 (4.8%)
Staff gender:	
Male	208 (72%)
Female	78.1 (27%)
The day before the incident, the staff was:	
On duty	164 (56.9%)
Off duty	124 (43.1%)
Patient to respiratory therapist ratio	6.8
The respiratory therapist works:	
Only ICU	232 (80.1%)
Float	57 (19.9%)

Table 22: prevalence of contributing factors

Contributing factors	Number of incidents (n=289)	%
Organizational and management factors:		
Shortage of staff	32	11
Unclear or unavailable policy for the procedure	5	1.7
Policy and procedure protocol has not been followed	194	67.1
Poor safety culture	52	18
Poor training	19	6.6
Work environment factors:		
High workload	53	18.3
Unfamiliar environment	-	-
Unavailable or lack of maintenance of equipment	30	10.4
Physical environment such as noise and temperature	-	-
Equipment failure	31	10.7
Electrical power failure	2	0.7
Team factors:		
Lack of communication	22	7.6
Inadequate assistance	8	2.8
No help offered	5	1.7
Poor supervision	69	23.9
Individual (staff) factors:		
Lack of knowledge	17	5.9
Inexperience	20	6.9
Distraction	13	4.5
Stress and fatigue	12	4.1
Failure to check	148	51.2
Unfamiliar procedure or equipment	12	4.1
Task factors:		
Lack of equipment	28	9.7
Equipment alarms were off	7	2.4
Unavailable or not accurate test results	14	4.8
Unavailable documentation	24	8.3
Patient factors:		
Critically ill patient with poor prognosis	41	14.2
Patients refuse the treatment	-	-
Language and communication barrier	-	-
Social or mental factors	-	-

Table 23: Equipment's failure incidents

Equipment	n (%)
Suction pump failure	19 (61.3)
Laryngoscope dysfunction	2 (6.5)
Mechanical ventilator and accessories dysfunction	7 (22.6)
Failure of arterial blood gas machine	2 (6.5)
Failure of Transport ventilator	1 (3.2)

Discussion

ICU patients are more prone to medical errors than other patients and that is due to the critical condition of patients in ICU, the use of high-tech devices like mechanical ventilation, and the fast-paced decision-making environment (Valentin 2007). Medical errors have been studied by a variety of specialties' points of view such as anesthesiologists, pharmacists, nurses, etc.; however, medical errors in the area of respiratory therapists' practice have not yet been investigated. This observational study identified the types and prevalence of common incidents that occur during Respiratory therapy in ICU and its relation to patients' characteristics and other contributing factors. The study shows at least one respiratory-related medical incident occurred in 17% of ICU admissions for incidents rate of 118.9 per 1000 patient-days. These results fall in the ranges of reported incidents in ICUs from different studies, which range from 13.8% to 20.4% of ICU admissions (Rothschild et al. 2005; Garrouste-Orgeas et al. 2010; Valentin et al. 2006; Meurer et al. 2006; Bracco et al. 2001; L B Andrews et al. 1997).

Our study found a significant relationship between patient age and LOS. The findings are consistent with previous studies (Vosylius, Sipylaite, and Ivaskevicius 2005; Nicolas et al. 1987; Moitra et al. 2016). The increase in LOS is associated with an increase in incidents rate (Marbella et al. 2011; Valentin et al. 2006; L B Andrews et al. 1997). Older patients are more ill, and the presence of comorbidities leads to a poorer prognosis therefore requiring more complex interventions which increase the chances of incidents occurrence (Valentin 2007; Heyland et al. 2016; Weingart et al. 2000). In addition, our study found that patients with long ICU stays suffer from more errors related to infection control which indicates a decrease in quality of care. This coincides with Heyland's study of the relativity of end of life patients and the occurrence of medical errors which found a significant relationship between the severity of patient illness and the possibility of medical errors (Heyland et al. 2016).

In our study, we found that the most frequent errors were related to documentation related incidents. Missing documentation such as the date of intubation or HME change date were among the most common reported missing information. Poor documentation has been reported as a common incident that could lead to further follow up incidents such as medication errors (Baylis, Price, and Bowie 2018; Khalil and Lee 2018).

Airway related incidents were found to be the second most common incidents with 38% of total incidents. Lipshutz et al reported that 50% of near-miss errors were airway related (Lipshutz et al. 2015). Airway related incidents are critical, and life-threatening and should be carefully handled by the management. Inappropriate ETT cuff pressure was the most frequent observed incidents in airway related incidents. Hardcastle and colleagues reported that only 23% of intubated patients had their ETT cuff pressure within the appropriate range (Hardcastle, Faurie, and Muckart 2016). Inappropriate ETT cuff pressure is associated with many complications such as ventilator-associated pneumonia and tracheal stenosis (Raynham, Lubbe, and Fagan 2009). Poor supervision and high workload were reported as contributing factors behind inappropriate ETT cuff pressure incidents.

VAP was investigated in many studies, however, their focus was the effect of positioning the patients. This study found a relation between VAP and HME related incidents. Around 71% of patients who developed VAP were exposed to HME related errors. No fatality was reported as a result of VAP until the study was concluded. Studies suggest a significant reduction in the incidence of VAP in patients humidified with HMEs during MV (Kola, Eckmanns, and Gastmeier 2005). In addition, findings showed that more patients developed VAP when they were exposed to inappropriate ETT cuff pressure. Underinflation of cuff pressure is considered one of the main risk factors for microaspiration and eventually developing VAP (Nseir et al. 2012). Therefore, monitoring ETT cuff pressure is essential in decreasing the incidents of VAP (Nseir et al. 2015, 2012).

Another area of respiratory-related medical incidents is mechanical ventilation related incidents. Seventeen observed incidents were related to PVA. The most common causes of PVA is auto triggering, or insufficient ventilation or agitated patients (Holanda et al. 2018). The respiratory therapist assessment and monitoring are essential to evaluate the patient's needs and adjust the settings to achieve better ventilation. Therefore, knowledge and training are critical elements in identifying and handling PVA. In a study of ICU staff's ability to identify PVA, only 10.2% of 411 ICU staff were able to identify all PVA. Trained ICU staff were found to be significantly more able to detect PVA compared to others (Alqahtani et al. 2020). In published case studies, PRVC was found to be associated with the occurrence of patient-ventilator asynchrony (Singh, Chien, and Patel 2020). PRVC is an adaptive mode, that changes delivered breath to achieve the calculated targets regardless of actual patient needs (Kallet et al. 2005). This kind of mode encourages the therapist to depend on the machine to achieve the targets. Patient-ventilator asynchrony could lead to poor patient progress and prolong the use of mechanical ventilation (Thille et al. 2006). More clinical education should be offered to respiratory therapists and more attention and monitoring should be paid to patients throughout the shift to avoid complications and improve patient outcomes. A study found that one-third of ICU physicians had poor knowledge of mechanical ventilation strategies such as lung-protective ventilation (Mikkelsen et al. 2009). In contrast to PRVC mode, assist control mode (A/C) is a control mode that doesn't change based on patient need, rather it delivers constantly what was set on the machine. The patient status could change, and if initial ventilation settings are not updated to correlate with this change in the patient's status, damage can occur. For this reason, our findings showed A/C mode was associated frequently with inappropriate MV settings.

In ICU management, the use of highly complex and sophisticated equipment and devices is required to save patient life. In this observational study, we found 31 (10.7%) incidents occurred as a result of equipment failure. Equipment failure was found to be a contributing factor to

incidents range between 2% to 14% (J. B. Cooper et al. 1978; Bracco et al. 2001). The SEE study found that 9.2 events (per 100 patient-days) were related to equipment failure. In their study, the most common equipment failures were infusion devices, then mechanical ventilators (Valentin et al. 2006). In our findings, suction pressure failure was the most common equipment to fail. The causes for this were related to failure in vacuum pressure and failure in the suction machine. Mechanical ventilation dysfunction incidents were reported second and were related to poor maintenance, unavailable sensors, and calibration issues. These findings correlate fairly well with previous results (Valentin et al. 2006; Garrouste-Orgeas et al. 2010).

In this study, comparing to other staff experience groups 1-5 & 6-10 years (42.2% and 52.9%, respectively), only 4.8% of incidents were committed by staff with more than 11 years of experience. This could be related to the fact that most experienced staff were working in their ICUs for a longer time than others and they had better team communication and developed better coping mechanisms with stressful working conditions. Staff with experience between 1-5 and 6-10 years, committed almost the same number of mistakes. That indicates that the department should not only focus on fresh staff during educational programs but include all staff.

In regard to incidents outcomes, the majority of incidents (67.5%) did not result in serious harm to patients. However, 13% of incidents had led to serious injury and increased the length of stay in ICU. Airway related incidents were the most common incidents that led to serious outcomes. Clinical education should be done to emphasize the seriousness of these incidents and appropriate policies should be designed to prevent these incidents from happening again.

High workload and poor supervision were reported among common contributing factors, 18.3%, and 23.9% respectively. These factors are associated with low motivation of staff and decrease in the work quality (Listyowardojo et al. 2017; Khalil and Lee 2018; Nerison 1999). Lack of supervision is connected to other frequent contributing factors: Policy and procedure protocol

have not been followed, and failure to check, 67.1% and 51.2%, respectively. The ability to supervise and monitor staff work quality increases the medical incidents rate (De Oliveira et al. 2013; Snowdon, Leggat, and Taylor 2017). Many studies associated better supervision with improved patient care outcomes (Farnan et al. 2012; Snowdon, Leggat, and Taylor 2017; Tomlinson 2015). The Weavers Model of Accident Causation for example, places a significant amount of responsibility for incidents occurrence on poor supervision and line management (Weavers 1971). Therefore, improved clinical teaching and bedside supervision improve patient care and decrease the prevalence of ICU incidents.

The findings of our research show the impact of poor supervision and management system deficiencies on patient care and incidents rate in ICU. Therefore, prevention programs should focus on the findings and these incidents to eliminate the contributing factors and eventually decrease the incidents prevalence. The management should emphasize on these common incidents and make their reporting mandatory.

To our knowledge, this is the first research to study ICU medical errors from the respiratory therapy point of view. This might be because the majority of the countries that have conducted research in this field, such as Australia, the United Kingdom (UK), and other European countries, don't have respiratory therapists as a part of their ICU medical teams.

In contrast, Saudi Arabia has a strong presence of respiratory therapy specialty as a prominent part of the multidisciplinary healthcare team in their hospitals. Unfortunately, studying medical errors in Saudi Arabia either in the ICU setting or non-ICU setting was not introduced until recently. The lack of medical error research in ICU settings in Saudi Arabia increases the value of this research.

Identifying the contributing factors of medical errors and their prevalence is important to design a prevention strategy based on the specific ICU setting in order to reduce the chances of repeating

medical errors with the same origin. Healthcare practitioners' awareness about the importance of their input on the incident reporting system must be encouraged and supported. Spreading the quality culture has an impact on reducing incidents that go unreported. Preventing the latent risk factors, such as poor supervision and inadequate communication, improves patient safety, and eliminates the chances of human error occurrence. In addition, establishing procedure policies and standardizing equipment and frequent maintenance will improve the prevention of errors.

Conclusion

To our knowledge, this is the first research done to study ICU medical errors from the respiratory therapy point of view. Documentation errors, not following infection control protocols, and inappropriate ETT cuff pressure were found to be the most common medical incidents related to respiratory therapy in ICU. The findings of this study will help the respiratory therapy management understand the types of medical errors that occur during respiratory therapy in ICU and therefore develop a targeted approach for preventing further errors with the same nature from happening in the future. Also, the findings should help in redesigning respiratory therapy hospital policies and improve patient safety.

Limitations

The study was conducted in only two ICUs specifically limited to medical and surgical ICU patients. Therefore, the findings may not be generalizable to other hospitals. However, we believe the findings give a good representation of the most common incidents related to respiratory therapy in ICU. In addition, our findings are consistent with findings from other studies. Furthermore, more frequent observations specifically at night or 24 hours observations would probably provide more data and strengthen the study. however, this would have been difficult to obtain. Another limitation, as any observational study, was that the observers may have been

biased and may have missed out on some events, even though we tried to minimize this by training and conducting observations with more than one observer.

Summary

The findings highlighted the prevalence of incidents that occur during respiratory therapy in ICU. Conducting further semi-structured interviews with the respiratory therapist ICU staff is important. Interviews are needed to understand the respiratory therapist's perception of committed incidents and what they believe are the causes of these incidents.

Chapter 4: Investigating the Respiratory Therapist Perception of Committed Medical Incidents in the Intensive Care Unit (ICU)

Introduction

Patient safety is a fundamental element of a successful healthcare institution. It is a product of positive safety culture, and the ability to deliver the necessary patient care with no harmful adverse events or errors (World Health Organization 2017). Improving safety culture is believed to be related to better patient outcomes and safer patient care (The Evidence Centre 2011).

A medical incident could occur in any setting, such as inside the hospital like in ICU, or outside the hospital like in a nursing home. The stressful environment, the severity of illness, the complexity of treatments, fast pace decision making, and critical procedures elevate the odds of medical error exposure in ICU (Bucknall 2010). Moreover, some studies have found that 45% of medical incidents were preventable (Rothschild et al. 2005). Valentin et al stated in his multinational Sentinel Events Evaluation study that respiratory procedures have a high chance of incident occurrence (Valentin et al. 2006). These findings are consistent with another study that has been done in 70 ICUs which found that respiratory-related incidents were among the most common incidents in ICU (Garrouste-Orgeas et al. 2010).

As part of the ICU medical team, the respiratory therapists are responsible for assessing, monitoring, and treating patients with cardiopulmonary diseases or any patient with breathing or pulmonary difficulties, including intubation with the use of mechanical ventilation (Keenan et al. 1998). Therefore, they have a major role in improving safety culture and preventing medical errors in ICU. To increase the efficiency of patient safety programs, staff perception and feedback should be used in the Development, Application, and Monitoring processes (Gaal et al. 2010). Consequently, understanding of respiratory therapist perceptions and experiences regarding medical incidents and adverse events is obligatory for the process of improving and monitoring patient care and safety culture. This could be inspected by conducting one to one interview with ICU staff in an familiar, trusting environment.

To help understand medical incidents related to respiratory care, I aimed to explore the most common errors that occur during respiratory therapy in ICU, participants' understanding of these medical incidents, the contributing factors, and patient safety.

Method

Interviews are an interesting tool that give a glimpse into the way others think, how they process the discussed issue, and how they make sense of the experience itself. In contrast, one of the limitations to the use of a quantitative questionnaire tool is the possibility that the results do not reflect what happened in the actual situation (Gabrani et al. 2015). Therefore, qualitative data can present greater descriptive findings that explain why the incidents occurred and how the staff felt about it (Listyowardojo et al. 2017). Assessing safety culture with various assessment tools provides a deeper understanding of the current safety culture level and strengthen collected data (Eeckelaert et al. 2011).

The semi-structured interview is a commonly used data collection method because of its ability to explore the participant's opinions and views of a complicated subject. Furthermore, because of the ability to use probing, the researcher can gain a better understanding of the experience and get more clarification of their answers (Louise Barriball and While 1994). Establishing a sense of rapport between the researcher and participant is essential for a successful validated result (Nieva and Sorra 2003).

In this study, the semi-structured interviews were designed to investigate further the findings of my previous observational study (chapter 3), to understand in greater detail the staff perceptions of how these incidents occur, how often, and why.

Study design

To gain a deeper understanding of respiratory therapists' perceptions regarding medical errors, a one to one semi-structured interview of 22 staff of the Respiratory Care department in two major hospitals was employed. Open-ended questions and props were used to gather more details about their experiences. Convenience sampling was used with considerations by selecting participants who have worked in ICU in the past month. In order to capture a better picture of participants experience, both senior and junior staff members were included with an average of 7 years of experience. Interviews were conducted on-site during a convenient time for each of the participants. Interviews were conducted between May and June 2019 and lasted between 15 to 25 minutes. Interviews were concluded after the participation of 22 respiratory therapists and data saturation was reached. In the study, the inclusion criteria included all respiratory therapists with a minimum experience of one year and who have worked recently in adult ICU for at least one month.

Data collection

The pre-interview period included: a brief description of the interview purposes; an explanation of the confidentiality of the interview; and finally, a documented verbal consent. All participant data were confidential and anonymous. Participants were asked the following questions to explore the staff's understanding of reporting incidents, medical incidents and contributing factors:

- How many incidents (medical errors) did you report to the management in the last 12 months?
- What are the factors that you believe contributed to the medical errors?
- How many incidents did you observe and did not report in the last 12 months?
- Why do you think some incidents don't get reported?
- How do you feel about the intensive care unit in this hospital regarding patient safety?
- What are the most common respiratory medical errors that happen in ICU?

Participants' responses and field notes were documented. A post-interview debriefing was done immediately to evaluate how the interview went, if there was any feedback needed to be added, or if any interview questions needed to be modified.

Data Analysis

All discussions and detailed notes were taken and transcribed, qualitatively analyzed using line by line coding, and then synthesized into narrative categories. Initially, a total of 45 codes were generated from the collected data. After reviewing the initial codes with Dr. Evley, the emerged focus codes were organized to 13 subcategories, then finally merged into five main categories. Dr. Evley conducted a training session on NVivo-11 software which was used to organize and manage the collected data. Thereupon organizing codes in categories, memos were written to document the initial ideas and discussions. Memos are essential to establish initial analysis and assumptions and identify any gaps in the collected data (Charmaz 2006).

Result

The average experience of participants was 7 years and ranged from 1 year to 20 years. Most of the participants were male 81.8% and 18.2% were female respiratory therapists. After analyzing the collected data from 22 interviews. Five main categories emerged (**Table 24),** based on the respondents' answers, issues related to safety culture were the most common category.

Table 24: Most common categories

Main category	Subcategory
Safety culture	• Aware of high incidents rate
	• Poor safety culture in ICU
Reporting Incidents	• Reluctant to report
	• Avoid personal conflict
	• Afraid of consequences

ICU Teamwork	• Feeling undervalued
	• Poor communication
Common Incidents types	• Airway problems
	• Poor ventilator management
	• Missing documentation
Incidents contributing factors	• Carelessness
	• High workload
	• Poor supervision

Safety culture

This section has been formed by the different statements collected regarding safety culture from the respiratory therapists' prospective. Participants felt that the overall evaluation of ICU safety culture was poor. The most stated explanation was that they believe that ICU is not strictly applying infection control protocols. Participants believed that physicians are not adhering to infection control protocol and nurses are not strict with the physicians as they are with respiratory therapists. A participant stated:

During morning rounds, the consultant will enter a patient's room and assess without gloves. He will take the stethoscope and auscultate, and the nurse is looking at him but is scared to say something (participant 3)

Moreover, in this category, a few responses included more details about some common unsafe practices such as performing a procedure without protection. The following are what participants stated in their responses on the question of explaining why they rated safety culture as poor:

One time I entered a patient's room, and a nurse was changing his wound without gloves (participant 20)

I went to check on a colleague to see if he needed help, and I saw him collecting a blood sample with no protection (participant 2)

Participants were cognizant about the importance of hand hygiene, isolation procedures and other infection control protocols. However, they felt the efforts made by management to apply these policies were not serious enough. This managemental behavior made staff believe that breaking these rules is somehow not a serious issue.

After describing their perception of safety culture, it was clear that participants were aware of the high rate of infection control issues in the ICU. Many statements described different medical incidents related to respiratory therapists or others, which will be further discussed in the section of common incidents in ICU.

Reporting incidents

The most common reasons for not reporting errors were fear of consequences and avoiding personal conflict with co-workers.

All participants mentioned that incident reporting is a topic that is not discussed in the unit. Even though participants knew about the occurrence of medical incidents, they were reluctant to report it. Participants suggested that the reporting system is unclear and has not been actively encouraged by the management. Reasons for not reporting an incident were mentioned in the interview. Participants stated:

I went to see my patient after endorsement, and I found that he had a lot of secretion. I suctioned the patient, and the nurse told me that the night shift respiratory therapist did not suction this patient at all. I report the incident to the department head. After that, my colleagues started treating me differently and the boss told me that they made complaints about my work. Since that occasion, I stopped reporting. Too much, stress... (participant 9)

It is too much of a headache to report an incident. I will be asked about it too many times. I am also afraid that I'd be putting a target on my back...others will start looking for my mistakes... (participant 14)

Common incidents in ICU

Participants believed the most common errors in ICU related to respiratory therapy were poor ventilator management, airway related medical incidents, and missing documentation. These results are supported by my previous observational study findings carried out in the same hospitals (chapter 3).

Participants strongly believed that a significant number of medical errors in the ICU was related to documentation, either missing documentation or false documentation.

Many times, I will try to check the intubation date and I'll not find it in any of the previous respiratory documentation. It is really common. (participant 8)

In the morning shift, the respiratory therapist is supposed to change the Heat and Moisture Exchangers (HME) and put a sticker with the date and time. But frequently I will check and see there is no sticker and therefore I do not know when it was changed. (participant 5)

The importance of good documentation was acknowledged by participants, but they felt there was no system in place. In addition, there was no person to follow-up with staff documentation and supervise the quality of their work which led to an increasing number of these behaviors.

Poor ventilatory management was mentioned as a common incident. Participants stated that ventilator asynchrony and inappropriate settings are the most common ventilation related incidents. Participant 3 provided an example:

I heard the ventilator alarm and when I went to check on a patient, I found him gasping for air. He was fighting to breathe. I did some changes, and I asked the nurse to call the doctor. When I checked the ventilator setting, they were different than before. When the doctor came, he told me he did some changes to see if the patient was ready!

In addition, participant 22 stated:

I received a patient on a ventilator and when I checked his blood gases, I found over oxygenated blood samples for the last 5 hours, and the respiratory therapist and doctor did not do any changes to decrease oxygen level to avoid toxicity.

The most common reported incident related to airway errors were inappropriate endotracheal tube (ETT) cuff pressure. Inappropriate ETT cuff pressure is supposed to be checked at the beginning of each shift based on the unit policy. However, a participant reported that he noticed that it was not performed regularly, and in many cases, it led to complicating patient health.

It is ridiculous how some people work….we should monitor the ETT cuff pressure every shift, but when I measure it, sometimes I find it high like 40 cm H2O, and when you check the patient file, it was documented as 30 cm H2O…(participant 5)

Further explanation was given into why these incidents occurred; these reasons are mentioned in the "incidents contributing factors" Section.

ICU teamwork

Participants' feedback showed issues related to ICU teamwork such as poor communication between doctors and the respiratory therapist. A noticeable number of respiratory therapists felt that some doctors do not include them in the process of establishing a patient care plan. Moreover, some doctors make changes in the mechanical ventilation settings without informing the assigned respiratory therapist, which is against ICU policies. These actions contribute to numerous medical incidents such as patient-ventilator asynchrony. In addition, these actions have made some participants feel undervalued and replaceable. Participant 6 stated:

Sometimes the physician will ask the nurse to start weaning the sedation. The respiratory therapist is supposed to know about this plan, otherwise, patient-ventilator asynchrony will occur, and that has happened many times.

Incidents contributing factors

Participants were asked to provide an explanation of why these mentioned incidents were considered common in the ICU. The most identified contributing factors were the carelessness of staff, poor supervision, and high workload.

It has appeared that participants are not satisfied with their job. They believe that supervision is poor or absent and management handling issues are not been satisfactory. Regarding the issue, participants have stated:

I told my boss about a colleague who kept missing major things during endorsement, many times. Nothing happens; this colleague still does the same issue. (participant 16)

At night, some staff do not do their job as they are supposed to. They see their patient once or twice instead of a minimum of 3 times. (participant 4)

During the interview, some participants stated that the respiratory therapist needs more support from the management during conflicts with other departments. They feel they are a disposal asset compared to nurses or doctors. They've stated the following:

During conflicts with nurses or doctors, we are always the ones who make a sacrifice. If a nurse or a doctor claims that I've done something wrong, my department will stand with them. This has happened before with my colleague. (participant 8)

Participants also described some colleagues as being careless when they handle patients:

I will check on the patient as soon I start my shift and I'll find out that the previous shift did not suction the patient… (participant 2)

During the night shift, I saw a fellow respiratory therapist writing a patient assessment without entering the patient's room. (participant 1)

Chronic patients do not get assessed at night by some respiratory therapists... (participant 18)

Another mentioned factor was high workload, with responses particularly from participants who have worked in ICU during staff shortages. The effects of high workload could directly contribute towards increasing the chance of staff burnout, and therefore, medical incidents occurrence.

When I start my shift with 8 ventilated patients, I do not have time to take a break…. I will start to do what is important… sometimes I forget to document or do the assessment. (participant 6)

Regarding factors contributing to poor ventilation management, participants believed that some doctors are not aware of some advanced ventilation management modes. Other participants stated that some respiratory therapist do not update ventilation settings based on patient status progress.

Discussion

The findings of this study showed an existing poor level of job dissatisfaction among respiratory therapists. In addition, the lack of proper supervision was mentioned as the main reason for the decrease in work quality and poor safety culture. This study identified the challenges that respiratory therapists believe were compromising safety culture in ICU.

Participants felt that the safety culture, within their ICU, was not positive. The reported infections control policy violations, poor communication between staff, poor supervision and monitoring, poor incidents reporting, poor management practice, and lack of development plans are all deemed characteristics of poor safety culture (D. Cooper 2001; Health & Safety Executive 2005).

Carelessness by some members of staff was deemed to be a contributing factor to patient safety incidents by participants. Furthermore, they believed the incidents to be a result of emotional distractions and a lack of motivation rather than negligence. The connection between lack of

motivation and emotional distractions with increased numbers of committed incidents has been discussed previously in the literature (Chan and Singhal 2013; Johnston and Cole 1976).

In addition to these factors, lack of motivation, lack of managerial support, and poor communication with doctors created an environment where some staff felt replaceable and unimportant. This environment had a negative impact on staff motivation and lead to a sense of being undervalued amongst staff. The management failed to provide the necessary support to ensure staff safety physically and mentally.

The overall emotional state of ICU staff members appears to be the result of complex factors that were not handled appropriately by the management, creating an unsupportive work environment and an overall dissatisfied staff (Othman and Suleiman 2013). In the Weavers model of accident causation, a significant amount of responsibility is placed, for incident occurrence, on poor supervision and line management (Weavers 1971).

The results of this study indicate that lack of motivation, lack of responsibility awareness, and careless behaviors of some staff are connected, with the potential to be causal factors in several reported patient safety incidents. These results are consistent with the findings of previous studies (Othman and Suleiman 2013; Chan and Singhal 2013), Boksem and colleagues also found that careless behaviors in addition to absence of punishments and rewards and poor supervision, made safety culture negative and increased error rate (Boksem et al. 2008).

The findings of this study showed that the respiratory therapy department suffers from poor supervision. Staff also reported that they have doubts about the department's management efficiency in handling issues. High workload and poor supervision are associated with low staff motivation and decrease in work quality (Listyowardojo et al. 2017; Khalil and Lee 2018; Nerison 1999). Management's lack of supervision in monitoring staff work quality increases the chances of staff careless behavior, and therefore increases medical incidents rate (De Oliveira et al. 2013;

Snowdon, Leggat, and Taylor 2017). Many studies demonstrated that better supervision is associated with improved patient care outcomes (Farnan et al. 2012; Snowdon, Leggat, and Taylor 2017; Tomlinson 2015).

The participants reported ventilator management related incidents as one of the most common patient safety incidents in ICU. These findings are consistent with the findings of my observational study carried earlier in the same ICUs (Chapter 3). In addition, several studies reported findings that corroborate with these results (Garrouste-Orgeas et al. 2010; Valentin et al. 2006).

Missing documentation was also mentioned as a common incident among respiratory therapists in ICU. A study done among nurses reported issues related to documentation as a major cause of medical error (Khalil and Lee 2018). In our study, airway related errors were mentioned as another common patient safety incident within ICU, specifically inappropriate ETT cuff pressure. Hardcastle and colleagues reported that only 23% of intubated patients had their ETT cuff pressure within the appropriate range (Hardcastle, Faurie, and Muckart 2016). Inappropriate ETT cuff pressure is associated with many complications such as ventilator-associated pneumonia and tracheal stenosis (Raynham, Lubbe, and Fagan 2009). Participants believed that poor supervision, high workload, and lack of motivation were the reasons behind inappropriate ETT cuff pressure incidents.

From my results I found that participants avoided reporting incidents. The main reason given for lack of reporting was the fear of consequences, this is in line with an early study (Vincent C, Stanhope N 1999). In addition, avoiding conflicts with colleagues was mentioned as a barrier for reporting. There were only a few participants who had experience with reporting incidents previously and they suggested the process of reporting was unclear and time-consuming. The reporting process was seen as a barrier for staff, consequently leading to low levels of reporting and subsequently a lower safety culture (Carson-Stevens et al. 2016). Despite the lack of

reporting, participants were aware of the increasing number of patient safety incidents, but the fear of consequences and avoiding conflicts with other staff are evidence of the presence of blaming culture within these ICUs, which has been shown previously within the literature (Khalil and Lee 2018; Vincent C, Stanhope N 1999).

The clinical environment and teamwork conditions have been found to have a significant impact on ICU safety culture. The findings from this study demonstrate the impact that these conditions had on the safety culture and patient safety. Through improving the working environment within these ICUs an improvement in the safety culture should ensue, subsequently leading to a reduction in patient safety incidents. In order to achieve this improvement a systematic approach is required to establish an interventional development plan. Integrating healthcare staff opinions in the development plan will facilitate the implementation process and improve the outcomes.

Conclusion

The findings of the study correlate with previous my observational study findings. Results suggest the need to develop an interventional development plan to improvement the working environment and establish a customized safety approach within these ICUs. Feedback to respiratory therapists around the processes of reducing medical errors to ensure improvement in patient care within the ICU is an essential component of this plan.

In order to ensure this interventional plan is comprehensive, the perspective of other ICU team members towards the respiratory therapist role and their understanding of respiratory related medical incidents should be further investigated. Moreover, respiratory therapists' job satisfaction should be assessed to provide a better understanding of the medical incidents contributing factors such as carelessness and supervision.

Limitation

This study presented the point of views of Respiratory therapists only and did not include other healthcare workers. The findings presented issues related to safety culture in ICU but did not present a suggested improvement plan. Further investigation is needed to explore the solutions from the ICU healthcare staff's point of view.

Summary

These findings demonstrate important factors that are believed to be associated with medical incidents in ICU. Further investigation of the effect of these factors such as feeling undervalued or poor supervision on job satisfaction is important to help department management to eliminate these factors and improve staff performance and patient care.

Chapter 5: Medical incidents and job satisfaction

Introduction

'Work is love made visible. And if you cannot work with love but only with distaste, it is better that you should leave your work and sit at the gate of the temple and take alms of those who work with joy.' Kahlil Gibran

According to the infield of organizational psychology, the topic of job satisfaction had been investigated since the 1930s. However, the 60s and 70s are considered important times for organizational psychology as the psychological theories were developed to understand job satisfaction dimensions (H. M. Weiss and Merlo 2015). Many authors and researchers defined job satisfaction as an emotion or feeling (Arches 1991; Spector 1997; Masvaure, Maharaj, and Ruggunan 2014; Masum et al. 2016; Oshagbemi 1999). Nerison defines job satisfaction as to how the worker feels regard for his or her job. These feelings could be positive (satisfaction) or negative (dissatisfaction) (Nerison 1999). In contrast, other authors use a more detailed multifaceted definition than that. Weiss and Merlo defined job satisfaction as *a positive or negative evaluation one makes about one's job or job situation.* Job satisfaction is an attitude that could be learned and improved; it is a mental state. (H. M. Weiss and Merlo 2015).

As an attitude, job satisfaction could be measured, and the influence factors could be identified. Moreover, the effect of job satisfaction or dissatisfaction could be inspected and controlled (Martins and Proença 2012). Various factors could influence staff job satisfaction. Factors such as work conditions, work policies, task clarity, coworkers support, supervision, workload, pay, and more. These factors are arranged under one domain: extrinsic satisfaction (D. J. Weiss et al. 1967). The other domain is intrinsic satisfaction which is represented by personality characteristics, knowledge level, moral values, recognition, work growth (Decker, Harris-Kojetin, and Bercovitz 2009). Both intrinsic and extrinsic contribute together to generate overall job satisfaction. However, intrinsic satisfaction has a stronger effect on predicting overall job satisfaction (Garg, Dar, and Mishra 2018). Moreover, the intrinsic satisfaction is very influenced

by extrinsic satisfaction. Decker et al found that supervisor behavior and pay satisfaction has a strong association with intrinsic satisfaction (Decker, Harris-Kojetin, and Bercovitz 2009).

Job satisfaction is a result and a cause at the same time. It has become clear that management decisions influence job satisfaction. Locke and Latham explained this relationship in their high-performance cycle concept. The management sets high goals which lead to high performance, and then as a result, rewards and recognition are achieved. This achievement has a direct effect on staff positive job satisfaction (Locke and Latham 2002). Contrarily, low-level job satisfaction could lead to decreased quality of work, Which eventually makes the level of job satisfaction lower (H. M. Weiss and Merlo 2015). Put simply, difficult work conditions lead to a dissatisfied worker, the dissatisfied worker delivers less quality of service (decrease in the quality of performed work), and less work quality makes the worker more dissatisfied with his job.

The ICU environment is a stressful workplace for healthcare professionals. Working in an ICU environment, the risk factors of stress and burnout increase. The fast-paced working process, high workload, conflict with coworkers, feeling undervalued, communication issues, or unsupporting supervisors all increase the chance of staff burnout (Ahola et al. 2009; Garrouste-Orgeas et al. 2015; Vermeir et al. 2018; Guirardello 2017; Habadi et al. 2018). Burnout is associated with a decrease in staff performance and lower job satisfaction (Aiken et al. 2012; Arches 1991). High-quality health care is a product of high-level job satisfaction among healthcare providers, therefore understanding the factors that could lead to better work conditions is requisite. Better work conditions lead to a higher level of satisfaction and resultantly improve the quality of patient care (Geisler, Berthelsen, and Muhonen 2019).

Reasons for the staff's poor attitude toward work could be a result of job dissatisfaction, low ambitions, or depression (Othman and Suleiman 2013; Padilha et al. 2017). Carelessness could be a result of emotional distractions. Studies have found that one of the most common reasons for car accidents is emotional distractions. Moreover, they found that lack of attention is highly

connected to the person's emotional state (Chan and Singhal 2013). The brain's cognitive control mechanism such as decision making, and short-term memory process is highly affected by the emotional state (Johnson et al. 2005). Also, it's been suggested that negative emotions cause more distractions for a longer period (Baumeister et al. 2001). Not feeling in control of your work or having low ambition could lead the person to feel dissatisfied with his job. Eventually, these negative emotions will make the situation worse and cause distractions which will lead to making careless mistakes.

Methods

After analyzing the qualitative data from the previous semi-structured interviews (Chapter 4), the results showed that staff's lack of motivation and not following hospital policies were considered to be a keys factors in staff committing errors such as missing documentation, missing labels, and more serious incidents such as neglecting physical examinations to assess patient status.

To further investigate this statement, job satisfaction was measured to evaluate the satisfaction level among the staff of the respiratory care department in both hospitals. One of the most common comprehensive methods to measure job satisfaction used in literature is the Minnesota Satisfaction Questionnaire (MSQ) (Hora, Ribas Junior, and Souza 2018). MSQ is an instrument that was developed in 1967 by Weiss et al. The aim of MSQ is to measure satisfaction with regard to various aspects of work and work environments. MSQ is widely used and considered the most used instrument internationally (Martins and Proença 2012). Moreover, the availability of an Arabic validated version makes it a big advantage for use in Saudi Arabia due to language compatibility. It provides an accurate understanding and retrieves reliable data. There are two versions available, a 100 question long one and a shorter version with only 20 questions. In this study, the shorter version was used. The questionnaire (**Appendix 5**) uses a Likert-type satisfaction scale, ranging from 5 for very satisfied to 1 for very dissatisfied. There are two main domains in the questionnaire, intrinsic satisfaction, and extrinsic satisfaction. In addition, overall

general job satisfaction could be obtained. Intrinsic satisfaction represents the positive feelings of the staff about their job performance (D. J. Weiss et al. 1967). These feelings are measured through questions 1, 2, 3, 4, 7, 8, 9, 10, 11, 15, 16, & 20. On the other hand, extrinsic satisfaction represents the external factors that influence work satisfaction such as salary, supervision, and work environment (D. J. Weiss et al. 1967) and they are measured through questions 5,6,12,13,14,17,18, &19. The participants were staff of the respiratory care department in two major hospitals in the Eastern Province of Saudi Arabia. The University of Minnesota doesn't require any prior permission or charges as per their website to use the MSQ. In addition to the questions, a list of demographical data was required including age, years of experience, gender, and level of education. Higher MSQ scores reflect a higher level of job satisfaction. The overall satisfaction is indicated by the sum score of all the 20 items which ranges from 20 to 100. A score below 25 is considered very low job satisfaction. A score of 25 to 50 is considered low job satisfaction. A score of 51 to 60 indicates a neutral attitude, a score ranging from 61 to 79 indicates being moderately satisfied, and a score of 80 indicates being highly satisfied (Sharp 2008).

Data collection

Data collection for the study occurred in a two-week period in March 2020. The study was conducted in two respiratory therapy departments in two main hospitals in the Eastern Region of Saudi Arabia. Questionnaires were distributed within the hospital settings and collected after two weeks. The privacy and confidentiality of all respondents were ensured. The respondent criteria included all respiratory care staff and management who have had at least one year of experience prior to the study. Incomplete questionnaires were considered as a criterion of exclusion.

Statistical analysis

All Data were transferred to an electronic worksheet in Microsoft® Excel on office 365. Then data were analyzed by using SPSS software (a statistical program for social sciences, Chicago, IL) version 25. A p-value of less than 5% was considered to be statistically significant. Descriptive

analysis was performed using ANOVA and paired sample t-tests in all demographic data including sex, age, educational level, job title, years of experience, and working shifts and compared to MSQ mean scores. Cronbach's alpha was used to assess the reliability of each domain in the Questionnaire (intrinsic, extrinsic, and general satisfaction).

Results

Of the study population, 40 subjects completed and returned the questionnaire. After two weeks, the response rate was 87%. The mean age of participants was 31.2 years (SD=4.04), with average years of experience of 7.8 years (SD=4.4). Fifty-five percent of participants were between 21 to 30 years old, and 62.5% were male while 37.5% were female. We found that 87.5% of participants are therapists and 17.5 are holding administration positions (supervisors and managers). Furthermore, 72.5% of participants work in variables shift schedules. The majority, 97.5% of participants, hold a bachelor's degree. The demographic characteristics of the participants are demonstrated in **Table 25**.

Table 25: participants characteristics

Characteristics	Frequency	Percentage
Age		
21-30	22	55.0
31-40	15	37.5
41 and more	3	7.5
Education		
Diploma	0	0
Bachelor's	39	97.5
Higher	1	2.5
Master's	0	0
Doctorate	0	0
Gender		
Male	25	62.5
Female	15	37.5
Position		
Respiratory Therapist	35	87.5
Respiratory therapy supervisor/administration	5	12.5
Years of experience		
1-5	14	35.0
6-10	20	50.0
11 and more	6	15.0

Type of shift		
Day	9	22.5
Night	2	5.0
Variable shifts	29	72.5
Hospital		
Hospital 1	22	55.0
Hospital 2	18	45.0

Average participants score for each hospital and overall score in intrinsic factors (12 questions, 5 points each), extrinsic factors (6 questions, 5 points each), and general satisfaction (20 questions, 5 points each) are demonstrated in **Table 26**. The total job satisfaction is 66.4 (SD=9.1). The results found no significant difference between two hospitals on the level of satisfaction (**Table 27**). In **Table 28** the percentage of each MSQ score category. Most participants (65%) have moderate job satisfaction. However, 20% of participants have a neutral attitude toward their job satisfaction.

Table 26: Average score in each domain.

Average total response	Hospital 1	Hospital 2	Overall
intrinsic factors	42.5	46.5	44.3
extrinsic factors	14.6	15.8	15.2
General satisfaction	64.1	68.6	66.4

Table 27: participants' distribution and score per hospital.

Hospital	N	Mean	Std. Deviation	Std. Error Mean
Hospital 1	22	64.1	10.3	2.2
Hospital 2	18	69.2	6.8	1.6

Table 28: distribution of MSQ score.

MSQ score	F	%
Below 25	0	0
25 to 50	2	5
51 to 60	8	20
61 to 79	26	65
80 and more	4	10

Table 29 shows the results of participants' responses for each item in the MSQ. The items with the highest positive responses were: item 11 "The chance to do something that makes use of my abilities" (n=36, 90%), item 9 "The chance to do things for other people" (n=35, 87.5%), item 4 "The chance to be "somebody" in the community" (n=32, 80%), and item 20 "The feeling of accomplishment I get from the job" (n=31, 77.5%). Noticeably, all these items are intrinsic factors. In contrast, the items with the most negative responses were: item 14 "The chances for advancement on this job" (n=33, 82.5%), item 12 "The way company policies are put into practice" (n=30, 75%), item 13 "My pay and the amount of work I do" (n=29, 72.5%), item 19 "The praise I get for doing a good job" (n=23, 57.5%), item 5 "The way my boss handles his/her workers" (n=22, 55%), and item 6 "The competence of my supervisor in making decisions" (n=17, 42.5%). Interestingly, all the items with the highest negative responses were extrinsic factors.

Table 29: percentage distribution of responses for each item and overall positive and negative responses.

Items	very dissatisfied	dissatisfied	Neutral	satisfied	very satisfied	Average positive response	Average negative response
1. Being able to keep busy all the time	0	15	35	45	5	50	15
2. The chance to work alone on the job	2.5	10	15	52	20	72.5	12.5
3. The chance to do different things from time to time	2.5	12.5	25	45	15	60	15
4. The chance to be "somebody" in the community	5	0	15	55	25	80	5
5. The way my boss handles his/her workers	2.5	52.5	12.5	22.5	10	32.5	55
6. The competence of my supervisor in making decisions	2.5	40	22.5	32.5	2.5	35	42.5
7. Being able to do things that don't go against my conscience	10	10	17.5	40	22.5	62.5	20
8. The way my job provides for steady employment	0	10	30	55	5	60	10
9. The chance to do things for other people	0	0	12.5	60	27.5	87.5	0
10. The chance to tell people what to do	0	2.5	35	52.5	10	62.5	2.5
11. The chance to do something that makes use of my abilities	2.5	0	7.5	62.5	27.5	90	2.5
12. The way company policies are put into practice	15	60	0	17.5	7.5	25	75

13. My pay and the amount of work I do	25	47.5	7.5	12.5	7.5	20	72.5
14. The chances for advancement on this job	32.5	50	7.5	10	0	10	82.5
15. The freedom to use my own judgment	7.5	15	42.5	30	5	35	22.5
16. The chance to try my own methods of doing the job	5	5	25	57.5	7.5	65	10
17. The working conditions	2.5	37.5	0	47.5	12.5	60	40
18. The way my co-workers get along with each other	0	7.5	30	50	12.5	62.5	7.5
19. The praise I get for doing a good job	5	52.5	7.5	35	0	35	57.5
20. The feeling of accomplishment I get from the job	5	2.5	15	60	17.5	77.5	7.5

The findings of this study showed insignificant differences (since P-value > 0.05) by applying ANOVA (F-test) between age groups on the level of job satisfaction. Moreover, this survey shows that there is no significant difference between the level of job satisfaction between groups based on their years of experience. However, we found a significant difference between the types of shifts on the level of job satisfaction (p=0.007). The staff who work mostly day scored = 73.7, staff work mostly at night= 73.0, compared to staff with mixed shifts schedule= 63.7. In addition, the result shows that there is a significant difference between respiratory therapists and respiratory therapy administration (supervisors and managers) on the level of job satisfaction with P-value = 0.002. the average respiratory therapist's MSQ score was 64.8, compared to average respiratory therapy administration (supervisors and managers) MSQ score of 77.6.

The reliability of MSQ was tested through measurement and assessment of internal consistency with Cronbach's alpha value. the generally accepted rule is that alpha of 0.6-0.7 indicates an acceptable level of reliability, and 0.8 or greater a very good level (Griethuijsen et al. 2015; Nimon, Zientek, and Henson 2012; Ursachi, Horodnic, and Zait 2015; De Vet et al. 2011). The Cronbach's alpha coefficients for the overall job satisfaction, intrinsic job satisfaction, and extrinsic job satisfaction were 0.82, 0.73, and 0.63, respectively.

Discussion

Based on the findings of a semi-structured interview study that was conducted in the same departments, the participants highlighted what they believed are the main contributing factors to incidents in their departments. This study aimed to investigate the extrinsic and intrinsic factors that affect respiratory therapist job satisfaction.

Saudi Arabia and other Middle Eastern countries have a different perspective on work and safety culture compared to western cultures. Research showed that one of the significant differences in Middle Eastern culture is the huge impact of religion on job satisfaction and attitude towards work (Aldhuwaihi, Shee, and Stanton 2012). More attention should be given to these differences between cultures and find a way to continuously assess and improve the work environment. To our knowledge, this study is the first study to assess job satisfaction among respiratory therapists in Saudi Arabia.

The findings of the study show that most of the respiratory therapists (65%) have an average level of overall job satisfaction. Furthermore, staff's years of experience, gender, and age doesn't affect job satisfaction. However, the results of this study showed that there is a difference in job satisfaction between respiratory therapists and respiratory administrators; managers and supervisors scored a higher level of job satisfaction than respiratory staff, especially with regard to extrinsic job satisfaction and general job satisfaction. Several studies reported that administrator employees have a higher level of job satisfaction compared to employees in a lower ranking in the staff hierarchical rank (Garg, Dar, and Mishra 2018; Olorunsola 2012; Mosadeghrad and Ferdosi 2013). However, different workloads, higher salaries, more control over the decision-making process, and more social recognition could explain the difference.

In this study, most items that positively influence respiratory therapist job satisfaction were related to intrinsic satisfaction. Factors such as the sense of achievement, moral values, social status,

and ability utilization received the highest level of job satisfaction score. The highest items the staff felt satisfied with were "The chance to do something that makes use of my abilities", "The chance to do things for other people", "The chance to be "somebody" in the community", and "The feeling of accomplishment I get from the job", they scored 90%, 87.5%, 80%, and 77.5%, respectively. On the other hand, the most negative items that affect job satisfaction were related to extrinsic factors such as career opportunities, following policies, pay, performance appraisal, and management and supervision quality. These findings are consistent with previous studies (Alsemeri 2016; Garg, Dar, and Mishra 2018; Strydom et al. 2012). To improve patient care and safety culture, more attention should be given to improve the level of job satisfaction among respiratory therapists and other healthcare professionals. However, staff job satisfaction cannot be looked at as intrinsic and extrinsic satisfaction separately. Intrinsic satisfaction is highly affected by extrinsic factors such as supervision, pay, and work conditions (Decker, Harris-Kojetin, and Bercovitz 2009).

When staff do not receive feedback about their work it is difficult for them to know what aspects of their performance they need to improve, or what type of mistakes they need to avoid. In addition, the absence of recognition and positive feedback decrease staff commitment and performance (Locke and Latham 2002). In this study, 57.5% of staff are dissatisfied with how management recognizes and appreciated their work. Job satisfaction is a result of high performance, and high performance is a result of specific set goals, supervision, feedback, and rewards. A significant positive relationship is found between job satisfaction and reward and recognition (Waqas et al. 2014).

Staff performance is significantly lower when asked to do work without explanation. Moreover, staff who participate in the process of policymaking and formatting strategies performed significantly better (Locke and Latham 2002). Furthermore, job satisfaction is connected to staff absenteeism (Locke and Latham 2002). In our findings, 75% of participants were dissatisfied with

12 "The way company policies are put into practice." Job performance and staff commitment to apply work policies are connected to job satisfaction (Locke and Latham 2002). Updating departments policies and developing protocols increase the work efficiency, improve quality of care (Metcalf et al. 2015), and decrease incidents rate (Collins et al. 2014). In a study done to examine respiratory therapist job satisfaction and the use of respiratory therapy protocols, they found a significant relationship between staff job satisfaction and the use of respiratory therapy protocols. Moreover, they found the use of protocols decrease job stress (Metcalf et al. 2015).

Management and supervision support have a positive influence on staff job satisfaction. The findings from this study showed more than half of the participants felt dissatisfied with the way management dealt with staff and the level of supervision provided. Supervision support has been found to be an important factor to decrease job stress and increase job satisfaction and productivity (Hoboubi et al. 2017). Therefore, more attention should be given to improve the relationship between staff and management. Better relationships and support will improve job satisfaction (Judge and Kammeyer-Mueller 2012; Waqas et al. 2014).

Management should emphasize and aim to increase the job satisfaction of their staff. A high level of satisfaction is associated with an increase in work productivity, efficiency, and work quality (Raziq and Maulabakhsh 2015; Christen, Iyer, and Soberman 2006). Improvements in working conditions and updating work policies are reported to have better results on staff job satisfaction (H. M. Weiss and Merlo 2015). Conversely, improve workplace conditions, and decrease workload would increase staff job satisfaction (Bagheri Hosseinabadi et al. 2018).

Finally, job satisfaction has been found to be an important indicator of staff health status. It is associated with mental health and life satisfaction (Judge and Kammeyer-Mueller 2012)(Faragher, Cass, and Cooper 2005). The development of stress management programs and establishing channels of communication between staff and administration to discuss areas of

weakness and ways of improvement, will ensure the mental health of staff is supported (Faragher, Cass, and Cooper 2005).

Conclusion

These findings generate the need for further investigation into the level of extrinsic, intrinsic, and general job satisfaction among respiratory therapy departments. This study will help the administration understand the department's staff needs and resources they require to provide better practice. Intrinsic satisfaction has a significant impact on general job satisfaction. In addition, extrinsic satisfaction contributes significantly to intrinsic satisfaction. Therefore, improving extrinsic satisfaction will enhance staff intrinsic and overall job satisfaction. Improving extrinsic factors such as working conditions and supervision relationships with staff would increase employee's job satisfaction and eventually their performance. Hospital administration must provide their staff with the necessary support to help them execute their duties in an ideal manner. Satisfied staff means better quality healthcare services and fewer incidents rate of medical incidents.

Limitation

This study uses self-reporting questionnaires, and this method has a limitation of self-reporting bias. However, the questionnaire length was short and the use of the Arabic version of the questionnaire decreased the chance of this limitation.

This study was done in public hospitals and the sample size was small, therefore, the findings may not be applicable to private hospitals or generalization. Moreover, a longitudinal design study rather than a cross-sectional study could provide better knowledge about staff job satisfaction since satisfaction and contributing factors could change over time. Further investigation of the effect of work stress and burnout on job satisfaction and performance would be highly valuable.

Summary

The job satisfaction findings of Respiratory therapy departments showed that lack of ambitions, unfollowed policies, poor supervision, and lack of recognition are reasons behind the decline in staff job satisfaction and negatively influence job performance. Based on findings from this study, the observational study, and the semi-structured interviews, conducting in-depth interviews with ICU staff including physicians, nurses, and Respiratory therapists are required to gain a better understanding of the contributing factors and establish an interventional development plan that can be assessed and monitored periodically.

Chapter 6: Intensive care unit staff perceptions of Respiratory related

medical incidents, contributing factors, and solutions: In-depth

interview.

Introduction

Safety culture in healthcare is a topic that needs to be addressed more often specifically in areas such as ICUs where stress, difficult work conditions, fast-paced work rhythm, and difficult patient management are expected. Staff performance is significantly lower when staff are working under high pressure and low safety measures (Habadi et al. 2018) which increases the probability of medical incidents occurrence (Wang et al. 2014). Moreover, working with low safety culture will decrease the quality of care and patient safety (Hansen, Williams, and Singer 2011). Eventually affecting job satisfaction negatively by decreasing the quality of performed work and safety culture (H. M. Weiss and Merlo 2015).

Medical incidents and safety culture must be strongly and frequently investigated within the institution to ensure the patient's safety and quality of care. Investigating the types or frequency of these incidents does not mean the causes of incidents are identified. Therefore, identification is necessary for creating an appropriate action plan (Keers et al. 2018). The use of questionnaires, observations, interviews, and other methods of investigations are required. Using mixed methods research provides more breadth and more information about the researched topic (McKim 2017). Qualitative findings can support quantitative data and provide more insightful explanations of incidents and safety in the studied area (Bowers et al. 2013). The use of qualitative data to support quantitative findings gives more credibility and provides more insightful explanations of the process that led to the outcomes (Wisdom and Creswell 2013).

The respiratory therapist is a fundamental member of the ICU team in Saudi Arabia and other countries such as the US, Canada, and the Philippines. Their work with mechanical ventilation, non-invasive ventilation, intubation, and other critical procedures put them under a high level of stress which increases the chances of incidents occurrence (Bucknall 2010; Valentin 2007). Respiratory related medical incidents in ICU are among the most common type of incidents in ICU (Rothschild et al. 2005; J. L. Vincent 2003; Mellott et al. 2014).

Furthermore, to create a complete picture of the types of medical incidents during respiratory therapy in ICU, the contributing factors, safety culture, and difficulties the respiratory care staff face during their work, other ICU team specialties that respiratory therapist interact with such as physicians and nurses must be included in the study. Understanding of ICU healthcare providers' perceptions and expectations regarding medical incidents and safety culture is therefore obligatory for the process of improving and monitoring patient care and safety culture. Their views on the Respiratory Care department and their understanding of the respiratory therapist's scope of practice could give insights into the issues and help identify the appropriate approaches towards/for improvement.

The purpose of an in-depth interview is to get an extensive insight into the ICU staff's understanding of how these incidents happened, and the reasons that led to these types of incidents (Guest, Namey, and Mitchell 2013; Boyce and Neale 2006). In addition, the interview is exploring what they think is the solution to eliminate these errors from happening again in the future. An in-depth interview is one of the common instruments used in qualitative research (Macqueen et al. 2005). Mainly because an in-depth interview aims to capture the participant's experience, point of view, attitude, and understanding of the researched topic to identify the underlying concepts behind the topic and explore solutions for the issues related to the topic (Boyce and Neale 2006).

Methods

To obtain a better understanding of ICU working conditions, safety culture, medical incidents, contributing factors, and how to improve the system, an in-depth interview was developed. In-depth interviews are interviews around sets of fixed open-ended questions about a specific topic. The questions and the interviewer should encourage the participants to elaborate on their responses as much as possible (Boyce and Neale 2006). These interviews are structured and

prepared, however, it gives the participants freedom to describe their experience and understanding in a detailed manner (Macqueen et al. 2005). Nevertheless, the interviewer needs to control the participant and steer the interview to remain within the topic. During the interview, the participant may find it difficult to present how he feels or his attitude towards the topic, or he may try to redirect the purpose of the interview to serve his interests. Therefore, the interviewer must adapt and find different ways to pose the questions. In addition, building a rapport with participants before the interview may ease the environment for both sides (McKim 2017). The interviewer should show interest in the participant's answers and use appropriate body language. A big advantage of in-depth interviews is that they provide more detailed descriptions of the issue, point of view, and the feelings of participants about the topic under a relaxed environment setting compared to other methods of collecting data, such as focus groups (McKim 2017).

The interviews were conducted one to one, and the selected location for the interview was within the hospital, in a quiet, accessible, and private location to ensure confidentiality. The interviewees were given the freedom to choose the appropriate, conventional time for the interview that fits their schedule. Prior to the interview, a one-day earlier reminder was scheduled. The selection process of the participants involved in the research was chosen randomly but with consideration to the years of experience, gender, and shift group. However, the inclusion criteria included physicians, nurses, and respiratory therapists, to represent diverse opinions and perspectives of different ICU team members. In addition, participants were required to have a minimum experience of one year in the studied adult ICU.

After reaching data saturation, and no more new ideas were generated, the total number of participants was 20 participants. This includes a total of 6 physicians (MD), 6 Registered Nurses (RN), and 12 respiratory therapists (RT). All staff selected had to be ICU staff. The nurses and physicians were given questions related to their point of view. Interviews were conducted on-site during the convenient time of the participants. Interviews were conducted between the 5th and 30th of Jan 2020 and lasted between 45 to 64 minutes.

Developing the interview guide

The in-depth interview questions (**Appendix 6**) were focused on the participant's perspectives about errors during respiratory therapy in ICU and developed from the findings of the quantitative and qualitative study, carried out previously in these ICUs (Chapter 3). After having analyzed the qualitative data from the semi-structured interview (Chapter 4), the most common themes were obtained and used to identify the fields that need to be further investigated through in-depth interview questions. The most common themes were: (1) feeling undervalued by the ICU team, (2) poor safety culture in ICU, especially among physicians, (3) poor supervision (4) high workload, and (5) staff carelessness. The most common incidents were: missing documentation, airway incidents, and ventilator related incidents. Finally, the biggest reasons for not reporting incidents were due to the fear of consequences and the avoidance of personal conflict with other staff. In addition, the quantitative findings were used to help to create the interview questions.

The purpose of in-depth interview questions is to get an extensive insight into the participant's understanding of how these incidents happened, and the reasons that led to these types of incidents (Guest, Namey, and Mitchell 2013; Boyce and Neale 2006). In addition, the interview questions explored what they thought could be the solution to eliminate these errors from happening again in the future. The questions were tailored specifically to each specialty's background; however, they will tackle the same issue.

Data collection

The pre-interview period included: a brief description of the interview purposes; an explanation of the confidentiality of the interview; and finally, a documented verbal consent. All participants' data were confidential and anonymous. In the interview, written notes and an audio recorder was used to collect and record information, which helped provide longer quotes from participants, as well as give a better understanding of their attitude toward the topic.

An introduction was given at the beginning of the interview, during this, the interviewer built a

rapport with participants and tried to ease the environment. The pre-interview period included: a brief description of the interview purposes; an explanation of the confidentiality of the interview; and finally, a documented verbal consent.

During the interview, it was important to show interest in the participant responses and to build a rapport after heavy questions. Clarifications were asked when needed, and sentences like the following were used to establish transition explanations: Based on what you have told me so far, I have some additional questions that might be difficult to discuss (Guest, Namey, and Mitchell 2013).

After finishing the set questions, the participants had a chance to add their comments and talk about any concerns. This concluded the interview, and the participants were thanked. The audio was tested after, and a quick review of the comments was done. A post-interview debriefing was done immediately. The idea was to evaluate how the interview went and if there was any feedback needed to be added or if any interview questions needed to be modified.

Data Analysis

All discussions and detailed notes were taken and transcribed, qualitatively analyzed using line by line coding, and then synthesized into narrative categories (Charmaz 2006). Initially, a total of 455 codes were generated from the collected data. After reviewing the initial codes with Dr. Evley, emerged focus codes were organized into 29 subcategories. Then finally merged into six main categories. NVivo-11 software was used to organize and manage the collected data. Thereupon organizing codes into categories, memos were written to document the initial ideas and discussions.

Results

A total of 20 in-depth interviews were conducted with 20 participants from two adult ICUs. The demographic characteristics of participants are summarized in **Table 30**. After analyzing the interviews, six main categories emerged: perception of safety culture, ICU issues related to

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respiratory therapy, incidents reporting culture, ICU teamwork & communication, organization & management, and work environment.

Table 30: Demographic data of participants.

Job classification	Mean Age (Years)	Mean Years of experience *%*				Gender *n (%)*		Nationality *n (%)*	
		1-4	**5-9**	**10-15**	**16 ≥**	**Male**	**Female**	**Saudi**	**others**
Respiratory therapists	30.1	37.5%	25%	37.5%	-	7(87.5%)	1(12.5%)	8(100%)	-
Physicians	45.7	16.6%	-	33.3%	50%	6(100%)	-	1(16.6%)	5(83.3%)
Nurses	29.5	33.3%	33.3%	33.3%	-	-	6(100%)	2(33.3%)	4(66.6%)

Perception of Safety Culture

To understand the perception of safety culture among healthcare workers in the ICU, participants were asked to define safety culture and why it is important. Most participants gave a general description of safety culture and importance.

Participant MD2: "*Safety is really important for the sake of the patient and the sake of staff. It is a core part of quality; we are JCI certified ICU. We are observing the work in ICU to monitor our work. Safety culture is to reduce harm or to make a zero-harm environment for patients or staff*".

Participant RN2: "*It's essential; it's how we should work and how should we treat. It's how we're supposed to do our job, following protocols, prevent the patient from harm, how we should work correctly*".

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Participant RT1: "*Hospital has policies that regulate our work, we are supposed to follow it to guarantee the quality of care*".

However, some participants' views of safety culture seem to be focused on following infection control protocols.

Participant MD1: "*What I understand, is anyone who takes care of patient follows protocols to prevent the patient from getting an infection*".

Participant RN5: "*Its how we can protect the patient from getting an infection. Its how we care. The first priority is to wash hands to prevent spreading infections*".

Participant RT3: "*If you mean isolation and patient safety, it is about protecting patients and protecting yourself*".

From the participants' point of view, the key factors to improve safety culture in ICU were education and monitoring. Participants believe that more education and training is needed:

Participant MD3: "*We need an education program, from time to time. we should have frequent sessions to remind and educate staff about safety, and infection control protocols*".

In addition, participants mentioned that better monitoring and supervision would improve work quality and decrease errors occurrence. Moreover, the absence or lack of monitoring decreased the quality of care and safety culture:

Participant RN5: "*Better monitoring, one time they assigned one infection control supervisor to monitor each room to make sure staff were following infection control*

protocols and were working, But after that, the stopped monitoring! and eventually the staff

and everything went back as before".

Participant RT6: "*They need better supervision, they need to be more feasible".*

ICU issues related to respiratory therapy

Based on the previous studies we determined the three most common respiratory care related medical incidents in ICU: Missing documentation, mechanical ventilation related incidents, and poor supervision. Participants were asked to describe the work process, contributing factors, and suggestions to avoid reoccurrence. In addition, participants were encouraged to mention any issues they faced while working with respiratory therapy department staff.

Missing documentation

Physicians and nurse participants mentioned that they usually don't access or check respiratory therapy documentation. Nurses and physicians record documentation in the patient file directly, however, respiratory therapists have their own external forms that they must fill, and it's usually stored next to the mechanical ventilation machine or outside the patient room. However, nurses and physicians' participants mentioned an issue of miscommunication as a result of this process:

Participant RN4: "*We don't check their documentation. Sometimes we find out RT made*

changes on MV without notifying us.

interviewer: do you check their documentation to see the MV settings?

No, I ask them personally and they tell me what kind of settings the patient is on".

Participant MD2: "*We don't check RT files that often, because we use the electronic file,*

but sometimes they change the ventilator setting, and they don't inform us and we don't

know why they made the changes".

In the following statements, respiratory therapist participants identified the most common missed items in the documentation,

Participant RT1: *"There is a lot of missing documentation on why changes were done. Also, for secretions assessment, they don't record the color, amount, and thickness of the secretion. Also, during extubation trials, if it failed, they don't document why. Also, I found ETT cuff is deflated".*

Participant RT2: "*the most common missed items? I think its patient care plan for sure and reason for intubation, sometimes they don't write it down".*

Participant RT8: "*I face this issue a lot, I see changes in the ventilator setting but nothing is documented why!".*

The most mentioned missed items in documentation were summarized in **Table 31**.

Table 31:Most missed data during documentation

Daily patient care plan
Reason for intubation
Reason for changing mechanical ventilation settings
ETT level & cuff pressure
Updating patient daily progress

To help improve documentation, the causes should be known. Participants highlighted that distractions and follow-up negligence were the causes of miss-documentation.

Participant RT2: "*(In response to a question about reasons for miss-documentation) Mostly, because the workload is high. That's why most staff forget to fill it out. And there*

is no monitoring for staff documentation. I saw a flowchart with no date; I had no idea when

it was done, whether for today or yesterday".

Participant MD3: "*Sometimes you get busy and you plan to do it after rounds and you*

forget".

Participants believe that digital documentation and management follow up on staff documentation will improve documentation and decrease the chances of miscommunication with other departments.

Participant RT1*: "Make it easy, like digital documentation. It will show the exact time of*

documentation, it will show who is doing good and who is bad. [we need better supervision

and follow-ups with consequences".

Participant RT3: "*follow up is very important so you can track the mistakes and see*

medication errors, without proper documentation you can't see who is involved or what

were the orders".

Mechanical ventilation related incidents

When participants were asked about the causes of these issues, physicians believe that lack of education among Respiratory therapists is a contributing factor. Nurse participants mentioned that lack of assessment and monitoring is likely to be a contributing factor. The respiratory therapist believes that in addition to the mentioned causes, physicians do not involve or consider respiratory therapists' opinions. In **Table 32**, a summary of the most frequent contributing factors to MV incidents are shown.

Table 32: contributing factors to mechanical ventilation (MV) related incidents.

Most frequent contributing factors to MV incidents
Lack of frequent monitoring and assessment
Lack of knowledge about MV among nurses and doctors

| Lack of training and knowledge about new guidelines among rt |
| Issues with the decision-making process |

The solutions for better mechanical ventilation management based on participants' statements were concentrated in three themes: Better communication, more education, and better supervision.

Participant MD6: "*Education and supervision. If a staff member knows that no one is monitoring his work, he will adhere less to the work policy and believe he is unquestionable. If he knows that he will be held responsible for everything that happens to the patient, he will not do any mistakes*".

Participant RN4: "*We should have bedside practical workshops for all. We need more monitoring to staff and maybe annual competency for staff, RT, doctors, and nurses*".

Participant RT3: "*I think if doctors listen to respiratory therapists' opinions it will help to make the right decision. And of course, education and workshops to all ICU staff on mechanical ventilation. Also, monitoring staff efforts to ensure they are taking good care of the patient*".

Poor supervision

Participants have described respiratory therapist supervision as below optimum. Moreover, they mentioned poor supervision as a contributing factor to most of the respiratory-related medical incidents in ICU.

Participant MD2: "*If a staff member knows that no one is monitoring his work, he will adhere less to the work policy*".

In addition, the lack of supervision during night and weekend shifts was believed to cause staff performance to drop. Nurses and physician participants stated that they observed long response

time from respiratory therapists during these shifts. Also, they conducted fewer patient assessments during night shifts compared to day times shifts.

Participant MD3: "*One time we needed an RT at night shift, we looked for him and we couldn't find him in the unit. So, we had to call him in the overhead, and he came late*".

Participant RN6: "*Also, I heard about an incident that happened at night and there was no supervisor to solve it because they don't work at night*".

Respiratory therapist participants reported that lack of supervision in the night and weekend shifts affects work quality. However, they mentioned that as a result of a lack of supervision during these shifts, a higher workload was presented. A supervisor would help with a high workload situation and these incidents would be avoided.

Participant RT4: "*During nights, I see my colleagues do fewer patient visits. For sure, if we had a supervisor we will make more visits. But also, we will ask him to help needed*".

Participant RT7: "*We would like to have a superior at night, at least when we have extra load, he could help or call for extra staff*".

In response to a question about the characteristics of a good supervisor, the most frequent attributes for a successful supervisor were:

Participant RT3: "*The supervisor is the role model and by being there he could make sure the staff is working based on the ICU guidelines and following protocols*".

Participant RT5: "*The supervisor should have a clear assignment, we should know what is his job role is and he should do it. If he monitors our work, the work quality would be better*".

Summary of the most frequently mentioned characteristics of good supervision in **Table 33**.

Characteristics of optimum supervision
supervisors need to have conflict resolution skills
supervisors need to ask other specialties for feedback about his staff work
supervisors need to be powerful so he/she can lead
supervisors need to ensure staff adhere to the practice
the supervisor should be helpful
the supervisor should be an experienced staff
the supervisor should evaluate his staff
supervisor observe staff work to avoid incidents

Incidents reporting culture

Reporting culture among participants is observed to be less than effective. Most participants stated that they have not reported any incidents in the last 12 months even though they observed many. In addition, they believe some incidents should be solved internally.

Participant RN1: "*Actually, I didn't report any cases. Because if I experience an issue (with another staff member) that could be solved amicably, I'll solve it and not report it. I have a good relationship with everyone and I want to keep it that way*".

Participant MD3: "*We have a cultural issue here, "if you report me you are my enemy." Also, they don't make it confidential if you raised a report. If RT reported a nurse everyone will know about this by the end shift. So, we try to solve this internally, "please x or y don't do this again." But if it happens again, we will have to report it*".

Participant RT5: "*No, because maybe some things could be solved without the need to make it official*".

Participants reported barriers that they believe prevent them from form reporting. The most frequent barriers are: avoid personal conflict, fear of consequences, not believing in the system.

Participant RN3: "*I worry that if I report it I could get in trouble, and I don't want to have an issue with anybody. If you're going to report someone, they will have a grudge on you, so the next time if you make a mistake you will be afraid that they will report you*".

However, multiple participants reported that non-Saudi staff, are afraid of reporting and that it may affect their re-contract.

Participant RN2: "*There is some fear, especially from non-Arabic nurses. I noticed that when I asked a Saudi nurse to write a report, she is fine to do it but if I ask non-Saudi nurses, she get afraid and nervous. I tell them it's all right, but she will say please don't write the tube was blocked. When I ask why? She says that it means I'll get in trouble and they will not renew my contract. that's why we try to fix issues internally*".

Participant RT8: "*Nurses from foreign countries get upset if you say anything about reporting incidents. They fear that it may affect their re-contract. Even if I try to calm them down and explain the importance, still they don't believe me. They will beg me not to inform the in-charge or reporting official, so we end up just covering it up. I don't anyone to get fired*".

Therefore, participants believe that management should start an educational campaign to educate and assure staff that reporting is an essential element of safety culture.

Participant RN5: "*We need sessions showing us how important it is to report, telling us how to report and follow up on these incidences, and showing us what difference these reports can make*".

Participant RT2: "*management needs to support, encourage reporting, and apply a no-blame policy. They should encourage us to do it*".

ICU teamwork & communication

During the investigation of ICU teamwork interaction and process of decision making. Participants which include physicians, nurses, and respiratory therapists were asked to describe the decision-making process, the daily rounds, and patient care plan discussions.

Multiple participants including doctors, nurses, and respiratory therapists mentioned that newly hired doctors, especially doctors coming from hospitals or countries that don't have respiratory therapists in their ICU team, have difficulty discussing or including respiratory therapists in making the patient care plan.

Participant RT3: *"Some doctors don't know what a respiratory therapist is, they came from a place or a country that doesn't have a respiratory therapist in their team".*

Participant MD4: *"we had a new group arrive recently from another hospital and some from another country which they have no experience working with a respiratory therapist. So, they came with the same mentality that doesn't align with ours, and don't know the work system here. Some came from hospitals with no RTs in their ICU team. That's the issue".*

However, participants reported that consultants are more considerate to involve nurses and respiratory therapists in the process of making patient care plans than younger doctors are.

Participant RT6: *"Most ICU consultants like to discuss the care plan with RT, even when the RT doesn't show initiative to give the plan. The consultant will discuss the plan with him, and explain the reasoning behind his actions".*

In regard to improving teamwork, participants believe these recommendations (**Table 34**) would improve teamwork and communication in ICU.

Table 34: participants' recommendations to improve teamwork.

Recommendations to improve ICU teamwork
early morning daily multidisciplinary ICU meetings
clear protocols and policies about shared responsibilities
frequent lectures about ICU topics to all ICU members conducted by RT, nurses, and doctors
new doctors should spend a day with respiratory therapists
all members of the ICU team should be involved in the decision-making process

Organization & Management

The respiratory therapist participants stated that the management needs to make improvements to the current culture. They believe that lack of motivation is one of the main reasons of staff dissatisfaction. They believe a lack of future career development and training are making staff less motivated to improve and in some cases staff turnover.

Participant RT4: *"That's regarding department vison, staff rights, like some staff, don't know what's in the future for our department regarding promotion, expanding, supervisions, etc. we need more incentives to work, like a scholarship. Other departments get it, but not our department. Also, educational leave to attend conferences".*

Participant RT6: *"I don't see any future plan here and that's why I'm seeking a better environment and leaving".*

Participant RT8: *"I think they need to motivate staff, maybe offer scholarships".*

In addition, participants mentioned that annual evaluation doesn't reflect the actual staff performance. Staff with good performance and staff with poor performance get the same annual allowance. This issue made staff, as per their statements, feel unmotivated to do their best work.

Participant RT2: *"its the same level of appreciation you get if you did a good job or bad one, same salary same annual evaluation. That's why some staff get careless, no motivation".*

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Participant RT 3: *"they have been working for more than 10 years and they don't accept change easily. They don't feel motivated to work. They are also getting the same annual evaluation as others. When they are asked "where do you see yourself after 5 years," they respond: "doing the same thing.""*

Respiratory therapist participants reported a high percentage of colleague absence. They reported that it is frequent for staff to call in sick and that it has led to an increase in the workload on the rest of them.

Participant RT2: *"(in response to a question about if they had called for sick-leave recently? And why?) Yes, because we had to. I take sick leaves often. I know it makes my colleagues handle more loads because of me, but I need my sick leaves because if I come to work I'll be handling full patients, and it is very stressful. No one helps me. So, I call for sick leave and they can do whatever with their load".*

When Respiratory Therapists were asked if they believe that some staff abuse the sick leave policy, participant RT8 responded:

"Maybe I'm the one in this department who take sick leaves the most, but I do that because I had an injury in my leg and sometimes it's very hard on me to cover a full load. Also, I lost two pregnancies because of the high workload. So, I think I deserve these days".

When respiratory therapist participants were asked about the work policy regarding absenteeism, most of the staff stated that they were not aware of it.

Participant RT6: *"I'm not sure how many sick leaves I'm allowed to have per contract, but I think the process is easy".*

Participant RT5: *(in response to question if they believe sick leaves are common and why).*

"Yes, very often. It is an abused policy especially when you know that someone can give you a sick leave and no one will ask about it".

Policies

Participants have highlighted that department policies need to be reviewed and updated. In some cases making a new policy if it is required. Moreover, they stated that the management needs to involve staff in the process of updating the policies.

Participant RT1: *"Policies need to be updated by the staff. They need to regularly have multidisciplinary meetings in the ICU to discuss issues and come up with recommendations and suggestions to update the policies".*

Participant RT4: *"Yes, there are some cases. I think the issue is that we don't have protocols. We don't have full guidelines. Like in ICU, when there are patients who are not intubated and need an ABG, there are no guidelines in this situation, and we've had a couple of unsolved conflicts. One time they say you do it, other times they say no. Our boss says something, and the head ICU will say the opposite".*

Participants from nurses and respiratory therapists reported that shared policies need to be changed. They reported that suctioning intubated patients is a shared responsibility between nurses and respiratory therapists. As a result of this policy, respiratory therapists tend to depend fully on nurses in performing this duty. Furthermore, participants reported that as a result of this policy, patient care in many cases was compromised.

Participant RN5: *"the suctioning should be a shared responsibility, but all RT's rely on nurses to do it. Everybody should know the job description of everyone".*

Participant MD2: *"We also had many cases with ETT blockages because the RT depended on the nurses to do it (take care of it?) and nurses didn't do it".*

Participant RT2: *"Also, like suctioning. In the policy, it says the job is shared with nurses, but if the nurse asks some RT, they get pissed off and they refuse. We need policies that are implemented, not only in papers".*

Work environment

Work location

Covering patients in different locations on the hospital premises was mentioned as one of the difficulties that respiratory therapists face during work. Moreover, participants reported that as a result of this issue, patient care was compromised.

Participant RT1: *"sometimes we also cover ER, and to get there, I need 5 to 8 minutes if I was walking fast.*

Interviewer: Have you ever received a call from the ER and arrived late?

Participant: Oh, many times. When I get there they say: you just came now?! I tell them that I was busy and it is far away".

Participant RT4: *"Today I'm handling 3 units, and each unit is on a different floor. I have patients in the burn unit which is on the 1st floor, and (my other?) patients are distributed on 6 floors, and in case of any emergencies I'm covering ER too".*

Participant RT7: *" It happened today. They called me for elective intubation while I was on the 6th floor. I couldn't wait for the lift, so I used the stairs, and when I arrived in the ER, the doctor had already intubated the patient. It is not my fault. I did my best".*

Participants mentioned that the location of the respiratory therapists break room is inconvenient. It is located in a different building which makes their response time far from appropriate.

> Participant RN6: "*We have an issue with locating RT. We have to look for them or call them more than once or we have to wait for a long time for them to answer*".

High workload

Several participants stated that respiratory therapists experience a shortage of staff and are under high workload and that this leads to a decrease in the care quality and sometimes a breach of policies.

> Participant RT4: "*I'm covering 9 ventilated patients. I had one patient on room air, and I didn't have time to check on him. Anyway, at night he got ill, and he needed to be intubated and the ventilator at the bedside wasn't ready.*"

> Participant RT3: "*when we have a high load of patients, even if you worked with professionalism and with the fear of God in your heart, no way that you will still be able to do it appropriately*".

Respiratory therapist participants mentioned that they use interns to handle patients without supervision which is against department policy.

> Participant RT5: "*Also, there's no follow up for interns' work. If you find an issue and you look at who is involved and you find out that it was an intern, there's no co-sign of his supervisor at that shift. Interns are here for a specific time then they leave, you can't look for them after that*".

Interns handling patients without supervision was also pointed out by physicians and nurse participants. Participants showed concerns about interns' knowledge and skills to handle difficult cases. Some participants stated that sometimes they refuse to work with unsupervised interns without supervision and that they do not allow interns to do procedures.

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Participant MD2*: "Twice I went to transfer the patient to the CT* (computerized tomography) *scan, and they send interns to go with their patients. No supervision. One time I looked for the RT and knocked on her door. When she answered, I told her she needed to see a patient. She sent an intern instead, and I refused".*

Participant MD5: *"I think we have a big number of trainees and they are not familiar with guidelines, so they make more mistakes comparing to our staff".*

When participants were asked if they ask for help when they are under high workload, female participants pointed out that they feel shy to ask for help.

Participant RT: *"No, I don't like asking for help. Maybe if someone was walking by and asked me if he could help me with something, I would accept his help, but I never go to someone asking for help.*

interviewer: why?

Participant: Because they are staff like me and I don't feel proud to ask because I don't want any favors from them".

Discussion

This study is considered one of the first qualitative studies done to investigate respiratory-related medical incidents among ICU staff. The findings of the study have provided a thorough understanding of the causes, possible solutions, and the issues related to respiratory-related medical incidents in ICU from the perspective of healthcare ICU staff.

This study included respiratory therapists in addition to multidisciplinary ICU healthcare professions who interact with them on a daily basis. This research intends to understand their perceptions towards the contributing factors of medical incidents that occur during respiratory

care, ICU safety culture, and their suggested methods of solving these issues and developing better systems to avoid incident occurrence and improve safety culture.

In this study, the findings demonstrate variation in the perception of safety culture among ICU staff. Better awareness about safety culture is needed. In the literature, a significant relationship between staff perception of safety culture and medical incidents rate was found (Hansen, Williams, and Singer 2011; X. Wang et al. 2014). Therefore, management needs to initiate educational campaigns to educate ICU staff about all elements of safety culture. In addition, implement protocols to monitor the work quality and evaluate the effectiveness of these methods.

In a study done to examine contributing factors to medical incidents In ICU, almost half of medical incidents were a result of lack of training /education (Pronovost et al. 2006). In addition, a study conducted among surgeons to analyze medical incidents reported 53% of incidents contributing factors were related to lack of training (Gawande et al. 2003). Moreover, the findings of our study support their findings. Lack of training courses, scientific contributions, and educational sessions in the respiratory care department and within ICU was reported as a contributing factor to respiratory-related medical incidents. In fact, in our study, training was frequently mentioned by participants especially from respiratory care department staff, as one of the main solutions to prevent the reoccurring of respiratory-related medical incidents and improving the quality of patient care. Further study is needed to assess the orientation process for new staff and interns and to evaluate the quality of in-service workshops in the department.

System failure is associated with many contributing factors to incidents (Garrouste-Orgeas et al. 2012). Staff poor judgment or lack of skill is strongly associated with a lack of supervision (Gawande et al. 2003). Many studies associated better supervision with improved patient care outcomes (Farnan et al. 2012; Snowdon, Leggat, and Taylor 2017; Tomlinson 2015). Lack of supervision was reported as a contributing factor in more than half of incidents committed by inexperienced staff (Gawande et al. 2003). In our study, we found that inadequate supervision

was frequently reported by respiratory therapists and other ICU healthcare providers as a contributing factor to respiratory-related medical incidents in ICU.

Management and supervision support have a positive influence on staff job satisfaction (Snowdon, Leggat, and Taylor 2017). Supervision support is an important factor to decrease job stress and increase job satisfaction and productivity (Hoboubi et al. 2017). In this study, participants believe that the lack of future job development and the absence of job recognition affected staff work quality and motivation. The absence of recognition and positive feedback decrease staff commitment and performance (Locke and Latham 2002). Several studies highlighted the causes for staff's poor attitude toward work could be a result of job dissatisfaction, low ambitions, or depression (Othman and Suleiman 2013; Padilha et al. 2017). The findings of our study correlate with the results of the job satisfaction study that was conducted recently in the respiratory care departments (Chapter 5). A high level of satisfaction is associated with an increase in work productivity, efficiency, and work quality (Raziq and Maulabakhsh 2015; Christen, Iyer, and Soberman 2006).

Participants in this study showed concerns about the high number of absenteeism among the respiratory therapy staff. It was reported that there were more than 218 sick leaves in 2019. Participants believe that stress and high workload are a contributing factor to staff absenteeism. In the literature, a positive association was found between stress, exhaustion, and absenteeism (Indregard, Knardahl, and Nielsen 2017). The absence of supervision support, high workload, and job satisfaction are connected to staff absenteeism (Locke and Latham 2002). Further investigation by the management is required to gain a deeper understanding of staff absenteeism. Furthermore, a review and update to the sick leave policy and acceptable medical sick leave requirements are necessary.

In an ICU environment, teamwork effectiveness has a significant impact on the quality of patient care (T. W. Reader et al. 2009). Furthermore, poor teamwork in ICU is a critical contributing factor

to medical incidents (Wright et al. 1991). Teamwork, leadership and communication are essential in improving work outcomes (T. W. Reader et al. 2009). Communication between physicians and other healthcare professionals about the care plan is crucial to the success of the patient care plan (Schnittker et al. 2018). Moreover, clear guidelines of the working process and understanding the scope of practice to every specialty would decrease the tension between the ICU team and improve communication. In this study, frequent statements of multiple participants stated the conflict between staff as a result of not understanding the job description of others, such as the respiratory therapists' role. As a result, miscommunication and conflict probability increased. Several studies found that a large number of medical incidents are associated with communication issues between ICU staff (Pronovost et al. 2006; Donchin et al. 2003; Gawande et al. 2003). Staff rotation was reported as a contributing factor to medical incidents and a cause of miscommunication between the ICU team (Hammoudi, Ismaile, and Abu Yahya 2018). In our findings, as well as in the literature, lack of knowledge about the unit policies and work processes leads to a lower level of work quality (Al Nuhait et al. 2017). As participants mentioned, newly hired staff, interns, and nurses rotated from other units are more involved in teamwork issues and miscommunication incidents. Moreover, the lack of knowledge about unit policy and practice was reported as a cause of medical incidents (Hammoudi, Ismaile, and Abu Yahya 2018).

In our study participants believe that not getting involved in the decision-making process affected their self-confidence and subsequent motivation to get involved in the decision-making process of patient care. Conflict avoidance with physicians was mentioned as a result of a lack of awareness about the scope of practice of respiratory therapists from some ICU physicians, especially physicians coming from a medical background that does not involve respiratory therapists as part of the ICU team. Respiratory therapist participants believe establishing a new multidisciplinary orientation program for new ICU staff which includes physicians working with

respiratory therapists for a day is a way to increase the awareness of the Respiratory therapy scope of practice and will lead to a better teamwork environment.

A large number of incidents could be avoided by implementing policies that prevent the reoccurrence of error-prone situations. For example, multiple respiratory-related medical incidents occurred as a result of the shared responsibility policy between nurses and respiratory therapists in regards to suctioning patient airways, therefore review and updating the department policies is a core move towards avoiding future medical incidents.

Updating departments policies and developing protocols increase the work efficiency, improve quality of care (Metcalf et al. 2015), and decrease incidents rate (Collins et al. 2014). Overcoming these barriers will improve the safety and quality of care. Moreover, a strong awareness of the need to adhere to department policies is highly important.

When working conditions are difficult, staff will try to create shortcuts in the system to avoid complications (Amalberti et al. 2006). For example, the respiratory therapist may neglect to conduct a full assessment of a stable patient to have time to deliver care to a critical patient or to have enough time to cover an ER call, which is located in a different building or is a long distance away. Difficult work conditions and high workload could create an environment that makes respiratory therapists breach policies and conduct a procedure in a way that's against hospital policy. These breaches are the result of an administrative failure that has been occurring for a long time and led these violations to become a practice (Amalberti et al. 2006). In this study, participants reported that high workload decreased their work quality. Similarly, many studies have found that high workload is connected to staff job dissatisfaction, stress, burnout, job turnover, and lower level of care (Javed, Balouch, and Hassan 2014; Meneses Oliveira et al. 2015; Steege and Rainbow 2017; Vermeir et al. 2018). Lack of practical policies with poor monitoring makes staff breach department policies with short cuts (Alomari et al. 2018).

Therefore, involving the ICU staff perspective and their opinions on how to avoid incidents in generating the department policies is essential to successfully implementing it and improving safety culture.

In this study, it's clear that the reporting culture is malfunctioned and in need of a serious makeover. The ICU staff developed an acceptance of medical incidents as part of their daily practice as a result of complicated safety culture. Lack of understanding the importance of reporting, lack of clarity of the seriousness of this issue by management, in addition to the unhealthy culture of reporting incidents (existing blaming culture and personal conflict), are barriers to building safe culture and are endangering patient safety (Pronovost et al. 2006; Kim and Lee 2020). In addition, this indicates that the previously collected data by management, if there is any, is clearly not representing the actual situation in ICU.

Participants indicated that the reporting process was not clear and they were not aware of any education about it. Participants indicated that the staff would be more willing to report if the reporting process was more clear and easy, if they felt supported by the management, and if they received feedback about previously reported incidents. Participants believe they require more education about reporting and reporting processes which could help encourage staff to report (Hartnell,2012).

In our study, we found there is a variation in reporting culture between doctors, nurses, and respiratory therapists. Doctors are more likely to report an incident more than nurses or respiratory therapists. This finding is consistent with findings from other studies (Waring 2004). However, it's observed that ICU staff (doctors, nurses, and respiratory therapists) prefer to report and solve medical incidents within the ICU department without involving management or the quality department in the process. In other studies consistent with the findings from our study, participants indicated that they are not reporting minor incidents or near miss and prefer to solve

incidents internally (Alomari et al. 2018). This shows a lack of understanding of the importance of reporting and incident analysis. Furthermore, participants reported their concerns about the existence of blame culture within the hospital. Moreover, in our findings, it was reported that non-Saudi nurses are afraid that reporting incidents may affect their contract status. In addition, personal conflict avoidance, fear of consequences, and not believing in the system were reported as main barriers to reporting. These findings illustrate the existing issues with the reporting system and the necessary approaches to improving safety culture in Saudi. Understanding the purpose of reporting and receiving feedback on previous reports and assuring staff by implementing an actual no blaming policy will improve the reporting culture (Waring 2004; Hammoudi, Ismaile, and Abu Yahya 2018; Peyrovi, Nikbakht Nasrabadi, and Valiee 2016).

Conclusion

To our knowledge, this is the first study to investigate Respiratory Care related errors in ICU through a Qualitative In-Depth methodology. To identify the issues surrounding respiratory-related medical incidents in ICU, a deeper understanding of the ICU staff perspective is necessary. Moreover, it will help to develop a complete picture of an interventional plan suitable for the targeted respective area. In our findings, various barriers and issues were identified by the participants which they believed had led to these incidents. In this study, we found that Improving Intra departments communications, better supervision, clear protocols, supportive management, staff recognition, continuous education and training sessions, non-punitive reporting system, and establishing a reward system for the reporting staff, would increase the quality of patient care and improve staff attitude towards safety culture. However, future research is needed to generate interventional plans, evaluate their effectiveness, and modify if needed based on the findings of these studies. In addition, further investigation is required to explore absenteeism, job turnover, and second victim syndrome among respiratory therapists working in ICU.

Limitation

This study was conducted in English and Arabic, however, some participants were non-English, non-Arabic native speakers and that may lead to misunderstanding or inability of participants to represent their opinions. In this study, convenience sampling was used and that may be cause selection bias. Moreover, this study included participants to recall events from the past and that may lead to recall bias. However, we limited the recall to 12 months range to help decrease the chances of biased results. Finally, the sample size was limited; therefore, the findings should be dealt with caution concerning generalizability.

Chapter 7: Conclusion

Conclusion and implications for practice

In 2007, the first batch of Saudi respiratory therapists graduated with their bachelor's degree in respiratory care, including myself. I was in a special position as I got to see how this profession evolved over the years from the start. Before Saudis entered the RT profession, the RT staff that had been working there were mostly westerners, and I noticed that there was a clear contrast between the two groups in the way they were able to criticize management. When Western RTs would raise issues with management it was more acceptable compared to when Saudis would, for example. Western RTs also earned a higher salary than did Saudi RTs for the same job. It was apparent between staff conversations that these differences affected morale and job satisfaction.

After completing my internship, I worked in various hospitals under different management styles and I experienced first-hand how stressful these environments were, especially in the ICU. High workload, stress, and the increased chances of making mistakes easily affected staffs' work quality. Besides that, colleagues would complain about their dissatisfaction with management and how unappreciated they felt.

I began working in the academic field thereafter, where I would take my students to the clinical areas. My students would raise questions about the RTs there and why they weren't following the procedures by the book or sticking to the policies, to which the RTs would respond that it's ok to perform shortcuts, that no one questions their methods anyway as long as there are no major fatalities or incidents. These collective experiences helped form my ideas and beliefs about why staff are not performing as they should, therefore pushing me to embark on my PhD research.

To establish a baseline about the safety culture in the studied hospitals, I conducted a safety attitude questionnaire. The results of this study showed that the safety culture at these hospitals were low and highlighted areas that needed further investigation. This then led me to conducting

the observational study. I saw incidents which needed more explanation and I also wanted to get a better understanding about the contributing factors of these incidents. These questions then led to the semi-structured interview with the RTs.

While conducting the interviews, I was worried that the Asian staff wouldn't be as open as Saudis toward speaking candidly about their experiences because of the notion that they might fear losing their job security as well as the cultural differences towards authority living in the Kingdom as expats. Some of them did seem reluctant to open up, however I did my best to ease their nerves by building rapport. During the semi-structured interviews, a noticeable number of the subjects mentioned how unsatisfied they were with their work. This was the reason for conducting the job satisfaction study. Finally after gathering all this data, I needed to conduct in-depth interviews with all the staff of the ICU to better understand how work is done, why mistakes are happening, what kind of actions are taken, and how to make it better.

I had to consider the people's culture while studying the hospital culture. The way people think about high authority in Middle Eastern culture is different than in some Western cultures. Highlighting problems for example, can be considered disrespectful even if the intent is to find solutions. Moreover, reporting incidents or criticizing management can question loyalty and become problematic. In Saudi Arabian culture management is considered above questioning and doubt, and this belief is transferred to staff which can make them believe that committing errors and incidents is shameful and should not be exposed. The idea of making a mistake is expected as long as there is a human factor.

To err is human, human is intended to make mistakes; they are not machines. Therefore, systems were designed to help eliminate these errors and mistakes. Identifying the contributing factors of medical errors and their prevalence is important to design a prevention strategy based on the specific ICU setting in order to reduce the chances of repeating medical errors with the same

origin. Healthcare practitioners' awareness about the importance of their input on the incident reporting system must be encouraged and supported. Spreading the quality culture has an impact of reducing incidents that go unreported. Preventing the latent risk factors, such as poor supervision and inadequate communication, improves patient safety and eliminates the chances of human error occurrence. In addition, establishing procedure policies and standardizing equipment and frequent maintenance will improve the prevention of errors. Moreover, the development of improvement plan requires engaging the management and staff in the process.

In the 4th of October 2020, king of Saudi Arabia his highness King Salman gave the approval to the newly established Saudi Patient Safety Center to start preparing the necessary rules and regulations for the disclosure of serious events that occur in the hospitals and report these recommendations to the Saudi Health Council. In addition, the approval included the Saudi Patient Safety Center preparing an annual report on serious events in all health sectors for the purpose of assessing and preparing an interventional development plan to reduce medical incidents and improving quality of patient care. Indeed, these new regulations and recommendations will push hospitals administrations to pay attention to assess, improve and evaluate the safety culture and patient safety within their institutions (saudi 24 news 2020).

With the new trends in healthcare in Saudi Arabia and the recent Royal orders, the value of our studies hold a greater value (privilege) to the studied ICUs. The data from our studies shows multiple challenges to improve safety culture such as lack of incidents reporting, lack of management support and planning, and teamwork and communication difficulties.

Safety culture were low in the examined ICUs, and we believe this is the case in many hospitals in the Easter province of Saudi Arabia. Management need to understand the problems and how to improve the level of safety culture in Hospitals. Improving work conditions, will improve performance and thus will improve job satisfaction. Satisfied employees are more efficient in work.

Therefore, management need to keep in mind that Satisfied healthcare provider means satisfied patient.

Based on our observations and the obtained data from interviews and surveys, an inclusive list of suggested actions required to improve safety and quality were summarized in **Figure 7**. However, it is not an exhaustive list. Management need to address the issues and changes with the staff and involving them in the process of developing an interventional plan process.

Achieving better outcomes and improving quality after applying an improvement plan is expected. However, maintaining high level of quality and safety require continuous monitoring, better supervision, frequent assessment, and annual reports and recommendations. Inter and intra departments communications should be encouraged and more open. Teamwork leadership should be strengthened and supported. To improve safety and quality of services in healthcare organizations, periodical assessment of Safety culture is considered an essential element for this process (Nieva and Sorra 2003; Zimmermann et al. 2013; NHS England and NHS Improvement 2019).
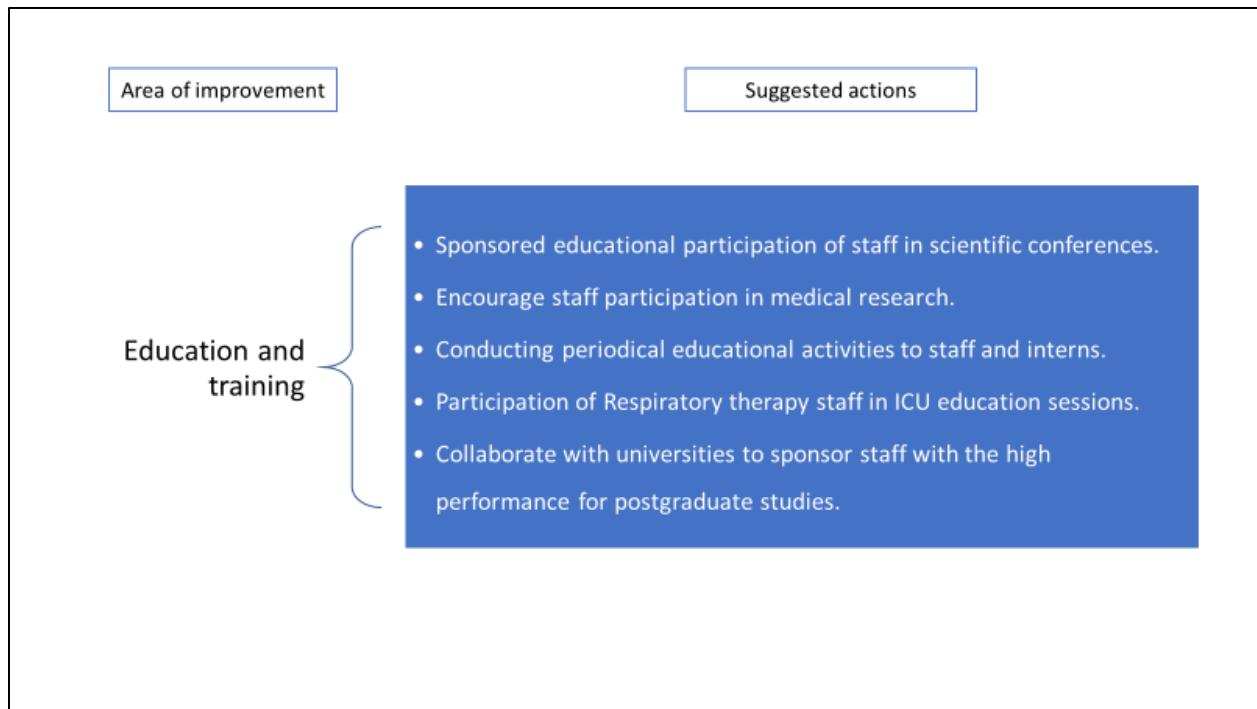
Figure 7: Sample of suggested action plan.

Limitations:

My research was conducted in only two public hospitals ICUs, specifically limited to medical and surgical ICU patients. Since the sample size was small, the findings may not be applicable to private hospitals or generalization. Moreover, a longitudinal design study rather than a cross-sectional study could provide better knowledge. Therefore, the findings may not be generalizable to other hospitals, but I believe the findings give a good representation of the respiratory therapy safety culture in ICUs in Saudi Arabia.

In my research, I used self-reporting questionnaires, and this method has a limitation of self-reporting bias. However, I tried to decrease this bias by using a short-length questionnaire and I used the Arabic version of the questionnaires to decrease the chance of the language barrier and minimize the misinterpretation of the questions. however, some participants were non-English, non-Arabic native speakers and that may lead to misunderstanding or inability of participants to represent their opinions. I tried to minimize this limitation by asking the participants if they have

any questions or if they needed further explanation. I learned from conducting my PhD research that you will face difficulties and you must do your best to ease them. Talking to people from different cultures and backgrounds makes you see how people may look or talk differently but still, they have the same aims of being and doing better.

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Appendices

Safety Attitude Questionnaire (ICU version)

Please answer the following items with respect to your specific unit or clinical area.

Choose your responses using the scale below:

Please answer the following items	Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly	Not Applicable
21. Nurse input is well received in this clinical area.	1	2	3	4	5	6
22. In this clinical area, it is difficult to speak up if I perceive a problem with patient care.	1	2	3	4	5	6
23. Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient).	1	2	3	4	5	6
24. I have the support I need from other personnel to care for patients.	1	2	3	4	5	6
25. It is easy for personnel here to ask questions when there is something that they do not understand.	1	2	3	4	5	6
26. The physicians and nurses here work together as a well-coordinated team.	1	2	3	4	5	6
27. I would feel safe being treated here as a patient.	1	2	3	4	5	6
28. Medical errors are handled appropriately in this clinical area.	1	2	3	4	5	6
29. I know the proper channels to direct questions regarding patient safety in this clinical area.	1	2	3	4	5	6
30. I receive appropriate feedback about my performance.	1	2	3	4	5	6
31. In this clinical area, it is difficult to discuss errors.	1	2	3	4	5	6
32. I am encouraged by my colleagues to report any patient safety concerns I may have.	1	2	3	4	5	6
33. The culture in this clinical area makes it easy to learn from the errors of others.	1	2	3	4	5	6
34. I like my job	1	2	3	4	5	6
35. Working here is like being part of a large family.	1	2	3	4	5	6
36. This is a good place to work.	1	2	3	4	5	6
37. I am proud to work in this clinical area.	1	2	3	4	5	6
38. Morale in this clinical area is high.	1	2	3	4	5	6
39. When my workload becomes excessive, my performance is impaired.	1	2	3	4	5	6
40. I am less effective at work when fatigued.	1	2	3	4	5	6
41. I am more likely to make errors in tense or hostile situations.	1	2	3	4	5	6
42. Fatigue impairs my performance during emergency situations (e.g. emergency resuscitation, seizure).	1	2	3	4	5	6
43. Management supports my daily efforts:	1	2	3	4	5	6
44. Management doesn't knowingly compromise pt safety.	1	2	3	4	5	6

45.	I get adequate, timely info about events that might affect my work.	1	2	3	4	5	6
46.	The levels of staffing in this clinical area are sufficient to handle the number of patients.	1	2	3	4	5	6
47.	Problem personnel are dealt with constructively by our department.	1	2	3	4	5	6
48.	This hospital does a good job of training new personnel.	1	2	3	4	5	6
49.	All the necessary information for diagnostic and therapeutic decisions is routinely available to me.	1	2	3	4	5	6
50.	Trainees in my discipline are adequately supervised.	1	2	3	4	5	6

1. **Have you completed this survey before?**   Yes ☐ No ☐   Don't Know ☐

2. **Today's Date** (month/year):_____

3. **Gender:** Male ☐ Female ☐

4. **Age:** _____

5. **Position: (mark only one):**

Attending/Staff Physician ☐   Fellow Physician ☐

Registered Nurse ☐   Respiratory therapist ☐

Nurse Manager/Charge Nurse ☐   Respiratory therapy supervisor ☐   Unit head ☐

Other (specify):

6. **Level of education:**

Diploma ☐ bachelor's degree ☐   Master, PhD, or equivalent ☐

☐   Others, specify:

7. **Years of experience in your specialty: _____**
8. **How many years did you work in this ICU? _____**

9. **How many hours per week do you work usually?**

Less than 39(part time) ☐ 40 to 59 hours ☐ 60 to 79 hours ☐ 80 hours and more ☐

10. **Which shift do you usually cover?**

Day ☐   Night ☐   variable shifts ☐

11. How you score the intensive care unit in this hospital regarding patient safety?

Excellent ☐ very good ☐ good ☐ fair ☐ poor ☐

12. Please describe the quality of communication and collaboration with the following personnel during your experience in this ICU

		Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly	Not Applicable
1	ICU head						
2	Attending/Staff Physician						
3	Fellow Physician						
4	Registered Nurse						
5	Respiratory therapist						
6	Nurse Manager/Charge Nurse						
7	Respiratory therapy supervisor						
8	Other (specify):						

13. How many incidents (medical errors) did you report to the management in the last 12 months?

None ☐ 1-2 incidents ☐ 3-5 incidents ☐ 6-10 incidents ☐ 11 and more ☐

Thank you for completing the survey - your time and participation are greatly appreciated.

Appendix 2: Ethical approval for research studies.

Armed Forces Hospitals Eastern Province
Institutional Review Board (IRB)

اللجنة الدائمة لأخلاقيات البحث العلمي

P PSMCHS, P.O. Box 33048, Dammam 31148, Eastern Region, Saudi Arabia, Tel.
013.8405487/8405490 **KACST Registration HA-05-DH-075**

IRB Protocol No.	AFHER-IRB-2020-017		
Protocol Title	Medication and Ventilation Errors during Respiratory Care in ICU		
Principal Investigator	Abdullah Alqahtani	Co-Investigators	
Institution	Prince Sultan Military College of Health Sciences	Department	Respiratory Care
IRB Review Date	Feb. 1, 2019	Effective Date	February 3, 2019
IRB Review Action	APPROVED	Expiration Date	February 2, 2020

Thank you for submitting your application to the Armed Forces Hospitals Eastern Region Institutional Review Board (IRB).

The IRB has determined that your proposed project employs a retrospective observational, qualitative survey study that pose less than minimal risk to the participants. The information will be obtained in such a way that one's responses will not be linked to one's identify or identifying information. The application was reviewed and approved.

Approval is given for one year from the date of approval. Projects, which have not commenced within one year of the original approval, must be re-submitted to the Institutional Review Board (IRB) Committee. If you are unable to complete your research within the validation period, you will be required to request an extension from the IRB Committee. *Please note that the approval of this protocol will lapse on 02-Feb-2020.*

On completion of the research, the Principal Investigator is required to advise the Institutional Review Board if any changes are made to the protocol, a revised protocol must be submitted to the Institutional Review Board for reconsideration. If an unexpected situation or adverse event happens during your investigations, please notify the AFHER IRB as soon as possible. Please refer to the IRB Protocol number denoted above in all communications related to your application and this approval.
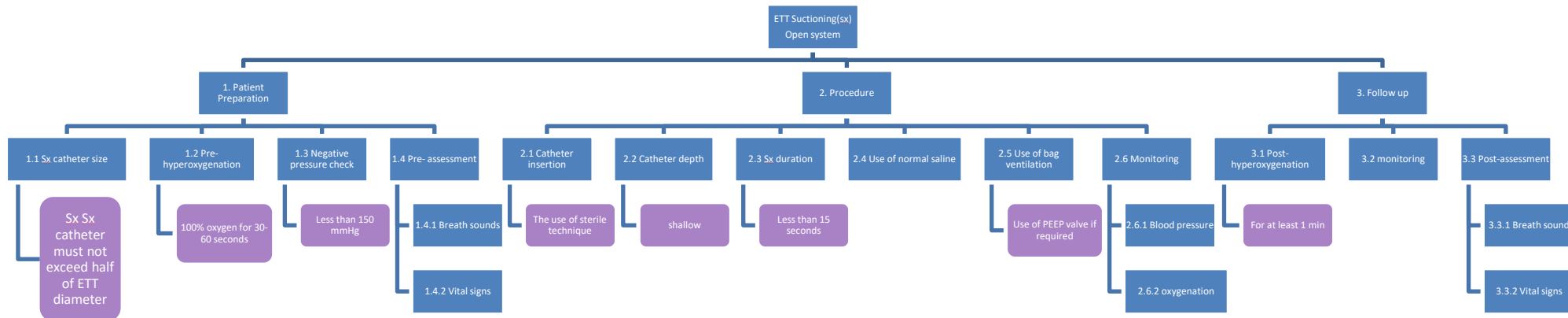
Approval is given on the understanding that the "KACST Implementing Regulations of the law of Ethics of Research" are adhered to. Where required, a signed written consent form must be obtained from each participant in the study group. **Accordingly, the principal investigator must submit progress/final report to the IRB Office once you completed your study**. The IRB extend their best wishes for the successful completion of this study.

MOHAMMED D. ALAHMARI, PhD, FAARC, FCCP Chairman of the Institutional Review Board

Appendix 3: ETT suction (open system) process.

ETT Suctioning(sx) Open system

1. Patient Preparation
- 1.1 Sx catheter size
  - Sx Sx catheter must not exceed half of ETT diameter
- 1.2 Pre-hyperoxygenation
  - 100% oxygen for 30-60 seconds
- 1.3 Negative pressure check
  - Less than 150 mmHg
- 1.4 Pre- assessment
  - 1.4.1 Breath sounds
  - 1.4.2 Vital signs

2. Procedure
- 2.1 Catheter insertion
  - The use of sterile technique
- 2.2 Catheter depth
  - shallow
- 2.3 Sx duration
  - Less than 15 seconds
- 2.4 Use of normal saline
- 2.5 Use of bag ventilation
  - Use of PEEP valve if required
- 2.6 Monitoring
  - 2.6.1 Blood pressure
  - 2.6.2 oxygenation

3. Follow up
- 3.1 Post-hyperoxygenation
  - For at least 1 min
- 3.2 monitoring
- 3.3 Post-assessment
  - 3.3.1 Breath sound
  - 3.3.2 Vital signs

Appendix 4: observations schedule form

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This form is confidential and anonymous and meant to be used for research purposes only.

Respiratory therapy medical incident form

Site and patient details				
Hospital name:	Number of beds:		ICU type:	ICU admission date:
Patient MRN:	Gender: M □ , F □	Age:	Days in ICU:	
Main reason for ICU admission:				
Comorbidities:				
ICU support: (select all that apply) Invasive mechanical ventilation □ Non-Invasive Mechanical ventilation □ Arterial Line □ Central venous catheter □ Chest drain □ Oxygen therapy □	Mechanical ventilation type:			
	Mechanical ventilation duration (Day):			
	Primary reason for mechanical ventilation:			
	Number of intubations:	ETT size:	MV mode:	

Details of the staff involved		
Years of experience:	Gender: M □ , F □	The day before the incident, the staff was : on duty □ off duty □
Patient to respiratory therapist ratio:	The respiratory therapist (RT) Works: only ICU □ , Float □	Number of RTs in the hospital (excluding admin staff):

Incident details	
Date:	Time:
Brief detail of the incident:	

Types of medical errors (for detail definition of the error see attached appendix)	
Mechanical ventilation related errors: Inappropriate settings for the patient on mechanical ventilator □ Patient Ventilator asynchrony □ Alarm failure □ Ventilator-Patient circuit disconnect or leak □ Noninvasive ventilation error □	**Airway related errors:** Suction failure □ Laryngoscope dysfunction □ Accidental extubation □ Airway unsecure /displaced ETT □ Artificial airway obstruction □ Unsafe ETT level □ Failed Intubation attempt □ Inappropriate ETT cuff pressure □ Heat and moisture exchanger (HME) failure □
Equipment related errors: Mechanical ventilator and accessories dysfunction □ Failure of arterial blood gas machine □ Failure of Transport ventilator □ Electrical power failure □	**Miscellaneous errors:** Arterial blood gas error □ Failure to follow infection control protocol □ Respiratory medication error □ Documentation error □ Behavioral incidences □

Follow up	
Was the error detected by the supervisor or other staff? Yes □, No □	Injury outcome: Near miss □ No harm or self-resolving injury □ Minor injury may require adaptation of treatment □ Serious injury may increase ICU days □ Serious permanent injury□ Death □
Did the incident get documented? Yes □, No □	
Did the patient or his relative get information about the error? Yes □, No □	
Complication associated with MV during ICU stay:	VAP: Yes □, No □ Pneumothorax: Yes □, No □ Sub.emphysema: Yes □, No □

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Contributing factors	
Organizational and management factors: Shortage of staff □ Unclear or unavailable policy for the procedure □ Policy and procedure protocol not been followed □ Poor safety culture □ Poor training □	**Work environment factors:** High workload □ Unfamiliar environment □ Unavailable or lack of maintenance of equipment □ Physical environment such as noise and temperature □ Equipment failure □ Electrical power failure □
Team factors: Lack of communication □ Inadequate assistance □ No help offered □ Poor supervision □	**Individual (staff) factors:** Lack of knowledge □ Inexperience □ Distraction □ Stress and fatigue □ Failure to check □ Unfamiliar procedure or equipment □
Task factors: Lack of equipment □ Equipment alarms was off □ Unavailable or not accurate test results □ Unavailable documentation □	**Patient factors:** Critically ill patient with poor prognosis □ Patient refuse the treatment □ Language and communication barrier □ Social or mental factors □

The incident was observed by:	
Date:	Time:

Appendix: Definitions of respiratory therapy related medical errors in ICU settings.	
Medical Error	**Definition**
Suction failure.	The suction system does not work properly: The pressure is not sufficient to ensure removal of pharyngeal and/or bronchial secretions
Laryngoscope dysfunction	The laryngoscope does not work properly: The light is not strong enough or does not turn on, assembly of the blades on the handle is difficult, or blade size is not available
Accidental extubation	Unplanned extubation or self extubation of ETT or tracheostomy tube
Airway unsecure/ displaced ETT	Incorrectly secured tube, totally displaced from patient, displaced from trachea in to soft tissues, displaced from trachea into pharynx, displaced from trachea into esophagus, or displaced from trachea into bronchus.
Artificial airway obstruction	ETT or tracheostomy blockage
Unsafe ETT level	Either there ETT level is too low or too high (optimal ETT level is 2-3cm above the carina and it could be assessed through chest X-ray)
Arterial blood gas error	Wrong technique (e.g. not performing Allen test to avoid complication), sample error (e.g. veins sample, or air bubble)
Failed Intubation attempt	Includes: Failure to intubate, Delay in intubation, Endobroncheal intubation, Esophageal intubation, and Aspiration of gastric contents
Inappropriate Endotrachial tube (ETT) cuff pressure	Either the mean pressure in the endotracheal cuff pressure is over (over inflation) or below (leak) the recommended pressure (it could be a result of inappropriate ETT size)., which is measured with an optimal range 20-30 cm H_2O.
Heat and moisture exchanger (HME) failure	Either failure because respiratory therapist didn't change it as instructed (every 48 hours) or failure due to secretion block
MV and accessories dysfunction	Lack of cleaning, or faulty equipment.
Inappropriate mechanical ventilator settings for the patient.	The settings are not optimal or updated for patient prognosis or auto cycling breathing
Patient Ventilator asynchrony	No sedation, not using the ventilator graphs to identify issues
Alarm failure	Inappropriate settings of alarms or alarms are turned off including pulse oximetry and end tidal CO2 monitoring alarms
Noninvasive ventilation (NIV)	Delay or absence of NIV, inappropriate Noninvasive interface size, or leak
Failure to follow infection control protocol	Including: Hand hygiene, Use of personal protective equipment (e.g., gloves, gowns, and masks), Safe injection practices, and Safe handling of potentially contaminated equipment or surfaces
Respiratory medication error	Either by administering medication to wrong patient, wrong dose, or delayed or wrong time
Documentation error	Absence, incomplete, or wrong documentation. Including the use of unapproved abbreviation
Failure of Transport ventilator	No charge or low charged battery
Electrical power failure	No backup power or battery, unaware staff with outage
Behavioral incidences	Rude, miscommunication, member inactive of team work
Prolong mechanical ventilation	Ventilation for 21 consecutive days for at least 6h/d.
Comorbidities	Defined as: congestive heart failure, coronary artery disease, chronic obstructive pulmonary disease, interstitial lung disease, pulmonary hypertension, end-stage renal disease, liver cirrhosis, diabetes mellitus, acute or chronic encephalopathy, cancer, and immunosuppressant usage.

Time of the incident	Observations

Appendix 5: The MSQ form

Job Satisfaction Questionnaire

Today's Date (month/year):_____

The purpose of this questionnaire is to tell me how you feel about your present job, this is for research purposes only.

Kindly, read each statement carefully and choose one of the following:

-if you feel that your job gives you more than you expected, check the box under (Very Satisfied);

-if you feel that your job gives you what you expected, check the box under (Satisfied);

-if you cannot make up your mind whether or not the job gives you what you expected, check

the box under (Neutral);

-if you feel that your job gives you less than you expected, check the box under (Dissatisfied);

-if you feel that your job gives you much less than you expected, check the box under (Very Dissatisfied).

14. **Gender:** Male ☐ Female ☐

15. **Age:** _____

16. Position: (mark only one):

Respiratory therapist ☐   Respiratory therapy supervisor/administration ☐

17. Level of education:

Diploma ☐ bachelor's degree ☐   Master, PhD, or equivalent ☐

18. Years of experience: _____

19. Which shift do you usually cover?

Day ☐   Night ☐   variable shifts ☐

Kindly after finishing the questionnaire please return it to the collector. Thank you for your time and participation.

	Please answer the following items	very dissatisfied	dissatisfied	Neutral	satisfied	very satisfied
51.	Being able to keep busy all the time	1	2	3	4	5
52.	The chance to work alone on the job	1	2	3	4	5
53.	The chance to do different things from time to time	1	2	3	4	5
54.	The chance to be "somebody" in the community	1	2	3	4	5
55.	The way my boss handles his/her workers	1	2	3	4	5
56.	The competence of my supervisor in making decisions	1	2	3	4	5
57.	Being able to do things that don't go against my conscience	1	2	3	4	5
58.	The way my job provides for steady employment	1	2	3	4	5
59.	The chance to do things for other people	1	2	3	4	5
60.	The chance to tell people what to do	1	2	3	4	5
61.	The chance to do something that makes use of my abilities	1	2	3	4	5
62.	The way company policies are put into practice	1	2	3	4	5
63.	My pay and the amount of work I do	1	2	3	4	5
64.	The chances for advancement on this job	1	2	3	4	5
65.	The freedom to use my own judgment	1	2	3	4	5
66.	The chance to try my own methods of doing the job	1	2	3	4	5
67.	The working conditions	1	2	3	4	5
68.	The way my co-workers get along with each other	1	2	3	4	5
69.	The praise I get for doing a good job	1	2	3	4	5
70.	The feeling of accomplishment I get from the job	1	2	3	4	5

Thank you for completing the survey - your time and participation are greatly appreciated.

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In-Depth interview Guide

Pre-interview data			
Years of experience:	Gender: M □, F □	Age:	Hospital:
Position:		Date:	Time:
I want to thank you for taking the time to meet with me today. Do you consent freely to participate in this audio recorded interview? Verbal Consent: Yes □, No □			
The interview should take around 30 mins. I will be audio recording this interview, so I don't miss any of your comments. Also, I will be taking some notes during the session.			
All your responses and comments will be confidential, and no names will be written in this form. You have the right to end this interview in any time. Also, you have the right to refuse answering any question. Do you have any question before we start?			

Interview Questions (Respiratory therapist version)	
-Examples	• **Poor safety culture** Q1: Could you tell me what do you know about safety culture? Q2: What is the safety culture in this hospital? why?
	Q3: how can it be improved? • **Feeling undervalued by ICU team:** Q4: Is teamwork important in ICU? why?
Examples	For nurses and physicians: what's the role of an RT? How important is his job? Q5: How would you describe the relationship between RT, nurses, and physicians? Why? Q6: How involved is the RT in the patient's care plan? Q7: How to improve the teamwork in ICU? • **Reluctant to report errors** Q8: How important is it to report incidents?

	Q9: What happens when you see an incident? -How is it reported Q10: Do you think all incidents are reported? why? Q11: It's been mentioned that, avoiding personal conflicts and the fear of consequences are the top reasons for not reporting. Do you agree or disagree, and could you explain? Q12: How can staff be encouraged to report incidents? • **Carelessness**: Q13: What kind of scenarios would you describe that staff acted carelessly? • **Missing documentations**: Q14: How important is documentations? when should be completed? Who should complete it? Q15: reasons documentation doesn't get completed? Types of missing documentation (like HME labels). Q16: How to improve documentation?
Reasons Motivation Job satisfaction	

Standard practice	**• Ventilator management** Q17: It was noticed that some of the ICU patients suffered from poor ventilator management during their stay in the ICU, could you tell me how the ventilator is handled in ICU? (What's the role of respiratory therapist?), (for nurses and physicians: How involved is the respiratory therapist in patient care plan?) Q18: reasons for poor ventilator management? (for physicians: do you discuss patient plan with the respiratory therapist?) Q19: What is the solution to prevent them from happening again? • Training • In services • Conferences **• Poor supervision** Q20: What's do you think the role of supervisor in: -preventing errors. -Adherence to practice. -Example of good supervision: -Example of bad supervisions: Q21: How can supervision be more effective?

	• **High workload:**
	Q22: What do you see as high workload?
	Q23: how do you manage high workload?
	Q24: What could be changed /put in place to reduce workload?

Post-interview

Is there anything more you would like to discuss that we haven't covered?

Thank you for your time.

Finishing Time: