View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by ScholarWorks @ SeattleU (Seattle University)

Seattle University

ScholarWorks @ SeattleU

Doctor of Nursing Practice Projects

College of Nursing

2021

# Examination of Nurses' Perceptions, Beliefs, and Conceptions Related to Rapid Bedside Implementation of Prone Therapy During the COVID-19 Pandemic

Alyssa Poghen
*Seattle University*

Emily La Riviere
*Seattle University*

Follow this and additional works at: https://scholarworks.seattleu.edu/dnp-projects

 Part of the Nursing Commons

## Recommended Citation

Poghen, Alyssa and La Riviere, Emily, "Examination of Nurses' Perceptions, Beliefs, and Conceptions Related to Rapid Bedside Implementation of Prone Therapy During the COVID-19 Pandemic" (2021). *Doctor of Nursing Practice Projects*. 33.
https://scholarworks.seattleu.edu/dnp-projects/33

This Project is brought to you for free and open access by the College of Nursing at ScholarWorks @ SeattleU. It has been accepted for inclusion in Doctor of Nursing Practice Projects by an authorized administrator of ScholarWorks @ SeattleU.

# Examination of Nurses' Perceptions, Beliefs, and Conceptions Related to Rapid Bedside Implementation of Prone Therapy During the COVID-19 Pandemic

Alyssa Poghen & Emily La Riviere

A DNP project submitted in partial fulfillment of the requirements for the degree of

Doctor of Nursing Practice

Seattle University

March 2021

Approved by: Benjamin J Miller Date: March 17, 2021
DNP Mentor: Benjamin Miller, PhD, ARNP, FNP-C, ACNPC, ENP-C, FAANP

Approve by: Diane Fuller Switzer Date: March 17, 2021
DNP Reader: Diane Fuller Switzer, DNP, RN, ARNP, FNP/ENP-BC, ENP-C, FAEN

Abstract

The COVID-19 pandemic of the SARS-CoV-2 virus created significant challenges for healthcare agencies and front-line healthcare workers. The SARS-CoV-2 virus has demonstrated a unique propensity to induce severe lung injury in the form of acute respiratory distress syndrome (ARDS). High rates of COVID-19 illness in the initial months of the pandemic in the United States led to a rapid influx of patients admitted to critical care units (CCUs) for ARDS. Prone positioning therapy (PPT) has shown substantial promise in treating refractory hypoxemia in people with severe ARDS but historically received poor acceptance as a first-line therapy. With the onset of the pandemic, hospitals became overwhelmed with critically ill COVID-19 patients experiencing severe ARDS, and utilization rates of PPT increased dramatically. This project evaluates the process by which one CCU in a metropolitan hospital rapidly implemented a PPT protocol for ARDS management during the COVID-19 pandemic. Interviews were conducted with five (n = 5) CCU RNs using semi-structured techniques. De-identified data from interview transcripts were analyzed using the interpretive phenomenological analysis (IPA) framework to produce a narrative account of nurses' lived experiences during the rapid implementation of a PPT during the COVID-19 pandemic.

*Keywords: Prone position therapy (PPT), acute respiratory distress syndrome (ARDS), just-in-time training (JITT), critical care unit (CCU), registered nurses (RNs), COVID-19 Pandemic, SARS-CoV-2, front-line healthcare workers, interpretive phenomenological analysis (IPA)*

Table of Contents

**Examination of Nurses' Perceptions, Beliefs, and Conceptions Related to Rapid Bedside Implementation of Prone Positioning Therapy During the COVID-19 Pandemic**

The novel coronavirus Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) emerged in rural China during the winter of 2019 and caused the pandemic known as Coronavirus Disease of 2019 (COVID-19) (World Health Organization, 2021). This viral pandemic incited unprecedented challenges throughout healthcare systems. Among those most affected by the crisis were *front-line healthcare workers* which includes many occupational groups and ancillary services that support the provision of care to acutely ill and hospitalized patients.

In the United States, Registered Nurses (RNs) are the largest occupation of healthcare workers in hospitals, comprising 30% of all hospital employees on average (Bureau of Labor Statistics [BLS], 2019). For comparison, physicians and other providers comprise approximately 5.5% of hospital employees (BLS, 2019). Although nurses prove vital to the U.S. healthcare system, global nursing shortages have prevailed for decades and are projected to continue if the supply of nurses cannot meet the projected growth in demand (BLS, 2020). Nursing shortages are attributed to various causes that affect both supply and demand, including a high incidence of burnout and turnover, the aging population of the "Baby Boomer" generation, and an insufficient supply of nursing educators (Hart et al., 2014; Woo et al., 2020).

The COVID-19 pandemic placed additional burdens on the nursing workforce in several ways (Sperling, 2021). Global shortages of personal protective equipment (PPE) forced healthcare workers to re-use PPE in ways that deviated from prior standards (Graham, 2020). Limited testing capacity, evolving recommendations from public health authorities, lack of precise knowledge regarding virus transmission, and many other factors contributed to a rapid

rate of collective change in the field of healthcare during the initial months of the pandemic (Ruiz-Fernández et al., 2020; Sperling, 2021; WHO, 2020). Consequently, nurses had to quickly accommodate new protocols and keep up with the rapid pace of change in patient care as part of the collective effort to combat such a severe disease process (Sperling, 2020). In consideration of the increased burdens on nursing staff, better understanding of nurses' lived experiences during the COVID-19 pandemic could contribute valuably to the provision of effective support to nurses and other essential healthcare workers in crisis and post-crisis circumstances.

## Background and Significance

### COVID-19 and Acute Respiratory Distress Syndrome

The virus responsible for the COVID-19 pandemic, SARS-CoV-2, is the third coronavirus to reach epidemic or pandemic proportions. Previous outbreaks include the SARS-CoV (SARS) outbreak of 2003 and the MERS-CoV (Middle East Respiratory Syndrome-Coronavirus) of 2012 (Loo et al., 2021). SARS-CoV-2 is unique to its counterparts due to its unprecedented rate of infection worldwide. As of March 2021, there have been over 114,900,000 global cases of SARS-CoV-2, while the total global cases for SARS and MERS-CoV are approximately 8,098 and 2,521 respectively (COVID-19 Map - Johns Hopkins Coronavirus Resource Center, n.d.; Johns Hopkins Coronavirus Resource Center, 2021). The estimated global mortality rates of MERS-CoV and SARS-CoV, are 35% and 9.6% respectively (Lu et al., 2020). The global mortality rate for SARS-CoV-2 infection proves difficult to estimate given the active status of the pandemic at the time this manuscript was written; however, the WHO estimates a 0.5-1.0% global mortality rate of SAR-CoV-2 infection as of March 2021 (Ioannidis, 2021).

The COVID-19 pandemic created major healthcare burdens in part due to its propensity to cause severe respiratory distress syndrome (ARDS), which is a devastating state of respiratory

failure that develops after exposure to a pathological trigger such as an infection or injury (Murthy et al., 2020; Schreiber, 2018). The gold standard for diagnosis of ARDS is the Berlin Definition of ARDS, which was created in 2011 as a result of the combined efforts between the European Society of Intensive Care Medicine, the American Thoracic Society, and the Society of Critical Care Medicine (Drahnak, 2015) (Figure 1).

Signs of ARDS develop approximately 7-10 days after an eliciting insult, as a systemic inflammatory response is triggered within the body Although the pathophysiology of how SARS-CoV-2 triggers ARDS is not fully understood, scientists have noted that SARS-CoV-2 has high binding affinity for angiotensin converting enzyme-2 (ACE2) receptors that are expressed on the surface of airway epithelial cells (Loo et al., 2021; Moore & June, 2020). Binding to these ACE2 receptors allows the virus to enter the host cell and rapidly replicate. This entry into the cell and replication of the virus stimulated an immune response, which includes that activation of inflammatory cytokines and the migration of haemopoietic cells such as neutrophils to the site of infection (Uras, 2020; Moore & June, 2020.).

***Inflammatory Response***

Inflammatory cytokines are produced by several immune mediators that are stimulated by the host's immune response (Ragab et al., 2020). Cytokines damage the epithelial lining of alveoli, leading to increased capillary permeability and fluid accumulation in the interstitial and alveolar space **(**Mitchell & Seckel, 2018; Keddissi et al., 2019; Arias et al., 2017). The most prominent inflammatory cytokine involved in the SARS-CoV-2 inflammatory response is interleukin-6 (IL-6), which is secreted in extremely high concentrations by the host immune system in COVID-19 patients (Moore & June, 2020; Ragab et al., 2020). High levels of IL-6 are also found in other respiratory viral infections like human respiratory syncytial virus (RSV) and

influenza (Okabayashi et al., 2006). However, coronaviruses are unique from other respiratory viruses because they induce minimal secretion of suppressor cytokine signaling-3 (SOC-3), an inhibitory cytokine that limits the inflammatory activity of IL-6. Other respiratory viruses stimulate the secretion of both IL-6 and SOC-3, activating the inflammatory cascade in response to infection but also preventing continuous, uninhibited IL-6 activity (Okabayashi et al., 2006). This uninhibited inflammatory response leads to IL-6 accumulation, causing a hyperactive immune state known as "cytokine storm" that exacerbates tissue damage and lung edema (Moore & June, 2020; Ragab et al., 2020; Okabayashi et al., 2006).

Under normal conditions, the alveolar membrane is made up of tight epithelial junctions that prevent alveolar flooding in the presence of normal hydrostatic pressure (Keddissi et al., 2019). Tight epithelial junctions maintain the stability structural integrity of the alveoli, which is vital in maintaining adequate arterial oxygenation as the alveoli are the site of oxygen diffusion into the bloodstream. Fluid accumulation of the alveolar space prevents oxygen from reaching capillary beds creating a ventilation-perfusion mismatch that allows blood to bypass the alveoli without being fully oxygenated (Schreiber, 2018). As this mismatch develops, supplemental oxygen delivery fails to increase arterial oxygenation as it does not correct the fluid barrier that prevents oxygen from reaching the bloodstream (Schreiber, 2018).

Alveolar dysfunction is further impaired by massive neutrophil activation, which is the body's first line of defense against microorganisms. After encountering a virus, neutrophils release antiviral enzymes that are stored in their intracellular components through a process called neutrophil degranulation (Akgun et al., 2020). Neutrophil degranulation is a normal immune response to viral respiratory infection but can also lead to the formation of neutrophil extracellular traps (NETs) which are sophisticated networks of neutrophil DNA and intracellular

proteins (Middleton et al., 2020; Borges et al., 2020). NETs are designed to enhance the innate immune response by physically capturing microorganisms, but they can also be coagulopathic and proinflammatory to surrounding pulmonary tissues (Middleton et al., 2020; Borges et al., 2020). NET-induced coagulopathy leads to the formation of micro-emboli which perpetuates damage to surrounding lung tissue, while the proinflammatory state permanently damages the alveolar endothelial layer and type II alveolar cells. Damage to type II alveolar cells renders surfactant inactive, leading to alveolar collapse which reduces the available surface area where oxygen exchange occurs (Middleton et al., 2020; Batah & Fabro, 2021; Drahnak, 2015). The end result of neutrophil degranulation and NET formation is continued inflammation and damage to pulmonary tissues, exacerbating hypoxemia and ultimately inducing respiratory failure in the form of ARDS.

ARDS is clinically significant because of its exceptionally high mortality rate. The average global mortality rate of ARDS prior to the COVID-19 pandemic was estimated to be as high as 45% in severe cases (Esteban et al., 2013; Bellani et al., 2016). Preliminary data regarding COVID-19 and ARDS suggest a similarly high global mortality rate. Multinational studies of ARDS in COVID-19 reported median mortality rates across all countries to be 39 - 45%, with the average European mortality estimated at 34% and the Asian mortality estimated at 65% (Hasan et al., 2020; Tzotzos et al., 2020). Although preliminary studies demonstrate similar mortality rates between COVID-19-induced ARDS and all-cause ARDS, the mortality rate remains unacceptably high and demands the investigation of more effective treatment interventions.

COVID-19-induced ARDS is unique from all-cause ARDS due to its high incidence and rate of occurrence. A global analysis of SARS-CoV-2 patients admitted to the hospital showed

that 33% of patients admitted to the hospital with COVID-19 developed ARDS (Tzotzos et al., 2020). In comparison, the incidence of sepsis-induced ARDS –which was the leading cause of ARDS prior to the emergence of SARS-CoV-2 – is about 6-7% in Western countries (Kim & Hong, 2016).

Treatment of ARDS relies on interventions designed to correct hypoxemia and alleviate respiratory distress. Traditional ARDS management includes non-invasive methods of ventilation such as continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP), mechanical ventilation, supplemental oxygen administration, lung protective ventilation, pulmonary vasodilators, and neuromuscular blocks (Drahnak, 2015). In the most severe forms of ARDS, traditional management strategies often prove inadequate in correcting refractory hypoxemia and promoting alveolar recruitment (Guérin et al., 2013; Marini et al., 2016). Moreover, the ineffectiveness of standard interventions in ARDS has led to greater interest in *prone position therapy (PPT)* as a promising adjunct treatment approach shown to reverse hypoxemia and improve mortality risk (Arias et al., 2017; Pugliese et al., 2018; Guérin et al., 2013).

**Project Aims**

This project aims to investigate the perceptions and experiences of RNs working in the critical care unit (CCU) of a large metropolitan hospital during the COVID-19 pandemic. Investigators focus specifically on the unit's rapid implementation of a protocol for Prone Position Therapy (PPT) as a treatment modality for critically ill adults with severe lung damage from COVID-19 illness. Investigators of this process evaluation project conducted individual interviews with five CCU RNs who performed PPT for patients with severe COVID-19 illness after receiving expedited training for PPT. Investigators believe that analysis of the lived

experiences of RNs during the COVID-19 pandemic will contribute significant value to the understanding of how to support RNs, promote retention, and combat burnout rates among those most taxed by the current healthcare crisis.

**Theoretical Framework**

The theoretical significance of this process evaluation project is supported by Kurt Lewin's Theory of Change. Kurt Lewin is known as the pioneer for organizational development and group dynamics. His three-step change model is based on the concept that change is an imbalance of opposing forces that disrupts organizational equilibrium (Udod & Wagner, 2018). *Driving forces* are those that push a person or organization in a direction of change, while *restraining forces* are those that hinder change. These forces influence the movement between Lewin's stages of change. As Lewin's change theory is structured around organizational change and macro-structures, the theory has also been expanded by theorists to highlight the importance of organizational leadership involvement in guiding successful change. (See Figure 2)

The first stage of Lewin's change theory is *unfreezing*, which involves finding a method to deviate from old patterns of behavior and overcome group conformity. In this stage, there is disequilibrium due to an increase in driving forces, a decrease in the restraining forces, or a combination of the two (Udod & Wagner, 2018). Examining the pandemic from the perspective of Lewin's change theory, the emergence of COVID-19 and the subsequent rise hospitalized ARDS patients represent an increase in the driving forces within the unfreezing stage. The restraining forces can be seen as the organizational barriers that normally prevent change from occurring quickly, including financial barriers and support from key stakeholders. These forces were decreased during the pandemic, as key stakeholders and organizational leaders recognized the vast significance of the pandemic and supported change with little resistance. There was also

an increase in funding to support the financial demand of the pandemic, alleviating the fiscal barriers that impede change under normal circumstances.

The second stage is *change*, where there is a shift in thought, feeling, or actual behavior. This stage highlights the importance of idea sharing and knowledge exchange at multiple levels within the organization, starting at the individual level. Individual employee involvement is crucial in this stage as it influences acceptance and engagement of organizationally implemented change. Active idea sharing and knowledge exchange at the individual level should be encouraged by the organization to generate new value that provides the mechanism and framework on which organizational change is formed. In this way, the value generated from individual knowledge sharing catalyzes the organization's macro-level learning process (Hussain et al., 2016). As the pandemic continued to develop, healthcare providers started to form new ideas on how to address the pandemic and treat COVID-19 affected individuals. These ideas were discussed and shared among professionals in order to create new protocols and treatment regimens.

The final stage is *refreezing* and occurs when implemented change becomes habitual and a new equilibrium has been reached (Udod & Wagner, 2018). This stage involves the implementation of long-term strategies to ensure that integrated change is sustained over time. Some of these strategies include activity planning to ensure successful short-term implementation, and commitment planning to ensure sustained support of key stakeholders/groups (Hussain et al., 2016). Within the organization of study, the protocols and habits implemented during the pandemic continue to be a part of standard patient care. This demonstrates the development of new norms that are solidified during Lewin's refreezing stage.

## Review of Literature

### Prone Position Therapy (PPT)

The first recorded use of PPT occurred in 1974 by physicians Froese and Bryan, who suggested that passive ventilation in the supine position for prolonged periods of time was suboptimal since it left the dependent areas of the lung without adequate oxygenation (Mitchell & Seckel, 2018). This concept has been the foundation for PPT as a treatment intervention for modern respiratory distress syndromes.

PPT involves positioning patients flat on their abdomen (prone) for 12-18 hours, followed by re-positioning onto their back (supine) for the remaining hours of the day (Arias et al., 2017; Hadaya & Benharash, 2020; Munshi et al., 2017). This can be achieved using mechanical equipment such as the Rotoprone bed, or by manual positioning (Morata et al., 2018; Vollman, 2001). Mechanical methods of PPT have been shown to have a higher incidence of adverse events such a pressure injury (Vollman, 2004). Alternatively, manual positioning is associated with fewer pressure injuries as well as shorter ICU length of stay, fewer total hospital days, and increased likelihood to discharge home after their hospital stay (Morata et al., 2018).

Manual positioning is labor intensive, requiring a minimum of four staff members to physically maneuver the patient as well as one respiratory therapist (RT) to manage the ventilator and ensure airway patency (Vollman, 2001). Proper body positioning once the patient is prone involves placing pillows/padding under the chest, pelvis, knees and ankles (Vollman, 2004; Mayo Foundation for Medical Education and Research, 2020). Elevation of the chest and pelvis with pillows/padding is important because it allows the abdomen to be free-hanging, which promotes better lung expansion (Kallet, 2015). The head should be rotated every 1-2 hours, while ensuring proper endotracheal tube (ETT) positioning. Range of motion of the arms should

be performed every two hours with one arm down to the side and the other outstretched and extended above the head (swimmer's position) (Vollman, 2004; Chantler, 2017; MFMER, 2020).

***Chest Physiology***

Anatomically, the lungs are a truncated, cone-shaped organ which rest within a cylindrically contoured chest cavity (Marini, Josephs, Mechlin & Hurford, 2016). The thoracic cavity is a five-liter compartment that is separated from the abdominal compartment by a thin membrane known as the diaphragm. The diaphragm is a mostly impermeable membrane of muscle that allows the thoracic cavity and the abdominal compartment to function as two distinct chambers, each maintaining steady-state pressure gradient. The abdominal compartment is a ten-liter compartment enclosed by two rigid walls (the pelvis and spine) and two flexible walls (the ventral abdominal surface and the diaphragm). The space between the lungs and the chest wall is a negative pressure zone called the pleural space. The resting pressure within the pleural space during supine positioning is about –6 cm H20. In contrast, the intra-abdominal pressure (IAP) during supine position is about 7-9 cm H20 (Kallet, 2015). IAP is highest in the dorsal regions of the body when supine and transmits pressure to the lung pleura. This pressure gradient that exists between the pleural space and intra-abdominal space promotes compression of the dorsocaudal lung fields, which can impede lung inflation if a person is left in the supine position for prolonged periods of time (Kallet, 2015).

It is also important to note that there are differences in lung tissue density that exacerbate ventilation abnormalities in ARDS. Dorsal lung tissue is more dense and alveolar-rich compared to ventral tissue (Arias et al., 2017). It is estimated that about 20% of lung tissue is oriented in the ventral plane (relative to the heart), while at least 50% of the lung tissue is oriented in the dorsal plane (Kallet, 2015).

### *Ventilation and Perfusion*

Ventilation (V) and perfusion (Q) are influenced by various pressure gradients that exist in the thoracic cavity and are responsible for maintaining equilibrium of gas exchange between the pulmonary alveoli and capillary beds. Dysfunctions in either mechanism can alter the body's oxygen diffusion capacity and lead to the development of hypoxemia.

Pulmonary blood flow is a vital part of systemic perfusion, as it is responsible for carbon dioxide (CO2) delivery to the alveoli for removal and delivery of oxygenated blood to systemic circulation (Lohser & Ishikawa, 2011). If pulmonary blood flow is compromised, CO2 accumulates, and blood oxygen levels drop as gas exchange between capillary beds and alveoli are impaired. Pulmonary blood flow is influenced by thoracic pressure gradients and gravitational forces which creates an uneven, heterogenous distribution of blood flow to different lung regions called "zones" (Lohser & Ishikawa, 2011; Nieman et al., 2015; Guerin et al., 2014). This heterogeneous blood flow to various lung zones is a normal physiological process that is dependent on body positioning.

Zone one pertains to the most superior lung region, while zone two and zone three represent the middle and inferior lung regions. Pulmonary blood flow between these zones is determined by pulmonary artery pressure ($P_{pa}$), pulmonary venous pressure ($P_{pv}$), and alveolar pressure ($P_{al}$) (Lee & Monahan, 2014; Lohser & Ishikawa, 2011). In the upright position, zone one lies in the apex region of the lung and is defined by alveolar pressures that exceed intravascular pressures ($P_{al} > P_{pa} > P_{pv}$). This pressure gradient causes pulmonary capillary collapse with nearly complete obstruction of blood flow (Lohser & Ishikawa, 2011). For this reason zone one is known as "alveolar dead space" since it lacks adequate blood flow for diffusion of oxygen to occur (Lohser & Ishikawa, 2011; Lee & Monahan, 2014; Costanzo,

2018). In zones two through three, the arterial pressure exceeds that of alveolar pressure, allowing capillary blood flow to occur (Lohser & Ishikawa, 2011; Costanzo, 2018). The change in pressure gradients across zones one through three cause a preferential distribution of pulmonary blood flow to the more inferior, dependent regions of the lungs (Lohser & Ishikawa, 2011; Vollman, 200)1. In the supine position, the orientation of lung zones change; zone 1 represents the ventral lung tissue closest to the sternum while zone three represents dorsal lung tissue along the spine. As pulmonary blood flow will still be preferentially distributed to zones two through three, dorsal lung tissues receive the greatest blood flow.

As stated previously, the alveolar edema and inflammation that occurs in ARDS affects dense dorsal lung tissues more than other regions of the lung, as it is dependent and prone to fluid accumulation (Arias et al., 2017). This leads to pulmonary blood flow that is preferentially distributed to areas of the lung that are filled with fluid and unable to participate in oxygen exchange. PPT has a unique effect on perfusion by altering preferential flow to the various lung zones, partially offsetting the ventilation-perfusion mismatch that occurs in ARDS. It would be expected that preferential blood flow in the prone position would be diverted to the ventral lung regions due to the orientation of gravity. Contrarily, studies show that pulmonary blood flow remains preferential to dorsal lung tissues despite the orientation of gravity in prone position (Guerin et al., 2014; Jones et al. 2001). Both human and animal studies have also shown that the distribution of alveolar edema is not strongly influenced by gravity, which implies that fluid accumulated in dorsal lung tissues does not “move” when the patient is placed in prone position (Guerin et al., 2014). Therefore, the most significant outcome of prone positioning related to perfusion is more homogenous transpulmonary blood flow distribution (Drahnak, 2015; Guerin et al., 2014; Mitchell & Seckel, 2018).

During passive ventilation in the supine position, inspiratory volume is preferentially distributed to the nondependent, ventral regions of the lungs (Kallet, 2015). This is partially due to the cephalad movement of the dorsal diaphragm that does not occur during active ventilation due to diaphragmatic contraction. The ventral chest wall is also much more compliant than the dorsal chest wall, which further promotes heterogeneous displacement of inspiratory volume (Kallet, 2015).

Prone position can improve ventilation by creating more even distribution of gravitation forces across lung tissue, also called the "Slinky Effect" (Kallet, 2015; Arias et al., 2017). In this phenomenon, the lungs are represented by a spring-shaped slinky which is suspended by its apex from the ventral surface of the chest wall. The base of the slinky lies on the dorsal surface of the lung and is distorted by its own weight (eg, the slinky is larger and heavier towards the base and is therefore more compressed compared to its apex). In prone position, the slinky (eg, the lungs) is suspended from the large surface of the dorsal chest wall and lungs tissues are more evenly distributed under gravity. This homogenous tissue distribution affects ventilation by promoting greater alveolar recruitment (Kallet, 2015; Guerin et al., 2014; Mitchell & Seckel, 2018). The prone position also leads to greater dorsal-caudal displacement of the diaphragm which results in more effective lung expansion (Kallet, 2015).

Another component to inadequate ventilation is the superimposed compressive forces of the heart (Kallet, 2015; Drahnak, 2015). In the supine position, the heart compresses the lungs (primarily the left lung) and exacerbates alveolar compression. In prone position, the heart rests almost entirely on the sternum which alleviates the compressive forces on the lower lung fields (Kallet, 2015).

**Benefits of PPT**

The most notable benefit of PPT in the treatment of ARDS is improved mortality. Patients with severe ARDS who receive PPT have lower 28-day and 90-day mortality rates, fewer days in the ICU, fewer total hospital days, higher rates of successful extubation, and greater likelihoods to discharge to home rather than a facility (Alessandri et al., 2018; Arias et al., 2017; Schrieber, 2018; Guérin et al., 2013).

PPT improves the V/Q mismatch and the degree of pulmonary shunting that occurs in ARDS, leading to an improvement in hypoxemia (Drahnak, 2015; Mitchell & Seckel, 2018; Guerin et al., 2014; Pugliese et al., 2018; Hadaya & Benharash, 2020; Marini et al., 2016). This is a major implication of PPT since other interventions used to treat ARDS are often insufficient in improving oxygenation.

Improvements to oxygenation may also decrease the severity of pulmonary hypertension by interrupting the negative feedback loop that controls pulmonary vasculature constriction (Arias et al.,2017). In states of hypoxemia, low oxygen levels in the blood trigger specific chemoreceptors that induce vasoconstriction throughout the lungs as a compensatory mechanism for hypoxemia. This leads to pulmonary artery hypertension if hypoxemia is not revolved (Alessandri, Pugliese & Ranieri 2018; Schrieber, 2018). Increased oxygenation may prevent or reduce the degree of pulmonary constriction, which has downstream effects that are hemodynamically beneficial. These benefits include increased preload, increased cardiac output, and correction of hemodynamic instability (Arias, Pokharel, Papathanassoglou & Norris, 2017; Vollman, n.d.).

**Adverse Outcomes of PPT**

Despite its significant advantages, PPT also carries considerable risks. Use of PPT can lead to loss of vascular access, pressure ulcers, vomiting, airway obstruction, facial edema, inadvertent extubation of the endotracheal tube, and increased vasopressor requirements (Guérin et al., 2013; Marini et al., 2016). Adverse outcomes with PPT may occur more frequently when inexperienced healthcare units implement PPT for the first time (Schotten et al. 2017). One of the largest randomized PPT trials to date demonstrated significant benefits with PPT, but the study was conducted in 27 ICUs that all had at least five years of experience using PPT (Guérin et al., 2013). A literature review of PPT trials suggested that nursing expertise and experience with PPT likely has strong influence over the benefits achieved with PPT use in ARDS (Marini et al., 2016).

Evidence-based strategies proven to mitigate risk in PPT include the use of simple, precise protocols to guide users in maintaining consistent and safe processes for PPT, ensuring adequate staff training, maintaining a sufficient number of staff performing PPT each time, and careful exclusion of patients at high risk for complications from PPT (De Jong et al., 2013; Girard et al., 2014; Messerole et al., 2002). Risk factors for complications from PPT include morbid obesity, elevated intracranial pressure (ICP), massive hemoptysis, recent neck surgery, recent facial trauma, unstable fractures of the spine, femur, or pelvis, chronic respiratory failure, end stage lung disease, severe burns >20% of total body surface area, and pregnancy among many others.

**Just-in-time Training**

*Just-in-time training (JITT)* is an education model that focuses on duty-specific, on-site training for essential skills needed to execute urgent tasks (Leider et al., 2017). JITT describes

the method of training used by the host organization to train CCU nurses in PPT, which deviated from the traditional training and education method used in this critical care unit. Instead of online education and skills training performed in a classroom setting, participants were educated and trained in PPT at the bedside of patients as the therapy was warranted during the COVID-19 pandemic.

The utility of JITT has been well-documented in commercial industries such as aviation and manufacturing, but studies on JITT in the healthcare setting are comparably minimal (Peebles et al., 2020). However, the available literature evaluating JITT use in acute care, inpatient settings demonstrate positive results (Mangum et al., 2017; Osei-Ampofo et al., 2018; Pade et al., 2018; Peebles et al., 2020). When JITT methods were used to educate a sample of over 500 nurses to appropriately recognize and respond to acute deterioration in patient status, results showed that JITT was correlated with increased frequency of nurse-directed escalation of care without seeking guidance from other providers (Peebles et al., 2020). When JITT methods were used to train healthcare professionals in essential patient care skills and procedural knowledge, results demonstrated participant retention of materials up to 11 months after training occurred as well as improvement in patient outcomes (Osei-Ampofo et al., 2018; Pade et al., 2018). Subjectively, clinicians who received education using JITT methods reported high levels of satisfaction due to increased applicability to clinical practice, greater flexibility, and increased use of hands-on interactive learning (Clark, 2016; Mangum et al., 2017; Soriano, 2017). Although more research is needed to determine the appropriateness of JITT in healthcare settings, current evidence suggests a valuable role for this training technique in healthcare education.

## Methods

### Setting & Design

This process evaluation project was conducted at the critical care unit (CCU) in a metropolitan medical center in the Puget Sound area of Washington State. The project investigators received approval for this project through the affiliated university's institutional review board (IRB) and have completed human subjects research training required. The intervention included semi-structured interviews with individual CCU nurses to explore their perceptions of a rapidly implemented prone therapy protocol for patients with ARDS during the COVID-19 pandemic. Qualitative methods of data collection and analysis were employed to better understand the lived experiences of CCU nurses who used PPT during the COVID-19 Pandemic. Additionally, relevant demographic data from participants was collected and reported with results in a deidentified format.

### Sample Recruitment

The sample population included all CCU RNs actively employed by the host agency as full-time or part-time employees from February 1, 2020 to May 1, 2020. Inclusion criteria required that nurses had cared for at least one patient receiving prone therapy during the COVID-19 Pandemic in the previously specified timeframe. Participants were excluded prior to conducting interviews if they were employed by a third-party agency (such as travel nurses or crisis response staff), were members of the agency's float pool (meaning they worked in several departments throughout the hospital) or were on professional probation (or another similar professional standing) at any point during the process evaluation time frame.

The process evaluation's sample group was selected using voluntary response sampling. The minimum sample size needed was five and the maximum sample size was 15. The optimal

sample size was determined based on scientific literature relevant to the specific method of data analysis used in this process evaluation: Interpretive Phenomenological Analysis (IPA). Together with the host agency, investigators sent emails to CCU RNs inviting them to participate in process evaluation. The email content (included in supplemental materials) explained in plain language the purpose of the project, inclusion and exclusion criteria for participation, process evaluation methods, and instructions for signing up for phone interviews. The email also contains a copy of a consent form to be reviewed prior to interviews for those who volunteered to participate.

**Data Collection**

RNs who volunteered to participate were able to schedule their interviews through the online platform Doodle or by contacting the co-principal investigator, EL, directly via text message or phone call. Verbal consent to participate was obtained after thorough presentation of all relevant information and address of participant questions prior to beginning interviews. Participants were assured that they could withdraw from the interview at any time without retribution. Participants were also informed that the interview may elicit unpleasant emotions or memories. If such circumstances arose, participants were referred to their agency's human resource department for additional support.

Interviews were conducted on telephones by EL and recorded using the Microsoft Windows voice recorder application from November 10 – December 20, 2020. Demographic data was collected in each interview and saved into a secured excel spreadsheet in a deidentified format that was uncoupled from all other interview data. Semi-structured interviewing methods were employed to explore nurses' perceptions and experiences using the prone therapy protocol during the COVID-19 Pandemic at their agency of employment as ICU nurses. Although the

structure of each interview varied, all participants were asked to share their thoughts on four main topics: the impact of COVID-19 Pandemic on their professional environment, the prone therapy protocol, the rapid implementation of the protocol, and the evolution of the protocol which included the addition of a standardized checklist and development of prone therapy teams.

Interview recordings were saved as MPEG-1 Audio Layer-3 (MP-3) files onto a device with double encryption password protection Interviews were next transcribed to text in de-identified format by EL and again saved on secure devices with double encryption password protection. Each transcript file was titled using a random number generated from a random number generator application. Per IRB requirements, all data containing direct identifiers were saved onto an external Universal Serial Bus (USB) drive with password protection and stored in a locked storage cabinet at the office of investigators' faculty advisor, Dr. Benjamin Miller at 901 12th Ave. #301 Garrand Hall Seattle, WA 98122.

***Implementation of PPT***

Participants began using PPT for patients with COVID-19 in February 2020 at the discretion of the CCU physicians. Given the acuity of the clinical context and the urgency demanded by the life-threatening severity of ARDS, rapid implementation of PPT was warranted. CCU nurses were instructed to follow the PPT protocol on the agency's intranet for guidance. However, this protocol was over three pages long and many CCU nurses had minimal experience with PPT prior to the Pandemic. Training for nurses to use PPT was conducted only when the therapy was ordered by physicians. Training occurred at the bedside of patients and under the direction of the unit's clinical educator or the nurses with prior PPT experience.

### *Evolution of PPT Protocol*

As the frequency of PPT use increased, many changes were made to optimize and streamline the protocol. A one-page, standardized checklist was developed in mid-March to replace the previous protocol and was posted in all patient rooms within the designated COVID unit. By April 2020, the CCU had established PPT Teams which were designed to offload some of the demands on nursing staff associated with such a labor-intensive process as PPT. Originally, the teams were composed of volunteer staff members from other units within the hospital in which patient census was low. When these staff eventually returned to their departments, prone teams were composed exclusively of CCU staff. As CCU staff became more proficient with PPT, the efficiency of the process improved significantly. Staff were able to perform PPT for eight to ten patients daily within one hour.

## Data Analysis

Data from transcripts were organized by topic according to the general question being answered by participants. Although interviews varied in a semi-structured format, all participants were asked the same general questions based on the goals of the research. Next, these data from interview transcriptions underwent analysis by investigators using the Interpretive Phenomenological Analysis (IPA) framework to identify common themes and produce a narrative account of nurses' experiences with the prone protocol. The IPA framework is founded on the belief that human beings are sense-making creatures whose narratives of an event reflect their attempts to make sense of their experiences (Alase, 2017). IPA is largely influenced by the theorist Van Manen and his theory of hermeneutical phenomenology. Van Manen described hermeneutical phenomenology as having two objectives – first, to describe the lived experience of participants and second, to interpret the life that participants have experienced (Alase, 2017;

Smith et al., 2009). In order to capture commonalities among people who share an experience, phenomenological theory suggests using a sample size of five to ten participants (Alase, 2017). Utilization of IPA to analyze participant responses in this project provided a framework for identifying commonalities and human phenomena, which will be documented as themes and presented in the discussion section.

Thematic analysis of interview data was performed in a stepwise fashion. First, each transcript was meticulously read several times by each investigator individually. Investigators focused on exploring broader meaning within participant responses through subjective interpretation while also identifying themes that emerged throughout the transcripts. Direct quotations from participants were extracted to support the authors' interpretations and more accurately represent participant accounts of their experiences.

After analyzing each transcript individually, investigators met and discussed their findings. Themes within each discussion topic emerged and were listed on a document as initial themes. Investigators next organized these initial themes into clusters according to connections or shared characteristics and referred to them as major themes. Each major theme was evaluated for accuracy and significance with direct quotations from transcripts and careful discussion between investigators. Finally, major themes were organized into table format according to the general topic to which they applied and supported with direct quotations from participants. Each quotation is followed by an identifier that corresponds to the location of the quotation in the transcript. This identifier is formatted: [interview number].[page number].[line number].

## Results

A total of five RNs volunteered and conducted interviews. No attrition occurred. Eighty percent of participants were male and 20% were female. The average length of RN experience

for the sample was 8.6 years and the average length of CCU experience was 7.9 years. One outlier in the data set was identified, and when excluded, the average length of RN and CCU experience was 3.0 years and 2.6 years, respectively.

Thematic analysis of interview transcripts revealed three primary topics of discussion present in all interviews: 1) The COVID-19 Pandemic, 2) PPT protocol, and 3) PPT teams. Results are reported as major themes and organized according to the primary topic to which they pertain. Themes identified by investigators are carefully supported with direct quotations from participants to produce a narrative of nurses' live experiences with the PPT protocol during the COVID-19. Direct quotations from interviews are included to promote validity of results and aid in distinguishing participant responses from investigators' interpretations of those responses. A concise summary of results is also presented in Table 2 of the Appendix.

**The COVID-19 Pandemic**

Thematic analysis was used to evaluate the impacts of the COVID-19 pandemic on CCU nurses sampled. Four major themes identified within this topic included: moral distress, fear, shared learning, and sense of belonging.

***Moral Distress***

The theme "moral distress" was derived from use of vocabulary such as "PTSD," "stress," or "burn-out", which is present in 100% of interviews. These adjectives were used by participants to describe various challenges nurses faced during the pandemic, particularly in the initial months after the first COVID infections were identified in the U.S in the Spring of 2020. Participant nine recalled, "In March and April [work] was just awful…I felt like quitting at times and was just exhausted and burnt out, because patients were *not* getting better. Lots of patients were dying. It was not fun" (9.1.42). Participant 12 described the initial months of the pandemic

saying, “It was gut-wrenchingly difficult. It was heartbreaking and absolutely awful” (12.1.22). The same participant later acknowledged poignantly, “In another year, I will probably go to therapy for this because I know I'm going to have some PTSD” (12.2.8).

Social and political polarization over pandemic-response practices and increased social isolation appeared to create a sense of destabilization in support networks among some nurses, further exacerbating their distress. As participant 12 shared,

> I’ve had to totally withdraw from social media...I just could not make sense of the world that I was suddenly living in [where people] are all upset with the governor over having to wear a mask...I really do not understand how this happened to our country. (12.3.1)

In another poignant example of the pandemic’s magnitude of moral distress participant nine recalled,

> The hardest part for me was having to FaceTime or call the patient's family on the phone and give them updates because a lot of them just had no idea how sick their love one really was because of [visitor restrictions]. (9.2.18)

The mental and emotional demands of caring for the critically ill while implementing new safety procedures without clear or consistent guidelines appeared to compound on the collective stressors reported by CCU nurses. Forty percent of participants recalled the shortage of personal protective equipment (PPE) and lack of clarity regarding PPE guidelines as a major stressor in their professional roles. Participant 22 recalled,

> There was a lack of understanding about what was going on [when the pandemic began]. So that made work a bit more stressful: coming in and not knowing what to expect, not knowing if we're doing the right things for ourselves to keep yourself safe. (22.1.12)

Participant nine shared a similar recollection stating, "[At work] you're just stressed out all the time because everything is so unknown" (9.1.38). Participant five shared, "I was stressed out because it's like am I doing things right?" (5.4.1)

The moral distress experienced by nurses in this context may represent a conflict between the ethical principles of *duty to care* and *duty to self,* which are part of the American Nursing Association's code of ethics. The *duty to care* principle requires that nurses remain committed to patient care and prioritize patient care above all other duties (Schroeter, 2008). However, the principle of *duty to self* states that nurses have the same ethical obligation to care for themselves (and their loved ones) as they do to care for patients (Schroeter, 2008). On one hand, nurses are obligated to care for COVID-19 patients by the *duty to care* principle. However, by caring for these patients, nurses threaten their own safety and that of their loved ones, defying their 'duty to self'. The inability to reconcile these conflicts and restore balance in nursing obligations could foster fear and distress among nurses as they attempt to fulfill conflicting responsibilities.

***Fear***

The various uncertainties about the virus in the early stages of the pandemic in addition to its virulence appeared to evoke a sense of fear among participants. Sixty percent of participants recalled feeling fear or dread while performing their professional duties, particularly in consideration of possibly transmitting the virus to their family members. As participant nine explained, "I've taken care of patients that have expired before, but it was never because of a disease process that you could potentially get yourself and take home to family members" (9.2.33). Participant 22 recalled, "I think my biggest stress with COVID and working was the threat of possibly bringing it home to [my family]" (22.1.33). Participant five shared, "A lot of people [in the beginning] just didn't want to go near a patient with COVID" (5.2.42).

### *Shared Learning*

As the pandemic response evolved, the acquisition of new information about the novel Coronavirus seemed to gradually rectify uncertainties. Participants often used positive terms to describe the global collaboration efforts they witnessed in response to the pandemic. For example, participant five noted, "I felt like we were learning *with* the doctors...A lot of the physicians were kind of stumped on how exactly to treat things. I think we've learned a lot about how to treat things now" (5.2.43). Participant 12 recalled, "During COVID, we were all learning so much every single day, even the doctors, everyone. That was one of the things that I had to stand back and was just so damn impressed with the field of healthcare" (12.5.9). Participant 22 acknowledged, "We're learning more about [COVID] as we go on in this pandemic" (22.7.25).

Participant perceptions of the increase in shared learning as a positive experience during the COVID-19 pandemic is a testimony to the influence of shared goals in strengthening professional team dynamics and promoting interdisciplinary collaboration, which is a subject that receives considerable attention in qualitative research literature (Cheruvelil et al., 2014; Morley & Cashell, 2017). Nurses and their colleagues were extremely motivated to advance their individual and collective knowledge because of the impact their experiences with critically ill COVID-19 patients had, along with the urgent demand for more effective treatment strategies.

### *Sense of Belonging*

All participants perceived a strengthening of professional and social bonds among their CCU colleagues as a consequence of the pandemic. Isolation from their usual social networks together with the rapid pace of interdisciplinary collaboration appeared to foster an increased sense of cohesiveness and belonging. Participant five recounted, "I felt like I was part of a team and not just alone" (5.3.3). Participant 22 explained, "Just going through everything together you

become a little bit more cohesive with your co-workers...Your family and friends don't really understand what you're going through unless they're also in healthcare" (22.7.2). Participant 12 stated pointedly, "This pandemic has 100% brought the unit closer together professionally and personally" (12.2.18).

Two participants explicitly used military jargon to describe the change in team dynamics they experienced during the pandemic. Participant 13 explained,

> If you're with your solider friends, you can get through it. But if you go out into like the real, normal world, then you lose a lot of that because you're the only one who has been traumatized in that way. You don't have anything to share with anyone because no one understands what you're talking about. As long as we're together, we can all kind of can revisit this together. I think we're stronger together. (13.6.11)

The sharing of traumatic or stressful experiences can forge strong bonds between victims of such events and is a phenomenon most often studied in military research (Elder & Clipp, 1988; Siebold, 2007). Enhanced social connection can mitigate feelings of isolation, stigma, and alienation among collective groups experiencing stress or trauma (Paturel, 2012). Thus, participant reports of strengthened social bonds between colleagues during the pandemic may likely serve as an indicator of the stress and trauma experienced during the pandemic.

**PPT Protocol**

Evaluation of nurses' perceptions about the PPT protocol implemented in their unit revealed five themes in the category: protocol implementation, checklist development, JITT methods, PPT teams, and leadership.

### *Protocol Implementation*

The implementation and evolution of the PPT protocol during the Pandemic represented a unique deviation from traditional training methods according to all participants. The phrase "on the fly" was used in 60% of participant accounts of the PPT protocol implementation. Furthermore, 80% of participants reported having none to minimal experience with PPT prior to the pandemic. Participant nine recalled,

> The whole proning process was kind of chaotic at first (9.3.9)… I remember just feeling kind of anxious and nervous because it's not something I've done before and I really wanted to do it, right. It was kind of done just on the fly (9.4.11)...There was no formal training for the unit that I remember. (9.5.19)

### *Checklist Development*

Participants unanimously supported the implementation of the PPT checklist as critical to the success of the PPT process. Participants often recounted the PPT implementation process as a dichotomy separated by the development of a simplified PPT checklist and discussed in terms of "before the checklist" and "after the checklist." For example, participant 12 recalled,

> "Before we had the checklist, we needed someone to stand there and help us with things and make sure we didn't mess up. We were all pretty exhausted and so we'd get forgetful and needed someone to make sure we weren't missing a step or messing up our PPE (12.3.41)

When asked about the evolution of the PPT protocol, participant 12 went on to explain,

> Yes, [improvements were made to the protocol after it was implemented]. It's nursing- everything is just done on the fly in real time. We see something that needs to change and

> we say, 'Hey, this needs to be changed. It's not working.' The checklist was part of that. (12.6.26)

Participant 22 notably admitted, "So my first few times with proning [before the checklist implementation], you could tell that we didn't completely know what to do (22.2.17)."

Participants viewed the checklist as a solution to discrepancies in the PPT process and a significant source of structure in an unfamiliar procedure. Participants reported an increase in perceived consistency, safety, and efficiency of PPT after the implementation of the checklist. As participant nine explained,

> There was always confusion among a lot of the nurses about which way do you roll the sheets, which way do we turn first, etc. People have differing opinions on how certain specific things are done [in PPT] (9.4.20)…The actual process [of PPT] became a lot safer after the [checklist] protocol was rolled-out. It felt structured to have a step-by-step checklist of what we're doing make sure we've done it all. It made it a lot easier and a lot simpler. You didn't have to second-guess yourself or worry about missing small details. (9.4.28)

Participants' perceptions of the PPT checklist support the proposition that checklists are a key component of successful training, particularly for complex therapies. The utility of checklists in the healthcare setting has been demonstrated in various capacities and is shown to decrease the occurrence of human error in stressful situations, provide greater diagnostic accuracy, and decrease perioperative mortality (Hales, Terblanche, Fowler & Sibbald, 2007; Walker, Reshamwalla & Wilson, 2012; Ely et al., 2011; Global Surg Collaborative, 2019). The sustained utility of checklists in healthcare notably depends heavily on acceptance by end-users, who are key stakeholders in checklist implementation (Thomassen et al., 2011).

### *Just-in-time Training (JITT)*

Although participants viewed the rapid bedside implementation of the PPT protocol using JITT methods as chaotic and unstructured initially, 60% of participants reported that when considering the constraints of the situation, they could not conceive of a better training tactic than the JITT methods that were used. As participant nine explained, "In our situation, there was no other way that we could have done it. We had sick patients and we needed to take care of them, so we did the best we could" (9.6.6). Participant 13 shared similar thoughts regarding JITT sating, "[The prone therapy process] definitely wasn't structured at all, but it was rolled out the best we could at the time. It could have been better, but we don't really roll-out anything perfectly here" (13.5.30). Participant 12 added, "[Training for prone therapy] was totally on the fly. But like I said, at [this hospital] there's a lot of support on our unit, so we managed to put together a really solid team and get people educated" (12.5.36). Participant 22 offered a valuable perspective on the training tactics used in PPT:

> I don't know if [the bedside implementation of the protocol] was the *right* way, but it was the *appropriate* way at the time (22.5.18)…I think *experience* plays a bigger role than trying to do a formal implementation in this scenario [of COVID and PPT]...Unless you were familiar with proning from *experience*, you kind of stumbled through it at first. (22.5.22)

Participant nine was the only participant who suggested a potential change to the PPT implementation process, offering that an in-service might be helpful in future similar circumstances. As participant nine explained:

> I think having some sort of in-service before you do it so that the first time you're doing it isn't on an intubated patient [who is very sick] would be easier and make staff feel less

> anxious and more comfortable. But in our situation, there was no other way that we could have done it. We had sick patients and we needed to take care of the, so we did the best we could.

Participant nine knowingly acknowledged that an in-service outside of normal shift hours may not have been welcomed by staff who were already feeling overworked in the initial months of the pandemic. As this participant explained:

> I'd probably not enjoy coming in on my day off. I didn't pick up any extra shifts during that time because it just working my 36 hours a week was rough as it was. So I'd probably not enjoy doing it, but if it was mandatory and we were required to do it, I would do it and I think it would have made our unit better and provide better care for our patients. (9.6.19)

These nurses' perceptions of JITT are significant because demonstrate support for JITT methods in the context of healthcare crisis and represent acceptance of these methods by end-users. Scientific literature supports the use of JITT during major disaster events in which resources are acutely restrained, but little evidence exists to support its use in an organized healthcare setting, particularly during a crisis such as the COVID-19 pandemic (Weiner & Rosman, 2019).

**Prone teams**

The implementation of teams to conduct PPT in the CCU was perceived as a significant development in the evolution of the PPT protocol. The majority of participants (80%) explicitly stated that the prone team provided additional, critical resources and reduced complications in the PPT process. As participant 13 recalled, "I think [the prone team] definitely relieved some pressure on the unit just because now you have that extra help" (13.4.16). Participant five

contributed, “[The prone team] really helped with infection control and that stuff. It’s really helped streamline things.” (5.2.29). Participant 22 added,

> [The prone team] definitely made a difference. They had a system going and that's why we could prone 8 people within a couple hours because you would just show up as the bedside nurse and you would have everything ready and the prone team would come in and they would literally just prone for you while you watch the lines and helped out with anything else. (22.4.27)

All participants noted an increased in perceived satisfaction and reduced stress during team-based PPT process when the prone team members were from specialty units, such as the emergency department (ED), where nurses had more extensive experience in acute or critical care. Sixty percent of participants directly acknowledged that acute-care trained staff members were key to making PPT implementation more efficient and safer for patients. As participant 13 explained,

> So even though we had a prone team, we didn't have consistency with who was on the prone team and so we didn't necessarily have competence. That was one of the things that was one of the big issues for us. (13.4.32)

Participant 22 explained further,

> We used [other staff] a lot to implement proning and a lot of them don't work with ICU patients so they don't know the level of care and they don't know the lines, don't know the ventilator or anything like that. So it was more of a stress for me when I had patients in the ICU and had people come in and they have no idea about the ICU. [They would say] stuff like ‘We're just going to prone this this patient. It’s just flipping a body.’ But it’s not

> that simple. There's all these other things that I have to worry about as a bedside nurse. And so I remember a few times when things got hectic because of that. (22.2.25)

It is important to acknowledge that these nurses who shared concerns about the prone teams were practicing patient advocacy with their comments and long after the concerning event occurred. Theses reactions demonstrate the innate sense of responsibility nurses feel towards patients and illustrates how nurses practice patient advocacy in profound and far-reaching ways that can have significant impacts on patient outcomes if acted upon in productive ways.

***Leadership***

All participants identified leadership as a crucial aspect of the prone teams and PPT protocol. Having a strong leader to focus on the checklist and coordinate the PPT process was perceived as a major contributor to positive outcomes in a PPT event. When discussing the importance of leadership in the prone teams, participant 12 acknowledged, "[Prone therapy requires] a lot of coordination with a lot of people, and that's hard work" (12.6.3). Participant 13 recalled, "I was confident in the proning process from the beginning if the right proning leader was involved, but if I was actually leading it, I never felt completely comfortable to be honest. There was always some sort of miscommunication" (13.3.5).

Several participants noted that the influence of leadership on PPT was particularly evident when other team members lacked experience with PPT or acute care. As participant 13 explained,

> The prone team wasn't always made up of people who had proned before, so the prone team will show up and depending on who your leader was, no one would necessarily know if these people had experience proning and sometimes we'd have to educate

> everyone on how to do it again. And if that [identification and education] doesn't happen, then you could have trouble. (13.4.24)

Participant five shared a similar perception:

> We had a lot of people who had no experience with proning. So that lack of leadership made things pretty difficult(5.4.36)…It's a little bit more clear now who the leader is. It happens less often that we have multiple people giving orders. (5.6.2)

Participant 22 added:

> If we didn't have one of the ICU nurses to help facilitate and lead the session, then it just added an extra stress to the bedside nurses trying to prone a patient with your team when everybody in the room has never proned before. So I guess having a leader that's aware of the patient population at all times was just definitely beneficial. (22.5.3)

The shared concerns among participants regarding leadership in the PPT process contribute valuable insight that can help optimize efforts when rapid implementation a complex, team-based procedure is warranted in future crises or resource-constrained settings.

## Discussion

The consequences of the COVID-19 pandemic on the U.S. healthcare system will likely continue to unfold after the threat of the virus has waned. This process evaluation exploring the nursing perceptions of JITT and PPT in the context of the COVID-19 pandemic illuminates some of the challenges faced by nurses as essential, front-line employees during a global healthcare crisis. Understanding the experiences of nurses carries the potential for informing future pandemic response efforts and guiding strategic implementation of PPT for ARDS management in other hospital units or future healthcare crises. Providing effective support and adequate resources to essential workers, particularly during a healthcare crisis, is prudent to preventing

adverse patient outcomes, reducing employee burn-out, and increasing retention within workforces that face significant shortages of skilled employees.

Participants reported experiencing moral distress and burnout. Feelings of burnout were commonly discussed in the context of moral distress, suggesting a correlation between moral distress and nurse burnout. This relationship is significant because it suggests that implementing interventions to alleviate the fear and emotional distress experienced by essential employees may reduce burnout and promote retention, thus helping to maintain an adequate workforce of nurses to combat future healthcare crises. Examples of interventions that may alleviate distress include offering free, confidential access to mental health services to hospital employees and ensuring adequate supply of personal protective equipment (PPE), as PPE is crucial to reducing the risk of virus transmission for employees and the surrounding community. In a future pandemic, officials may also consider offering alternative housing to front-line healthcare workers who share housing with vulnerable populations. This would show organizational acknowledgement of the risk frontline healthcare workers face while working with COVID-19 patients and alleviate fear of viral transmission to loved ones.

Another tactic that could support the emotional well-being of nurses includes promoting a positive work environment in which employees feel supported, appreciated, and part of a cohesive team. Increased social connection can decrease feelings of isolation, decrease stigma, and decrease feelings of alienation in situations where there is stress or trauma (Paturel, 2012).

Results regarding the PPT process and protocol have several implications. First, unanimous support among participants for checklists marks the checklist as a crucial element of the PPT protocol. As key stakeholders, nurses and other end-users should be involved in the review and revision processes for and checklists they are expected to use. Including end-users in

protocol development appears essential to ensuring the success and sustainability of new protocols. Second, if prone teams are utilized in PPT, it may be beneficial to use only people with appropriate experience as members of prone teams.

Feedback from participants recommended that future PPT protocols include the addition of specific guidelines for cardiopulmonary resuscitation (CPR) in patients in the prone position. Future PPT protocols should also consider adding modifications for morbidly obese individuals in whom proper prone positioning may not be possible due to body habitus, thus reducing the potential benefit from PPT.

**Limitations & Recommendations**

This project is limited by its small sample size which may fail to represent the sample population. The predominance of males over females and the proportion of RNs with less than five years of nursing experience in the sample are both likely a consequence of the small sample size. A larger sample size or use of multiple agencies would likely enhance the internal and external validity of the data by more accurately representing the population evaluated; however, it would also increase the time cost for investigators throughout the research process and likely require additional assistance from other personnel. A larger sample size may have been achieved by using more extensive, multimodal recruitment strategies, which were restricted in this project due to COVID-19 risk reduction requirements throughout hospitals and academic institutions. Offering financial incentives to participants is one example of a recruitment strategy that may have increased the sample size, which could be possible in future studies with more financial resources available to investigators. Additionally, extending the inclusion criteria to encompass all staff who were involved in the PPT process would likely foster a larger sample size and also

offer a more dynamic perspective of the lived experiences of front-line healthcare workers as a whole.

In this project COVID-19 limitations restricted interviews to be conducted virtually. Investigators recommend that future studies employ in-person interviews, which may contribute richer dialogue and foster deeper connections during interviews. In-person interviews would be less convenient for participants and would like require incentives for participants. Virtual interviews conducted on video in which a face-to-face interaction occurred may be a reasonable substitute from in-person interviews and would provide more convenience for participants.

Additionally, the results of this project could be further supported with quantitative data regarding patient outcomes who received PPT in the CCU where this project was conducted. This could contribute substantially to the collective understanding of PPT in ARDS and COVID-19. More research is needed to determine the optimal management strategies for severe ARDS after COVID-19 infection and the most productive approach for implementing PPT protocols in CCUs.

## Conclusion

The consequences of the COVID-19 pandemic triggered major adaptations in healthcare and catalyzed the development of new healthcare standards. Participants reported having minimal experience with PPT prior to the pandemic which is similar on a national scale as well. Overall, it can be presumed that the general experience and knowledge about PPT prior to the COVID-19 pandemic was minimal. The surge in ARDS cases related to COVID-19 illness increased interest in PPT, which quickly became a primary intervention. PPT and COVID-19 have become almost synonymous in critical care settings, representing a world of healthcare that has been permanently remodeled by the virus.

Implementation of PTT for the management of ARDS requires a dynamic change in unit culture to adopt this proven therapy. The normal process of the Lewin's Change Theory became accelerated in the presence of a pandemic for CCU nurses in this project. The high incidence and severity of COVID-19 illness in the initial months of the pandemic acted as intense driving forces, suddenly disrupting the organizational equilibrium enough to *unfreeze* and overcome old patterns of behavior concerning PPT and ARDS. The pace of *change* occurred in accordance with the rapid speed of collaboration among medical professionals as they desperately searched for more effective management strategies in severe COVID-19 illness. Preliminary evidence suggested benefit with PPT use in COVID-19 complicated by severe ARDS and quickly promoted this therapy from a last-line approach to primary intervention.

The healthcare agency in this project currently remains in stage two of Lewin's Theory of Change model. Having overcome resistance to PPT use and successfully implemented a PPT protocol during the COVID-19 pandemic, this unit must complete Lewin's final stage of change: *re-freezing.* This stage requires the implementation of long-term strategies to ensure that integrated change is sustained over time and becomes the new equilibrium (Hussain et al., 2016). One such strategy includes commitment planning, which helps ensure continued support of key stakeholders. As the key stakeholders in this context, nurses should continue to be involved in any future modifications to the PPT protocol. Additionally, as the demand for PPT wanes, it remains prudent for trained staff to regularly exercise PPT skills by conducting consistent in-services or refresher courses.

## References

Akgun, E., Tuzuner, M. B., Sahin, B., Kilercik, M., Kulah, C., Cakiroglu, H. N., Serteser, M., Unsal, I., & Baykal, A. T. (2020). Proteins associated with neutrophil degranulation are upregulated in nasopharyngeal swabs from SARS-CoV-2 patients. PLOS ONE, 15(10), e0240012. https://doi.org/10.1371/journal.pone.0240012

Alase, A. (2017). The Interpretative Phenomenological Analysis (IPA): A Guide to a Good Qualitative Research Approach. International Journal of Education and Literacy Studies, 5(2), 9. https://doi.org/10.7575/aiac.ijels.v.5n.2p.9

Alessandri, F., Pugliese, F., & Ranieri, V. M. (2018). The Role of Rescue Therapies in the Treatment of Severe ARDS. Respiratory Care, 63(1), 92–101. https://doi.org/10.4187/respcare.05752

Arias, C. D., Pokharel, B., Papathanassoglou, E., & Norris, C. M. (2017). Prone positioning for the treatment of adult respiratory distress syndrome. Connect: The World of Critical Care Nursing, 11(3), 49–54. https://doi.org/10.1891/1748-6254.11.3.49

Borges, L., Pithon-Curi, T. C., Curi, R., & Hatanaka, E. (2020). COVID-19 and Neutrophils: The Relationship between Hyperinflammation and Neutrophil Extracellular Traps. Mediators of Inflammation, 2020. https://doi.org/10.1155/2020/8829674

Bourgeault, I. L., Maier, C. B., Dieleman, M., Ball, J., MacKenzie, A., Nancarrow, S., Nigenda, G., & Sidat, M. (2020). The COVID-19 Pandemic presents an opportunity to develop more sustainable health workforces. Human Resources for Health, 18(1), 83. https://doi.org/10.1186/s12960-020-00529-0

Bureau of Labor Statistics. (2019, April 12). Registered Nurses: Occupational Outlook Handbook: U.S. Bureau of Labor Statistics. https://www.bls.gov/ooh/healthcare/registered-nurses.htm

Center for Disease Control and Prevention (CDC). (2020). COVID-19 and Your Health. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/transmission/variant.html

Chantler, Jonathan. (2017). AICU/CICU guidelines for Prone Ventilation in Severe Hypoxic ARDS. Retrieved from https://oxicm.files.wordpress.com/2014/03/proning-standard.pdf

Cheruvelil, K. S., Soranno, P. A., Weathers, K. C., Hanson, P. C., Goring, S. J., Filstrup, C. T., & Read, E. K. (2014). Creating and maintaining high-performing collaborative research teams: The importance of diversity and interpersonal skills. Frontiers in Ecology and the Environment, 12(1), 31–38. https://doi.org/10.1890/130001

Clark, K. R. (2016). Teaching Techniques. Just-in-Time Teaching. Radiologic Technology, 87(4), 465–467. http://www.radiologictechnology.org/content/87/4/465.extract

Costanzo, L.S. (2018) Respiratory physiology in Physiology 6th ed., Philadelphia. Elsevier. Chapter 5 Pages 189-243

COVID-19 Science Update. (2020). Retrieved from 2020-11-24-Science-Update_FINAL_public.pdf (cdc.gov)

De Jong, A., Molinari, N., Sebbane, M., Prades, A., Futier, E., Jung, B., Chanques, G., & Jaber, S. (2013). Feasibility and effectiveness of prone position in morbidly obese patients with ARDS: A case-control clinical study. Chest, 143(6), 1554–1561. https://doi.org/10.1378/chest.12-2115

Elder, G. H., & Clipp, E. C. (1988). Wartime Losses and Social Bonding: Influences across 40 Years in Men's Lives. Psychiatry, 51(2), 177–198. https://doi.org/10.1080/00332747.1988.11024391

Ely, J. W., Graber, M. L., & Croskerry, P. (2011). Checklists to Reduce Diagnostic Errors. Academic Medicine, 86(3), 307–313. https://doi.org/10.1097/ACM.0b013e31820824cd

Ferguson, N. D., Fan, E., Camporota, L., Antonelli, M., Anzueto, A., Beale, R., Brochard, L., Brower, R., Esteban, A., Gattinoni, L., Rhodes, A., Slutsky, A. S., Vincent, J.-L., Rubenfeld, G. D., Thompson, B. T., & Ranieri, V. M. (2012). The Berlin definition of ARDS: An expanded rationale, justification, and supplementary material. Intensive Care Medicine, 38(10), 1573–1582. https://doi.org/10.1007/s00134-012-2682-1

Girard, R., Baboi, L., Ayzac, L., Richard, J.-C., Guérin, C., & for the Proseva trial group. (2014). The impact of patient positioning on pressure ulcers in patients with severe ARDS: Results from a multicentre randomised controlled trial on prone positioning. Intensive Care Medicine, 40(3), 397–403. https://doi.org/10.1007/s00134-013-3188-1

GlobalSurg Collaborative. (2019). Pooled analysis of WHO Surgical Safety Checklist use and mortality after emergency laparotomy. British Journal of Surgery, 106(2), e103–e112. https://doi.org/10.1002/bjs.11051

Graham, Y. (2020, July 20). How a pandemic affects the mental health of the nursing workforce. Nursing Times. https://www.nursingtimes.net/covid-19-are-you-ok/how-a-pandemic-affects-the-mental-health-of-the-nursing-workforce-20-07-2020/

Guérin, C., Reignier, J., Richard, J.-C., Beuret, P., Gacouin, A., Boulain, T., Mercier, E., Badet, M., Mercat, A., Baudin, O., Clavel, M., Chatellier, D., Jaber, S., Rosselli, S., Mancebo, J., Sirodot, M., Hilbert, G., Bengler, C., Richecoeur, J., … Ayzac, L. (2013). Prone

Positioning in Severe Acute Respiratory Distress Syndrome. New England Journal of Medicine, 368(23), 2159–2168. https://doi.org/10.1056/NEJMoa1214103

Hadaya, J., & Benharash, P. (2020). Prone Positioning for Acute Respiratory Distress Syndrome (ARDS). JAMA, 324(13), 1361. https://doi.org/10.1001/jama.2020.14901

Hales, B., Terblanche, M., Fowler, R., & Sibbald, W. (2007). Development of medical checklists for improved quality of patient care. International Journal for Quality in Health Care, 20(1), 22–30. https://doi.org/10.1093/intqhc/mzm062

Hart, P. L., Brannan, J. D., & Chesnay, M. D. (2014). Resilience in nurses: An integrative review. Journal of Nursing Management, 22(6), 720–734. https://doi.org/10.1111/j.1365-2834.2012.01485.x

Hasan, S. S., Capstick, T., Ahmed, R., Kow, C. S., Mazhar, F., Merchant, H. a, & Zaidi, S. T. R. (2020). Mortality in COVID-19 patients with acute respiratory distress syndrome and corticosteroids use: A systematic review and meta-analysis. Expert Review of Respiratory Medicine, 1–15. https://doi.org/10.1080/17476348.2020.1804365

Hasan, S. S., Capstick, T., Ahmed, R., Kow, C. S., Mazhar, F., Merchant, H. a, & Zaidi, S. T. R. (n.d.). Mortality in COVID-19 patients with acute respiratory distress syndrome and corticosteroids use: A systematic review and meta-analysis. Expert Review of Respiratory Medicine, 1–15. https://doi.org/10.1080/17476348.2020.1804365

Hussain, S. T., Lei, S., Akram, T., Haider, M. J., Hussain, S. H., & Ali, M. (2016). Kurt Lewin's change model: A critical review of the role of leadership and employee involvement in organizational change | Elsevier Enhanced Reader. https://doi.org/10.1016/j.jik.2016.07.002

Ioannidis, J. P. A. (2021). Infection fatality rate of COVID-19 inferred from seroprevalence data. *Bulletin of the World Health Organization*, *99*(1), 19-33F. https://doi.org/10.2471/BLT.20.265892

Johns Hopkins Coronavirus Resource Center. (2021, March 3). COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) – COVID-19 Map. Johns Hopkins University & Medicine. https://coronavirus.jhu.edu/map.html

Jones, A. T., Hansell, D. M., & Evans, T. W. (2001). Pulmonary perfusion in supine and prone positions: An electron-beam computed tomography study. Journal of Applied Physiology, 90(4), 1342–1348. https://doi.org/10.1152/jappl.2001.90.4.1342

Kallet, R. H. (2015). A Comprehensive Review of Prone Position in ARDS. Respiratory Care, 60(11), 1660–1687. https://doi.org/10.4187/respcare.04271

Kim, W.-Y., & Hong, S.-B. (2016). Tuberculosis & Respiratory Diseases. Sepsis and Acute Respiratory Distress Syndrome: Recent Update, 79(2), 53–57. https://doi.org/10.4046/trd.2016.79.2.53

Kim, Won-Young & Hong, Sang-Bum. (2016). Sepsis and Acute Respiratory Distress Syndrome: Recent Update. Tuberculosis and Respiratory Diseases. 79. 53-57. 10.4046/trd.2016.79.2.53.

Lee, H., & Monahan, C. (2014). Ventilation and Perfusion. In B. S. Freeman & J. S. Berger (Eds.), Anesthesiology Core Review: Part One Basic Exam. McGraw-Hill Education. accessanesthesiology.mhmedical.com/content.aspx?aid=1102569074

Leider, J. P., DeBruin, D., Reynolds, N., Koch, A., & Seaberg, J. (2017). Ethical Guidance for Disaster Response, Specifically Around Crisis Standards of Care: A Systematic Review.

American Journal of Public Health, 107(9), e1–e9. https://doi.org/10.2105/AJPH.2017.303882

Lewin, K. (1951). Field theory in social science: Selected theoretical papers (Edited by Dorwin Cartwright.) (pp. 346). Harpers & Row, 1951.

Lohser, J., & Ishikawa, S. (2011). Physiology of the Lateral Decubitus Position, Open Chest and One-Lung Ventilation. In P. Slinger, MD, FRCPC (Ed.), Principles and Practice of Anesthesia for Thoracic Surgery (pp. 71–82). Springer New York. https://doi.org/10.1007/978-1-4419-0184-2_5

Loo, J., Spittle, D. A., & Newnham, M. (2021). COVID-19, immunothrombosis and venous thromboembolism: Biological mechanisms. Thorax, thoraxjnl-2020-216243. https://doi.org/10.1136/thoraxjnl-2020-216243

Lu, L., Zhong, W., Bian, Z., Li, Z., Zhang, K., Liang, B., Zhong, Y., Hu, M., Lin, L., Liu, J., Lin, X., Huang, Y., Jiang, J., Yang, X., Zhang, X., & Huang, Z. (2020). A comparison of mortality-related risk factors of COVID-19, SARS, and MERS: A systematic review and meta-analysis. *The Journal of Infection*, *81*(4), e18–e25. https://doi.org/10.1016/j.jinf.2020.07.002

Mangum, R., Lazar, J., Rose, M. J., Mahan, J. D., & Reed, S. (2017). Exploring the Value of Just-in-Time Teaching as a Supplemental Tool to Traditional Resident Education on a Busy Inpatient Pediatrics Rotation. Academic Pediatrics, 17(6), 589–592. https://doi.org/10.1016/j.acap.2017.04.021

Marini, J. J., Josephs, S. A., Mechlin, M., & Hurford, W. E. (2016). Should Early Prone Positioning Be a Standard of Care in ARDS With Refractory Hypoxemia? Respiratory Care, 61(6), 818–829. https://doi.org/10.4187/respcare.04562

Mayo Foundation for Medical Education and Research (MFMER). (2020). Prone Therapy, Manual. Retrieved from https://ce.mayo.edu/sites/ce.mayo.edu/files/Prone%20Therapy.pdf

Messerole, E., Peine, P., Wittkopp, S., Marini, J. J., & Albert, R. K. (2002). The pragmatics of prone positioning. American Journal of Respiratory and Critical Care Medicine, 165(10), 1359–1363. https://doi.org/10.1164/rccm.2107005

Middleton, E. A., He, X.-Y., Denorme, F., Campbell, R. A., Ng, D., Salvatore, S. P., Mostyka, M., Baxter-Stoltzfus, A., Borczuk, A. C., Loda, M., Cody, M. J., Manne, B. K., Portier, I., Harris, E. S., Petrey, A. C., Beswick, E. J., Caulin, A. F., Iovino, A., Abegglen, L. M., … Yost, C. C. (2020). Neutrophil extracellular traps contribute to immunothrombosis in COVID-19 acute respiratory distress syndrome. Blood, 136(10), 1169–1179. https://doi.org/10.1182/blood.2020007008

Mitchell, D. A., & Seckel, M. A. (2018). Acute Respiratory Distress Syndrome and Prone Positioning. AACN Advanced Critical Care, 29(4), 415–425. https://doi.org/10.4037/aacnacc2018161

Moore, J. B., & June, C. H. (2020). Cytokine release syndrome in severe COVID-19. Science, 368(6490), 473–474. https://doi.org/10.1126/science.abb8925

Morata L, Sole ML, Ogilvie C & Anderson R. (2018) Comparing Outcomes in Manual and Automatic Prone Positioning Therapy for Acute Respiratory Distress Syndrome. National Teaching Institute Research Abstracts Presented at the AACN National Teaching Institute in Boston, Massachusetts, May 21-24, 2018. American Journal of Critical Care, 27(3), e3–e4. https://doi-org.proxy.seattleu.edu/10.4037/ajcc2018805

Morley, L., & Cashell, A. (2017). Collaboration in Health Care. Journal of Medical Imaging and Radiation Sciences, 48(2), 207–216. https://doi.org/10.1016/j.jmir.2017.02.071

Morris, Z. S., Wooding, S., & Grant, J. (2011). The answer is 17 years, what is the question: Understanding time lags in translational research. Journal of the Royal Society of Medicine, 104(12), 510–520. https://doi.org/10.1258/jrsm.2011.110180

Murthy, S., Gomersall, C. D., & Fowler, R. A. (2020). Care for Critically Ill Patients With COVID-19. JAMA, 323(15), 1499–1500. https://doi.org/10.1001/jama.2020.3633

Nieman, G. F., Gatto, L. A., & Habashi, N. M. (2015). Impact of mechanical ventilation on the pathophysiology of progressive acute lung injury. Journal of Applied Physiology, 119(11), 1245–1261. https://doi.org/10.1152/japplphysiol.00659.2015

Okabayashi, T., Kariwa, H., Yokota, S., Iki, S., Indoh, T., Yokosawa, N., Takashima, I., Tsutsumi, H., & Fujii, N. (2006). Cytokine regulation in SARS coronavirus infection compared to other respiratory virus infections. Journal of Medical Virology, 78(4), 417–424. https://doi.org/10.1002/jmv.20556

Osei-Ampofo, M., Tafoya, M. J., Tafoya, C. A., Oteng, R. A., Ali, H., & Becker, T. K. (2018). Skill and knowledge retention after training in cardiopulmonary ultrasound in Ghana: An impact assessment of bedside ultrasound training in a resource-limited setting. Emergency Medicine Journal, 35(11), 704–707. https://doi.org/10.1136/emermed-2018-207716

Pade, K. H., Seik-Ismail, S. T., Chang, T. P., & Wang, V. J. (2018). Utilization of just-in-time training for nursing education using the LA Phonospirometry asthma tool. The Journal of asthma : official journal of the Association for the Care of Asthma, 55(7), 811–815. https://doi.org/10.1080/02770903.2017.1366507

Paturel, A. (2012). Power in numbers. https://www.apa.org/monitor/2012/11/power

Peebles, R. C., Nicholson, I. K., Schlieff, J., Peat, A., & Brewster, D. J. (2020). Nurses' just-in-time training for clinical deterioration: Development, implementation and evaluation. Nurse Education Today, 84, 104265. https://doi.org/10.1016/j.nedt.2019.104265

Ragab, D., Salah Eldin, H., Taeimah, M., Khattab, R., & Salem, R. (2020). The COVID-19 Cytokine Storm; What We Know So Far. Frontiers in Immunology, 11. https://doi.org/10.3389/fimmu.2020.01446

Ruiz-Fernández, M. D., Ortega-Galán, Á. M., Fernández-Sola, C., Hernández-Padilla, J. M., Granero-Molina, J., & Ramos-Pichardo, J. D. (2020). Occupational Factors Associated with Health-Related Quality of Life in Nursing Professionals: A Multi-Centre Study. International Journal of Environmental Research and Public Health, 17(3). https://doi.org/10.3390/ijerph17030982

Schroeter, K. (2008). Duty to Care Versus Duty to Self. Journal of Trauma Nursing, 15(1), 3–4. https://doi.org/10.1097/01.JTN.0000315779.97341.d3

Seppala, E. (2012). How the Stress of Disaster Brings People Together. Scientific American. https://www.scientificamerican.com/article/how-the-stress-of-disaster-brings-people-together/

Siebold, G. L. (2007). The Essence of Military Group Cohesion. Armed Forces & Society, 33(2), 286–295. https://doi.org/10.1177/0095327X06294173

Soriano, R. D. (2017). Just-in-Time Education for Intensive Care Nurses. St. John's Fisher College Fisher Digital Publications. Wegman's School of Nursing. https://core.ac.uk/download/pdf/84856768.pdf

Sperling, D. (2021). Ethical dilemmas, perceived risk, and motivation among nurses during the COVID-19 pandemic. Nursing Ethics, 28(1), 9–22. https://doi.org/10.1177/0969733020956376

The ARDS Definition Task Force. (2012). Acute Respiratory Distress Syndrome: The Berlin Definition. JAMA, 307(23), 2526–2533. https://doi.org/10.1001/jama.2012.5669

Thomassen, Ø., Espeland, A., Søfteland, E., Lossius, H. M., Heltne, J. K., & Brattebø, G. (2011). Implementation of checklists in health care; learning from high-reliability organisations. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 19(1), 53. https://doi.org/10.1186/1757-7241-19-53

Tzotzos, S. J., Fischer, B., Fischer, H., & Zeitlinger, M. (2020). Incidence of ARDS and outcomes in hospitalized patients with COVID-19: A global literature survey. Critical Care, 24. https://doi.org/10.1186/s13054-020-03240-7

Udod, S., & Wagner, J. (2018). Common Change Theories and Application to Different Nursing Situations. In Leadership and Influencing Change in Nursing. University of Regina Press. https://leadershipandinfluencingchangeinnursing.pressbooks.com/chapter/chapter-9-common-change-theories-and-application-to-different-nursing-situations/

Uras, U. (2020). Coronavirus: Comparing COVID-19, SARS and MERS. Retrieved March 3, 2021, from https://www.aljazeera.com/news/2020/4/8/coronavirus-comparing-covid-19-sars-and-mers

Vollman, K. M. (2004). Prone positioning in the patient who has acute respiratory distress syndrome: The art and science. Critical Care Nursing Clinics, 16(3), 319–336. https://doi.org/10.1016/j.ccell.2004.04.007

Vollman KM. (2001) Acute respiratory distress syndrome & positioning for optimal pulmonary function. In Schell HM, Puntillo KA: Critical Care Nursing Secrets. Philadelphia, Hanley & Belfus, inc., 2001, 175-184.

Vollman, K. M. Nursing Clinical Procedure and Policy by Kathleen Vollman, RN, MSN, CCNS, CCRN, FCCM, FAAN. Retrieved March 4, 2021, from http://www.vollman.com/policy.cfm

Walker, I. A., Reshamwalla, S., & Wilson, I. H. (2012). Surgical safety checklists: Do they improve outcomes? British Journal of Anaesthesia, 109(1), 47–54. https://doi.org/10.1093/bja/aes175

Weiner, D. L., & Rosman, S. L. (2019). Just-in-Time Training for Disaster Response in the Austere Environment. Clinical Pediatric Emergency Medicine, 20(2), 95–110. https://doi.org/10.1016/j.cpem.2019.07.001

Woo, T., Ho, R., Tang, A., & Tam, W. (2020). Global prevalence of burnout symptoms among nurses: A systematic review and meta-analysis. Journal of Psychiatric Research, 123, 9–20. https://doi.org/10.1016/j.jpsychires.2019.12.015

World Health Organization (WHO). (2020, March 18). Mental health and psychosocial considerations during the COVID-19 outbreak. https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf?sfvrsn=6d3578af_2

World Health Organization (WHO). (2021). Timeline: WHO's COVID-19 Response. Retrieved March 8, 2021, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline

# Appendix

## Figure 1

Berlin Definition of ARDS

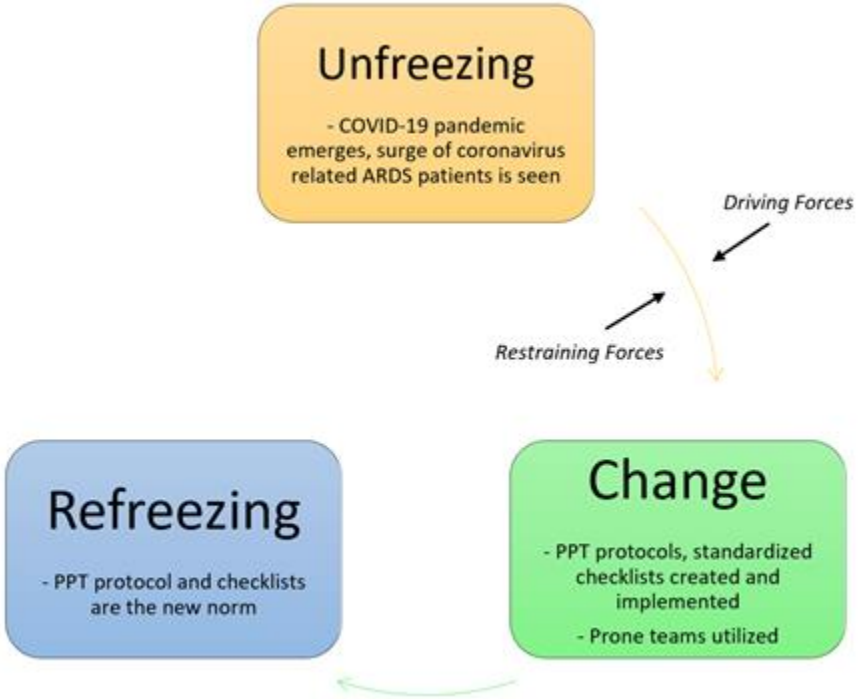
| Qualifying Characteristic | Definition of Characteristic |
|---|---|
| **Timing** | Diagnosed within 1 week of injury, symptom onset, or worsening in symptoms |
| **Chest Imaging** | Opacities present in bilateral lung fields |
| **Edema** | Respiratory failure not fully explained by cardiogenic edema or hydrostatic edema. Requires an objective assessment that excludes hydrostatic causes |
| **Hypoxemia (PaO2/FiO2 and PEEP)** | Mild ARDS<br>- **PaO2/FiO2**: 200-300 mmHg<br>- **PEEP:** ≥ 5 cmH2O (or CPAP use)<br>Moderate ARDS<br>- **PaO2/FiO2**: 100-200 mmHg<br>- **PEEP:** ≥ 5 cmH2O<br>Severe ARDS<br>- **PaO2/FiO2**: ≤ 100 mmHg<br>- **PEEP:** ≥ 5 cmH2O (or CPAP use) |

The Berlin Definition of Acute Respiratory Distress Syndrome (ARDS) is a diagnostic guideline established in 2012 by the ARDS Definition Task Force developed by the European Society of Critical Care Medicine and accepted by the American Thoracic Society and the Society of Critical Care Medicine (Ferguson et al., 2012; The ARDS Definition Task Force, 2012). The definition requires that specific characteristics be present regarding timing of diagnosis, chest imaging results, and origin of edema. The definition also identifies three distinct categories of ARDS according to severity of disease and based on arterial hypoxemia as measured by the PaO2/FiO2 ratio (P/F): mild—P/F 201 to 300 mm Hg; moderate—P/F 101 to 200 mm Hg; and severe—P/F ≤ 100 mm Hg.

*Abbreviations: Arterial oxygen saturation (PaO2), fractional concentration of inspired oxygen (FiO2), positive end-expiratory pressure (PEEP)*

**Figure 2:**

Theory of Change Applied to the Rapid Implementation of a PPT Protocol during the COVID-19 Pandemic




Adapted from Lewin's Theory of Change (Lewin, 1951)

Lewin's Theory of Change model is a three-stage, cyclical, and dynamic theory that relies on the equilibrium of balancing forces. The first stage (unfreezing) is defined by a disruption in existing norms that leads to changes in thought or behavior. The emergence of the COVID-19 pandemic brought about the unfreezing stage. Transition to the second stage of change (change) occurs when the driving forces surpass restraining forces. The high demand for care of critically ill COVID-19 patients was a major driving force, which demanded change in existing healthcare practices. The change stage is defined by the formation of new knowledge and practices. The final stage (refreezing) occurs when new knowledge and practices become standardized into practice, becoming the new norm.

**Figure 3**

PPT Example

| STEPS | PROCEDURE |
|---|---|
| **1. Gather materials**<br>- Flat sheet x2<br>- 3 sets of double stuffed pillows<br>- Several mepilex of differing size<br>- Extra set of EKG leads | 1. Coordinate with **RT and MDs** to organize a time to prone the patient. Begin preparing the materials and the patient PRIOR to this time so everything is ready when the team arrives.<br>2. RNs to manage the patient and associated lines/equipment<br>3. RTs to manage the airway and ventilator<br>4. MD must be present in the room for proning process |
| **2. Organize your tools and prepare the patient** | 1. Remove all clothing and non-essential equipment<br>Includes:<br>- Gown<br>- A-line wrist splint<br>- Rook boots/SCDs<br>- Un-used EKG leads<br>- Foley stat lock<br>2. Also remember:<br>- Max-inflate the bed<br>- FiO2 100%<br>- Lines secured<br>- Side rails down<br>- Tube feed off and disconnected<br>3. Pad all boney prominences with mepilex.<br>Remember:<br>- Tops feet (knuckles of the feet)<br>- Knees<br>- Tops of hands (knuckles)<br>- Elbows<br>- Anterior shoulder<br>- Chin<br>- Cheek bones<br>- Forehead<br>- Nipples<br>- Anterior ischial crest (hips)<br>4. Paper tape over the eyes to keep closed<br>5. Untuck the fitted sheet over the bed |

| | |
|---|---|
| **6. Prepare your patient and gather your team** | 1. Lay blue pad (white absorbent side down) over the groin<br>2. Lay one flat sheet over the patient.<br>3. Place pillows over the patient's **chest**, **pelvis**, and **shins**.<br>4. Lay second flat sheet over the pillows.<br>5. RT will manage the ETT. The patient will always roll **towards the ventilator** for proning<br>6. Minimum 6 people to prone the patient (3 on each side)<br>7. Minimum 2 RTs to manage airway<br>8. RN leader<br>9. MD |
| **7. Wrap the patient** | 1. Wrapping the patient<br>Make sure that they patient's arms are down by their side and their **hands are facing their body**.<br>Ventilator side will roll their sheets **UP**<br>Non-ventilator side will roll their sheets **DOWN**.<br>Roll your sheets **tightly** and hold on with **both hands** until instructed to do otherwise.<br>2. Slide the patient away from the ventilator.<br>Airway check. Line check.<br>3. Turn patient on their side.<br>Airway check. Line check.<br>4. Switch 1st hand to reach for the sheets on the opposite side of the patient.<br>Airway check. Line check.<br>5. Switch 2nd hand so both hands are on the same side.<br>Airway check. Line check.<br>6. Roll the patient onto their stomach.<br>Airway check. Line check. |
| **8. Safety check** | 1. Immediately perform safety checks and ensure VSS<br>2. Uncover the patient and **reapply EKG leads** on the back – same orientation as supine position<br>3. Ensure pillows are positioned properly and abdomen is **free-hanging**<br>4. Ensure RT is comfortable with airway patency |
| **9. Prone positioning** | 1. Position arms in swimmer position. Alternate **Q2 hours**.<br>2. Be mindful not to over-extend the patients neck and arms.<br>**NEVER** bring the patient's arms past the coronal plane |
| **10. Post proning safety checks** | 1. Assess head position<br>- Make sure there is no pressure on ETT/OG/NG tubes |

| | |
|---|---|
| | 2. Assess boney prominences<br>3. Resecure foley catheter and lines |

**Table 1**

Key terms and Definitions

| WORD/PHRASE | ABBREVIATION | DEFINITION |
|---|---|---|
| Acute respiratory distress syndrome | ARDS | A severe form of respiratory failure that is characterized by hypoxemia, occurring as a result of infection or injury to the lungs. It can be broadly defined and diagnosed using the Berlin Criteria (figure 1) |
| Prone position therapy | PPT | The act of placing a patient to lie on his or her stomach for the majority of a 24 hour period, followed by repositioning into the supine position (back lying) for the remaining hours in an effort to redistribute the forces involved in pulmonary function and reverse damage caused by a respiratory insult |
| Severe acute respiratory syndrome coronavirus 2 | SARS-CoV-2 | A virus belonging to the coronavirus family that is the second virus of its kind known to induce severe lung damage in some humans who are infected |
| Coronavirus disease of 2019 | COVID-19 | The name of the disease that is caused by SARS-CoV-2 |
| Hypoxemia | | Low oxygen levels in blood |
| Front-line healthcare workers | | People employed in healthcare who directly interact with community members and are essential relative to other agents of the healthcare system for providing services for those with acute medical needs; e.g. nurses, nurse aids, providers, paramedics, etc. |
| Just-in-time training | JITT | an education model that focuses on duty-specific, on-site training for essential skills needed to execute urgent tasks |

**Table 2**

Themes from Interview Data

| **Topic 1: Nurses' Perceptions of the COVID-19 Pandemic** | |
|---|---|
| **Major Themes** | **Evidence** |
| 1. Sense of belonging | - "I felt like I was part of a team and not just alone." (5.3.3)<br>- "I think [the COVID pandemic] brought us closer together as a team." (9.7.7)<br>- "Just going through everything together you become a little bit more cohesive with your co-workers...Your family and friends don't really understand what you're going through unless they're also in healthcare." (22.7.2)<br>- "This pandemic has 100% brought the unit closer together professionally and personally." (12.2.18)<br>- "I think there's a sense of solidarity among those [nurses] who were there before COVID and are still here now." (13.5.43)<br>– "If you're with your solider friends, you can get through it. But if you go out into like the real normal world, then you lose a lot of that because you're the only one who has been traumatized in that way. You don't have anything to share with anyone because no one understands what you're talking about. As long as we're together, we can all kind of can revisit this together. I think we're stronger together." (13.6.11) |
| 2. Shared learning | - "I felt like we were learning *with* the doctors." (5.2.43)<br>- "It's been a pretty steep learning curve." (5.2.17)<br>- "A lot of the physicians were kind of stumped on how exactly to treat things. I think we've learned a lot about how to treat things now." (5.2.17)<br>- Before COVID, I felt like I always knew what I was going to do in any given situation." (12.1.19)<br>- "During COVID, we were all learning so much every single day, even the doctors, everyone. That was one of the things that I had to stand back and was just so damn impressed with the field of healthcare." (12.5.9)<br>- We're learning more about [COVID] as we go on in this pandemic. (22.7.25) |
| 3. Moral distress | – "In March and April [work] was just awful." (9.1.37)<br>– "[At work] you're just stressed out all the time because everything is so unknown." (9.1.38)<br>– "There was a lack of understanding about what was going on [when the pandemic began]. So that made work a bit more stressful: coming in and not knowing what to expect, not knowing if we're doing the right things for ourselves to keep yourself safe." (22.1.12)<br>– "I felt like quitting at times and was just exhausted and burnt out, because patients were *not* getting better. Lots of patients were dying. It was not fun." (9.1.42) |

| | |
|---|---|
| | – "The hardest part for me was having to FaceTime or call the patient's family on the phone and kind of give them updates because a lot of them just had no idea how sick their love one really was." (9.2.18)<br>– "I thought that the swine flu was the worst thing that I had ever seen and then this happened and changed my mind about all of that." (12.1.14)<br>– "This has absolutely been the hardest thing that I've ever gone through in my life second only some very hard personal things." (12.1.16)<br>– "It was gut-wrenchingly difficult. It was heartbreaking and absolutely awful." (12.1.22)<br>– "It feels like we're just kind of in this place all together like a bunch of migrants." (13.1.31)<br>– "I was stressed out because it's like am I doing things right?" (5.4.1)<br>– "So in another year, I will probably go to therapy for this because I know I'm going to have some PTSD." (12.2.8)<br>– "It was like a war zone but it definitely brought us closer together." (12.2.18)<br>– "I think everyone's been traumatized to some extent. It's like, if you're a soldier and you go to war, you become a much better soldier." (13.6.6) |
| 4. Fear | – "I've taken care of patients that have expired before, but it was never because of a disease process that you could potentially get yourself and take home to my family members." (9.2.33)<br>– "I think my biggest stress with COVID and working was the threat of possibly bringing it home to [my family]." (22.1.33)<br>– "A lot of people [in the beginning] just didn't want to go near a patient with COVID." (5.2.42)<br>– "Newer nurse [with less proning experience] were like deer in headlights." (5.3.11) |
| **Topic 2: Nurses' Perceptions of PPT Protocol** | |
| **Major Theme** | **Evidence** |
| 1. Unstructured | – Before we had the checklist we needed someone to stand there and help us with things and make sure we didn't mess up. We were all pretty exhausted and so we'd get forgetful and needed someone to make sure we weren't missing a step or messing up our PPE. (12.3.41)<br>– The whole proning process was kind of **chaotic** at first. (9.3.9)<br>– I didn't feel that there was a clear or formal standard for how prone therapy should be done in the context of COVID at first [when we started proning patients]. (9.3.36)<br>– "There was always confusion among a lot of the nurses about which way do you roll the sheets, which way do we turn first, etc. People have differing opinions on how certain specific things are done." (9.4.20)<br>– "There were a couple situations that were **super stressful** [before we had the checklist]." (12.4.8) |

| | |
|---|---|
| | – "So my first few times with proning [before the checklist implementation], you could tell that we didn't completely know what to do." (22.2.17) |
| 2. Structured checklist | – "The actual process [of proning] became a lot safer after the standardized protocol was rolled-out. It felt structured to have a step-by-step checklist of what we're doing make sure we've done it all. It made it a lot easier and a lot simpler. You didn't have to second-guess yourself or worry about missing small details." (9.4.28)<br>– "The team ended up getting proning done really fast with that checklist. We made that a requirement for every single time a patient was proned, because we realized that not everyone was going to do it the same way without a checklist." (12.3.38)<br>– "It probably took us a few couple months I'd say to actually get something written down on paper and have it to where everybody kind of falls into the roll and into the place and there much quicker, much easier, much safer." (22.2.19)<br>– "I thought [the checklist] was really helpful. I think it made people generally more comfortable." (13.5.13)<br>– "It was a lot a lot better than what we have been doing without the checklist. I never felt uncomfortable with that part of the whole process." (9.5.26)<br>– I think getting experience and then having the checklist along with that made everything go more smoothly, with no problems and a lot faster. It also made it feel a lot safer because you couldn't forget a step if you followed the checklist." (9.4.40) |
| 3. PPT Leadership | – "[Prone therapy requires] a lot of coordination with a lot of people so that's hard work." (12.6.3)<br>– "I was confident in the proning *process* from the beginning if the right proning leader was involved, but if I was like actually leading it, I never felt completely comfortable to be honest. There was always some sort of miscommunication." (13.3.5)<br>– "The prone team will show up and depending on who you're leader was, no one would necessarily know if these people had experience proning and sometimes we'd have to educate everyone on how to do it again. And if that [identification and education] doesn't happen, then you could have trouble." (13.4.26)<br>– "We had a lot of people who had *no* experience with proning. So that lack of leadership made things pretty difficult." (5.4.36)<br>– "The only thing I've really noticed lacking is not having a clear leader. It's a little bit more clear now that the primary RN should be running the proning process. It's becoming more established who the leader is. It's happens less often that we have multiple people giving orders." (5.6.2)<br>– "If we didn't have one of the ICU nurses to help facilitate and lead the session, then it just added an extra stress to the bedside nurses trying to prone a patient with your team when the everybody in the room has |

| | |
|---|---|
| | never proned before. So I guess having a leader that's aware of the patient population at all times was just definitely beneficial." (22.5.3) |
| 4. Perceived Benefit | – "[Prone therapy] seemed to initially work well and then after a few days, if they didn't improve in that time period, it didn't seem to work well." (9.5.38)<br>– "It's been pretty impressive to watch how effective proning has been especially for COVID patients." (12.6.43)<br>– "[Prone therapy] was the only [treatment] that seems to reliably work. Maybe not for everyone of course. Some people, they're just so sick that they never get better. But even the sickest ones seemed to benefit from it, at least for a little while." (13.6.28)<br>– "It's labor intensive, yeah and at times it's really tough, but I really think it's worth it. I feel good about it. From what I've seen, it benefits people. The only thing I don't get is why we don't do it sooner." (5.6.33)<br>– "I definitely feel it's worth it. I think sometimes it *sucks* actually doing it- the labor of it and everything, but I've seen it really help people [who were very sick]." (22.7.14) |
| 5. Prone Teams | – "I think [the prone team] definitely relieved some pressure on the unit just because now you have that extra help." (13.4.16)<br>– "[The prone team] really helped with infection control and that stuff. It's really helped streamline things." (5.2.29)<br>– "Using like 8 or 9 people [to prone patients] makes the biggest difference I think." (12.6.32)<br>– "So that was helpful- having consistency and continuity with the prone team [implementation]." (22.4.31)<br>– "Going from doing all that [work] by yourself to having a helper was definitely huge." (9.2.8)<br>– "[The prone team] definitely made a difference. They had a system going and that's why we could prone 8 people within a couple hours because you would just show up as the bedside nurse and you would have everything ready and the prone team would come in and they would literally just prone for you while you watch the lines and help out with anything else." (22.4.27)<br>– "I think [the prone team] definitely relieved some pressure on the unit just because now you have that extra help." (13.4.16)<br>– "[The prone team] really helped with infection control and that stuff. It's really helped streamline things." (5.2.29)<br>– "Using like 8 or 9 people [to prone patients] makes the biggest difference I think." (12.6.32)<br>– "So that was helpful- having consistency and continuity with the prone team [implementation]." (22.4.31)<br>– "Going from doing all that [work] by yourself to having a helper was definitely huge." (9.2.8)<br>– "[The prone team] definitely made a difference. They had a system going and that's why we could prone 8 people within a couple hours because |

| | |
|---|---|
| | you would just show up as the bedside nurse and you would have everything ready and the prone team would come in and they would literally just prone for you while you watch the lines and help out with anything else." (22.4.27)<br>– "So even though we had a prone team, we didn't have consistency with who was on the prone team and so we didn't necessarily have competence. That was one of the things that was one of the big issues for us." (13.4.32)<br>– "So it was more of a stress for me when I had patients in the ICU and had people come in [to help prone] and they have no idea about the ICU or ICU patients." (22.2.25)<br>– "The prone team wasn't always made up of people who had proned before, so the prone team will show up and depending on who your leader was, no one would necessarily know if these people had experience proning and sometimes we'd have to educate everyone on how to do it again. And if that [identification and education] doesn't happen, then you could have trouble." (13.4.24) |
| **Topic 3: Nurses' perceptions of Training and Education** | |
| **Major Themes** | **Evidence** |
| 1. Informal Implementation | – "There was no formal training [for using the prone therapy checklist] for the unit that I remember." (9.5.19)<br>– I remember just feeling kind of anxious and nervous because it's not something I've done before and I really wanted to do it, right. It was kind of done just on the fly." (9.4.11)<br>– Yes, [improvements were made to the protocol after it was implemented]. It's nursing. Everything is just done on the fly in real time. We see something that needs to change and we say, 'Hey, this needs to be changed. It's not working.' (12.6.26)<br>– "was kind of *on the fly"* (22.2.16) |
| 2. Appropriateness of JITT methods | – "In our situation, there was no other way that we could have done it. We had sick patients and we needed to take care of the, so we did the best we could." (9.6.6)<br>– "[The prone therapy process] definitely wasn't structured at all, but it was rolled out the best we could at the time. It could have been better, but we don't really roll-out anything perfectly here." (13.5.30)<br>– "[Training for prone therapy] was totally on the fly. But like I said, at Overlake there's a lot of support on our unit, so we managed to put together a really solid team and get people educated. "(12.5.36)<br>– I don't know if [the bedside implementation of the protocol] was the *right* way. It was the *appropriate* way at the time." (22.5.18)<br>– I think experience plays a bigger role than trying to do a formal implementation in this scenario [of COVID]...Unless you were familiar with proning from experience, you kind of stumbled through it at first." (22.5.22) |