



HHS Public Access

Author manuscript

CHEST Crit Care. Author manuscript; available in PMC 2023 October 08.

Published in final edited form as:

CHEST Crit Care. 2023 September ; 1(2): . doi:10.1016/j.chstcc.2023.100008.

Adaptation and Uncertainty:

A Qualitative Examination of Provider Experiences With Prone Positioning for Intubated Patients With COVID-19 ARDS

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Abstract

BACKGROUND: Prone positioning was widely adopted for use in patients with ARDS from COVID-19. However, proning was also delivered in ways that differed from historical evidence and practice. In implementation research, these changes are referred to as adaptations, and they occur constantly as evidence-based interventions are used in real-world practice. Adaptations can alter the delivered intervention, impacting patient and implementation outcomes.

RESEARCH QUESTION: How have clinicians adapted prone positioning to COVID-19 ARDS, and what uncertainties remain regarding optimal proning use?

STUDY DESIGN AND METHODS: We conducted a qualitative study using semi-structured interviews with ICU clinicians from two hospitals in Baltimore, MD, from February to July 2021. We interviewed physicians (MDs), registered nurses (RNs), respiratory therapists (RTs), advanced practice providers (APPs), and physical therapists (PTs) involved with proning mechanically ventilated patients with COVID-19 ARDS. We used thematic analysis of interviews to classify proning adaptations and clinician uncertainties about best practice for prone positioning.

RESULTS: Forty ICU clinicians (12 MDs, 4 APPs, 12 RNs, 7 RTs, and 5 PTs) were interviewed. Clinicians described several adaptations to the practice of prone positioning, including earlier proning initiation, extended duration of proning sessions, and less use of concomitant neuromuscular blockade. Clinicians expressed uncertainty regarding the optimal timing of initiation and duration of prone positioning. This uncertainty was viewed as a driver

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Author contributions: Conception and design: C. H. H., D. N. H., and M. N. E. Acquisition of Data: C. H. H., and M. N. E. Analysis and interpretation of data: C. H. H., M. E. C., B. S., D. N. H., and M. N. E. Drafting or revising of the manuscript: C. H. H., M. E. C., B. S., D. N. H., and M. N. E. Final approval of manuscript: C. H. H., M. E. C., B. S., D. N. H., and M. N. E.

Financial/Nonfinancial Disclosures

None declared.

Additional information: The e-Appendix and e-Table are available online under “Supplementary Data.”

of practice variation. Although prescribers intended to use less deep sedation and paralysis in prone patients compared with historical evidence and practice, this raised concerns regarding patient comfort and safety amongst RNs and RTs.

INTERPRETATION: Prone positioning in patients with COVID-19 ARDS has been adapted from historically described practice. Understanding the impact of these adaptations on patient and implementation outcomes and addressing clinician uncertainties are priority areas for future research to optimize the use of prone positioning.

Keywords

acute respiratory distress syndrome; COVID-19; implementation science; prone position

Early prone positioning for patients with moderate to severe ARDS is one of few interventions that reduces mortality in ARDS.^{1–3} Although studies before the COVID-19 pandemic showed that only 6% to 14% of eligible patients with ARDS were prone,^{4–8} early pandemic studies indicated widespread proning adoption and showed that more than 50% of eligible patients with COVID-19 ARDS were prone.^{9–12} These studies also indicated that prone positioning was delivered in ways that differed from historical evidence and practice.^{6,12–14} In implementation science, these changes would be referred to as *adaptations*, in which interventions are altered to fit a given clinical environment and local context.¹⁵ Adaptation has not been described in depth in critical care,¹⁶ and yet it is common as interventions move from controlled trials into real-world practice.

Prone positioning for patients with ARDS secondary to COVID-19 provides an example of intervention adaptation in critical care. In our health system and others, patients with COVID-19 ARDS were prone very early after meeting criteria (ie, within 6 hours) and were left in the prone position for long periods (median of approximately 40 hours per proning session).^{12,14,17} This contrasts with the protocol of a landmark trial of proning, in which patients were only randomized if they remained sufficiently hypoxemic after a 12- to 24-hour stabilization period after initial criteria were met.¹ They were then prone for at least 16 h/day (average, 17 h/day) and underwent daily supination to assess whether proning was still indicated per the protocol. The extended sessions described in patients with COVID-19 are also longer than observed in pre-COVID-19 observational studies in our setting and others.^{6,12} Use of neuromuscular blockade (NMB) also changed. In the landmark trial and in pre-COVID-19 ARDS practice, most patients received NMB (87% of prone patients receiving NMB).¹ In contrast, in COVID-19 ARDS, there was less use of deep sedation and NMB (43%–59% of prone patients received NMB).^{12,14,17}

Adaptations can alter the intervention being delivered and influence implementation and patient outcomes.¹⁸ Understanding how proning was adapted in COVID-19 ARDS, and understanding the clinician uncertainties that may drive or arise from adaptation, could identify aspects of prone positioning that warrant further study to optimize patient and implementation outcomes. Implementation science frameworks such as the Model for Adaptation Design and Impact (MADI) provide a systematic approach to classify adaptations and their potential impact on patient and implementation outcomes.¹⁹

In this study, we conducted a secondary analysis of a qualitative interview study to evaluate ICU clinicians' experience with adaptations to the practice of prone positioning for ARDS in the setting of COVID-19. Our specific objectives were to understand clinician decision-making, attitudes, and uncertainties around practice adaptations to prone positioning for COVID-19 ARDS and to identify areas of ongoing clinical uncertainty regarding how to optimize this lifesaving intervention.

Study Design and Methods

We performed an ancillary analysis of a qualitative study involving semistructured interviews with ICU team members involved in caring for patients with COVID-19 ARDS. The parent study, which was designed to identify facilitators and barriers to prone positioning in mechanically ventilated patients with COVID-19 ARDS, has been described in detail elsewhere.²⁰ We recruited participants from ICUs in two hospitals of the Johns Hopkins Health System. Participants included attending and fellow Pulmonary and Critical Care Medicine (PCCM) medical doctors (MDs), advanced practice providers (APPs), registered nurses (RNs), and respiratory therapists (RTs). We additionally recruited physical therapists (PTs) who were part of a "proning team" that was formed to assist with proning during periods of high volume during the COVID-19 pandemic.²¹ We used purposive sampling to recruit MD, APP, and PT participants known to be engaged with COVID-19 critical care or the "proning team" (in the case of PTs). We used convenience sampling to recruit RNs and RTs via email to staff listservs and announcements at staff meetings. We sought to recruit five of each provider type per hospital (except for PTs and APPs, who only worked in the larger academic center). The final sample size was determined based on thematic saturation, defined as no further themes emerging with additional interviews.

The Johns Hopkins School of Medicine Institutional Review Board approved the study (IRB00259955), and informed consent was obtained from participants. This report follows the Consolidated Criteria for Reporting Qualitative Research (e-Table 1).²²

Interview and Data Collection

One-on-one semi-structured interviews were conducted over video conferencing software by the first author (C. H. H.), who was a senior PCCM fellow at the time of the study. Interviews followed a guide (e-Appendix 1 and 2), with questions that explored participants' experiences with prone position in mechanically ventilated patients with COVID-19 ARDS. The initial interview guide was piloted with one PCCM fellow and revised by study team consensus before additional interviews. This guide was then iteratively updated after each interview (if necessary) to explore emerging themes. Interviews were audio recorded and transcribed verbatim by a medical transcription company.

Qualitative Analysis

Analysis was performed with the assistance of NVivo 12.0 software (QSR International Pty Ltd.). For the initial analysis, which was reported elsewhere,²⁰ authors C. H. H., B. S., and M. N. E. used inductive coding of the first five interview transcripts to develop a codebook. We then used thematic analysis to classify codes into themes focused on implementation

barriers and facilitators. C. H. H used this initial codebook to code the remaining transcripts, with additional codes added as new themes emerged. All transcripts were then coded in duplicate by an additional study team member (B. S. or M. E. C.), and discrepancies were resolved in discussion with the senior author (M. N. E.), an implementation scientist with expertise in qualitative research. Coding comparison between the two coders of each transcript revealed high percent agreement (99%) and fair Cohen's kappa statistic (0.40).

In the original analysis, several codes relating to proning adaptations arose, prompting this ancillary analysis. For this we relied on the MADI framework which is organized into three domains (Fig 1).¹⁹ In domain 1, the content of practice adaptations (ie, what was adapted and for whom) are systematically defined. In domain 2, a framework for thinking about the processes of adaptation and how these influence the refined practice is provided. Finally, in domain 3, the impact of this refined practice on patient and implementation outcomes is considered. We focused our investigation primarily on domain 1, because the interview guide from the study elicited information on proning practices. Furthermore, we focused on aspects that changed how the patient received proning, and not on changes that altered how teams were able to carry out the proning procedure (eg, a proning team or enhanced nurse staffing), which we considered to be facilitators of proning. To complete the analysis presented here, codes from the original study transcripts were classified into themes related to the content of proning adaptations or clinician uncertainty, which we hypothesized may drive or arise from practice adaptations. No transcripts were recoded for this analysis.

Results

Of 44 ICU clinicians who responded to initial recruitment efforts, we conducted interviews with 40 participants between February and July of 2021. Participant characteristics are shown in Table 1. Interview length was a median of 24 min (range, 12–44). MDs, APPs, and RNs were primarily working in three medical ICUs (ranging from 12- to 24-bed units), and RTs and PTs worked in multiple ICUs in both hospitals. The census of patients with COVID-19 varied as COVID-19 surges waxed and waned.²³ All participants were recruited from ICUs that were exclusively dedicated to COVID-19 care at points during the pandemic.

Consistent with quantitative COVID-19 studies, participants noted that prone positioning for COVID-19 ARDS differed from the intervention described by the landmark randomized controlled trial Proning Severe ARDS Patients¹:

(APP03): If you look at the [Proning Severe ARDS Patients] trial, it's much different than what our practice is now...

Adaptations to proning described by our study participants are outlined, along with supporting quotations, in Table 2. Prone positioning was initiated very early during ARDS and mechanical ventilation, and prone positioning sessions were extended beyond durations outlined in historical evidence and practice.

(RT07): "At the beginning of COVID, we really had a strict 16 hours [prone], 4 hours [supine]....Going further into it, we realized that 16 hours wasn't enough time.... So I liked when they [patients] were proned longer because I started seeing benefit."

Clinicians reported variable motivations behind the adaptation of extending proning sessions, suggesting an informal adaptation process. A local guideline did recommend proning patients with moderate to severe COVID-19 ARDS for 18- to 24-hour sessions but did not delineate the much more extended sessions that some of our participants described and that we demonstrated in prior quantitative work.¹² Although some clinicians noted that extended proning sessions were related to concerns about supinating severely hypoxemic patients with COVID-19 ARDS, others referenced this strategy as specifically related to their understanding of the physiology.

(MD10): “I am of the opinion that we should keep patients prone for prolonged periods of time, so at least 18 hours, and probably more than that until you start seeing a sustained improvement in oxygenation or lung compliance.”

Others also noted that the repetitive nature of proning and supinating was labor intensive, and this influenced decisions to extend the duration of proning.

(APP02): “Because it was my experience that supinating patients just because you got them down to 60% $F_{I_{O_2}}$ with a very marginal P/F ratio [$PaO_2/F_{I_{O_2}}$ ratio]—you would supinate them, and then within 8 hours have to prone them again, which isn’t necessarily a failure ... but can be labor intensive to be flipping back and forth quite a bit.”

Proning sessions were also repeated further into the course of mechanical ventilation for ARDS, and this was noted as a change in local practice.

(MD08): “I honestly don’t remember proning, supinating, proning, supinating pre-COVID.... You prone them and then supinate them just to give them kind of a holiday so that you alleviate pressure sores or anything. And then we prone on them again. Whereas I feel like pre-COVID, we would just prone them once and see if it worked.”

Compared with pre-COVID-19 proning practice, there was a move toward using less deep sedation and NMB in prone patients.

(APP01): “Historically [we target] a RASS [Richmond Agitation Sedation Scale] of -4, maximizing synchrony and then we’d prone. And that’s kind of changed.... There’s been a dialogue, a really good dialogue, about RASS goals and what we’re actually looking to achieve.... [This change] takes time and then experience from the provider and nursing and a comfort level between them.”

Related to patient safety and comfort, PTs helped develop adjustments to patient positioning to try to decrease the risk of musculoskeletal issues. Furthermore, the frequency of head turning and patient repositioning, which had previously been protocolized, was adjusted to less frequent turns to reflect the longer overall duration of proning sessions, as well as patient severity (instability with movements).

Clinician uncertainties regarding proning use reflected issues related to practice adaptations (Table 3). Although proning was being initiated earlier than previously, some clinicians noted concerns with this practice and stated that this was not necessarily consistent with

best evidence. Likewise, clinicians expressed uncertainty regarding the extended proning sessions.

(RT03): “Absolutely no uniform practice [regarding length of proning].... If they were getting better, and we had reached an $F_{I_{O_2}}$ or PEEP [positive end-expiratory pressure] that we thought was acceptable to supinate, then we would. But we had patients who were prone for weeks.”

Multiple clinicians voiced that this uncertainty led to practice heterogeneity. In a related issue, some clinicians raised concern that the repeated proning sessions were not rational, and believed that this supported using fewer and longer proning sessions. Clinicians also reported uncertainty about how far into the course of ARDS to continue proning in patients with persistent ARDS.

Additional areas of uncertainty were raised by RNs and RTs involving the safety and comfort of prone patients receiving less sedation/paralysis.

(RN11): “We couldn’t even get nonintubated patients to prone for a long period of time because it’s so uncomfortable and unnatural for most patients. So that still seems to be an area of tension between the nursing staff and the physician staff.... [T]o me, this [proning in undersedated patients] seems like a big setup for [posttraumatic stress disorder].”

Lastly there was uncertainty from the RN staff regarding how often patients needed to be moved to reduce risk of pressure injury and promote comfort.

Discussion

This study of ICU clinicians involved with proning mechanically ventilated patients with COVID-19 ARDS provides detailed qualitative data describing adaptations to prone positioning and shows a different approach to the therapy than that described in the landmark proning randomized controlled trial and historical practice. This includes earlier initiation of proning once a patient meets criteria, extended duration of proning sessions and less use of deep sedation and NMB. Clinicians remain uncertain about how to best deliver prone positioning to mechanically ventilated patients with ARDS, including when to initiate proning, how long to keep a patient prone, and when to stop repeating proning maneuvers. Although concomitant use of deep sedation and NMB for prone patients may be decreased compared with historical practice, not all care teams were comfortable with this adaptation.

The data from this study provide context for the prone positioning adaptations that have been quantitatively demonstrated by our group and others.^{12,14,24,25} Regarding extended proning sessions, COVID-19 ARDS studies reveal significant variability in this practice, with some centers much more likely to adhere to proning sessions around 16 hours^{25,26} and others using far extended sessions.^{12,14,17,27} Clinician uncertainty regarding optimal proning duration, concerns about the labor-intensive nature of repetitive proning and supination, and hesitance to supinate severely ill patients, as described in this study, may drive some of this heterogeneity. Whether extended proning is beneficial to patients, or superior to standard duration proning, is not known. Although emerging observational evidence

supports the safety and potential efficacy of this practice,^{14,17} further study is needed. Clinician uncertainty about several issues around timing (initiation, duration) and repetition of proning sessions indicates a need for stronger evidence to optimize use of proning. Finally, clinician uncertainty around proning can inhibit a shared mental model of proning purpose amongst ICU team members. This presents a challenge to uniform implementation of this evidence-based intervention.²⁸

Our study also offers insight into team views around prone positioning in ARDS. RNs and RTs expressed concern about not using deep sedation and paralysis for prone patients. This is consistent with a prior survey of nurse and physician attitudes toward proning, which also revealed RN concerns around not using NMB for prone patients.²⁹ Our data suggest that in some cases RN attitudes toward sedation and paralysis are driven by concerns regarding patient comfort and safety, rather than questions regarding the efficacy of proning with spontaneous respiratory efforts. It is important to understand and reconcile differences of opinions amongst multidisciplinary ICU teams, because team agreement is key to successful implementation of complex ICU therapies, including prone positioning.^{20,30,31}

Adaptations of proven therapies and interventions are common in routine practice and can significantly affect patient and implementation outcomes. As such, therapeutic adaptation should be monitored as interventions move from tightly controlled trials to real-world practice. Although historically understudied in implementation research, several recent advances in understanding adaptation have been made, and they provide a framework for understanding intervention adaptation in real-world settings.^{18,19} The analysis for this study was guided by the MADi framework, and it focused mainly on the content of adaptations (domain 1).¹⁹ Future work should assess the processes by which ICU teams make these adaptations (domain 2). We note that our participants did not describe a systematic process leading to these adaptations (ie, implementation of new guidelines or policies), and they described varying goals for some of the changes (eg, supporting severely hypoxemic patients, or that extended proning was in line with their understanding of the physiology). As such, it appears that these adaptations were mostly reactive and driven by clinician and ICU teams via informal processes.

Although this study describes the adaptations to proning that occurred during the COVID-19 pandemic, it does not provide evidence that these adaptations were beneficial to patients or would be beneficial to a broader population of patients with ARDS. Rather, these data highlight several areas where further study is needed to understand the impact adaptations may have on patient outcomes (eg, safety and efficacy of extended proning, benefit of prioritizing very early pronation). Although clinicians expressed a need for more evidence to help optimize use of proning, this should not be interpreted as a lack of evidence for this lifesaving intervention.

There are several limitations of this study. Data were collected during the first 2 years of the COVID-19 pandemic, when large and rapid changes in proning practice occurred. Adaptations, and clinician's views of these adaptations, surely continue to evolve, and more recent impressions are not captured here. Importantly, our data only address use of proning for mechanically ventilated patients. We did not query clinicians about proning patients

receiving noninvasive support because evidence for this practice early in the pandemic was lacking. Additionally, because this was a post hoc analysis, we focused on the content of proning adaptations and did not have detailed data about the processes of adaptation (domain 2 of the MADI). Finally, this study represents adaptations to proning for COVID-19 ARDS from two hospitals in the same medical system and may not reflect the approach to ARDS more broadly.

Interpretation

Adaptations to prone positioning in patients with COVID-19 ARDS include very early initiation and extended duration of proning sessions. These changes have yielded a therapy that is different from that described in historical evidence and practice, and it requires further study to understand how this impacts efficacy and implementation. Clinician uncertainties around how to deliver optimal, safe, and comfortable prone positioning may drive some adaptations and suggest several areas for research to further optimize this therapy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding/Support

C. H. H is supported by NIH-NHLBI F32HL160039; C. H. H., M. E. C., and B. S. were supported by NIH-NHLBI T32HL007534 (C. H. H., M. E. C., and B. S.).

Role of sponsors:

The sponsor had no role in the design of the study, the collection and analysis of the data, or the preparation of the manuscript.

ABBREVIATIONS:

APP	advanced practice provider
MADI	Model for Adaptation Design and Impact
MD	medical doctor
NMB	neuromuscular blockade
PCCM	Pulmonary and Critical Care Medicine
PT	physical therapist
RN	registered nurse
RT	respiratory therapist

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Take-home Points

Research Question:

How have clinicians adapted prone positioning for ARDS to the COVID-19 context, and what clinician uncertainties remain regarding optimal proning use?

Results:

Though clinicians employed prone positioning earlier during ARDS, for longer sessions, and with the intent to use less sedation and concomitant neuromuscular blockade, uncertainties about how to optimally deliver prone positioning remain.

Interpretation:

Prone positioning in the COVID-19 ARDS context was used differently than as described in historical evidence and practice. Uncertainties surrounding optimal proning use may drive practice heterogeneity.

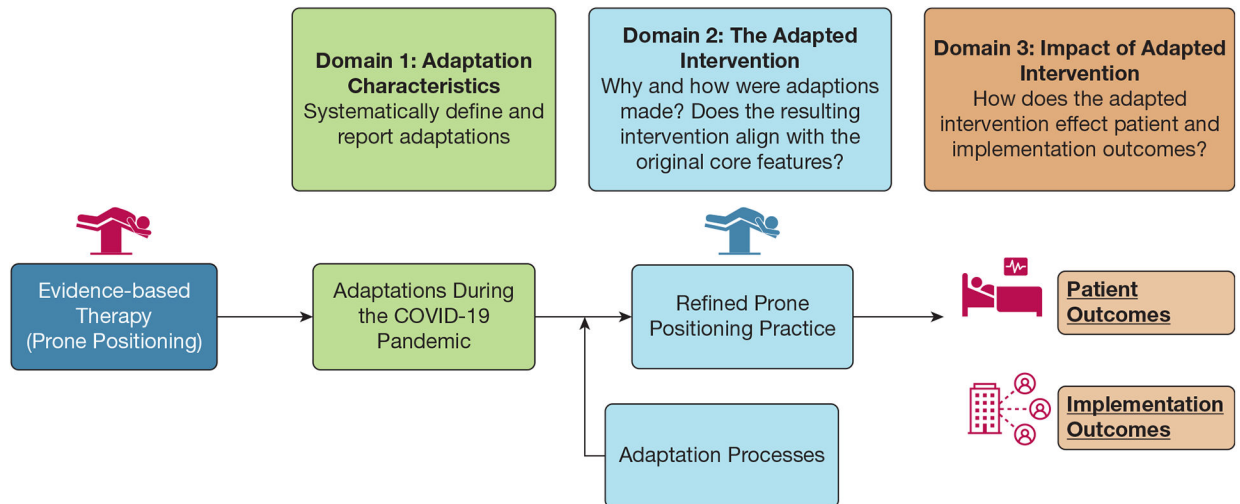


Figure 1 –.

The Model for Adaptation Design and Impact (MADI) framework adapted to prone positioning in COVID-19 ARDS. The MADI framework contains three domains to assist researchers in conceptualizing the content, processes, and impact of intervention adaptations. In Domain 1: Adaptation Characteristics, adaptations are systematically catalogued. In Domain 2: The Adapted Intervention, the process of adaptation and its impact on the refined intervention, and the way in which the refined intervention relates to its original core function, are considered. Finally, in Domain 3, the impact of the adapted intervention on patient and implementation outcomes is considered.

TABLE 1]

Demographic and Occupational Characteristics of Study Participants

Characteristic	Study Population (N = 40)
Provider type	
Attending MD	7 (17.5)
Fellow MD	5 (12.5)
APP	4 (10.0)
RN	12 (30.0)
RT	7 (17.5)
PT	5 (12.5)
Demographics/occupational ^a	
Academic hospital	28 (70.0)
Community-academic hospital	13 (32.5)
Age, y; median [IQR]	34 [30–39]
Female	29 (72.5)
Years in ICU, median [IQR]	7.0 [3.5–10.0]
Clinical role exclusively in ICU	24 (60.0)

Data are presented as No. (%) unless otherwise indicated. APP = advanced practice provider; IQR = interquartile range; MD = medical doctor; PT = physical therapist; RN = registered nurse; RT = respiratory therapist.

^aOne participant reported equal time at both academic and community-academic hospitals and is counted in both categories.

TABLE 2]

Adaptations to Prone Positioning Practice During the COVID-19 Pandemic

Adaptation Themes	Supporting Data (Provider Type): Quote
Proning initiated earlier in the course of ARDS	(MD09): <i>“The teams I was on, it [proning] was among the first things we would do... Proning those people was something we would usually do within the first 12 hours, first shift of them arriving in that kind of progressive hypoxicemic state.”</i>
Extended duration of proning	(APP03): <i>“There’s been patients that were proned for a week, just because their P/F was so terrible, and we didn’t really have anything else to do to help them.... I’ve noticed [that] throughout the time we’ve been taking care of COVID patients that we’re proning people for a lot longer.”</i> (MD03): <i>“My understanding of the physiology is the benefits are not—it’s not a rotisserie, right? ... It’s basically a lung-protective type strategy.... So I’m kind of not up for flipping back and forth. I think it’s both labor intensive and not necessarily consistent with what the physiology and the benefit is. So, my answer leads to a decent amount of variability in practice.”</i>
Repeated proning sessions	(APP01): <i>“That’s definitely changed as far as the reproning. That was something, I think, at the beginning of the pandemic that was thought as a failure, like, ‘We’re going to have to flip back and then why’d we even do it in the first place?’ And I think now it’s just seen as a natural course of the disease. And we may be doing this pronation, supination, 20 times over the course of a week, which is fine.”</i>
Proning with less sedation and neuromuscular blockade	(RN10): <i>“Typically, [before COVID] the patients were heavily sedated and most of them were paralyzed, too. Further on in COVID ... they were trying to do proning with less sedation and not paralyzing.”</i>
Positioning and repositioning to reduce the risk of musculoskeletal and pressure injuries	(PT04): <i>“As we started to see more of the brachial plexus issues and shoulder subluxations, then we really kind of stepped up to try to be more vocal about it... [and make modifications to the positioning].”</i> (RT02): <i>“I was a little bit afraid with the frequency of how we were doing the head turns, because we were doing every 2 to 4 hours at first. But then we noticed that ... if we padded more of the area, we were able to stretch out our turns to longer periods ... [every] 6, 8, or even 12 hours.... [This allowed] the patient to still be on their bellies for longer, [and] had a good outcome.”</i>

TABLE 3 |
Clinician Uncertainty Around Prone Positioning Practice During the COVID-19 Pandemic

Uncertainty Themes	Supporting Data (Provider Type): Quote
Ideal time to initiate prone positioning is unknown	(MD03): "In my mind, the pendulum swung too far in one direction.... I've seen where somebody gets intubated and they're on ... 70% [F _{IO₂}] and 12 [of PEEP], and they [ICU team] want to flip them right away. And I am telling them, 'Just slow down. That's not the therapy.' It's not immediately after intubation you've got to flip somebody over...."
Optimal duration of a proning session is unknown	(MD08): "Zero idea [when to supinate]? I think the longest [proning session] I did was around maybe the 72-hour mark.... But, honestly this is all made up. I don't think I ever got any guidance on how long the patient is allowed to be prone."
The benefit of repeated proning sessions not clear	(MD10): I don't think we know enough to know what really is the best trigger for re-supinating someone, whether it's just we should do it on a routine basis, like the <i>rotisserie style</i> , or whether we should do it based on compliance or whether we should do it based on oxygenation."
Safety and comfort of prone patients with less sedation was a concern	(MD06): "One thing I've seen is ... late proning, 2 or 3 weeks into their hospital [stay], still proning people. Could it potentially help from a hypoxemic standpoint? Yes. I think it may affect lung recruitment and shunt even further on. Does that translate to a clinically meaningful benefit? I'm just not sure. I think there's a clear absence of evidence, and we're proning those people late, just because we can. We know we can now, but I'm not really sure it's evidence based. I'm not really sure it helps."
	(RT01): "A lot of providers push for just let's wean off the sedation if we can, and paralyze them once we have to.... They don't see what we see while we're trying to turn the patient, and they are literally grabbing their endotracheal tube ... they're fighting for us.... And things like that where the patient is clearly just in agony."
The frequency of repositioning needed to reduce pressure injuries is unknown	(RN09): "Wound care and care in general is a big deal to nurses. So, telling a nurse that you don't get to move a person's face [frequently] when you're looking at it smooched in a pillow for 2 days, I think people were very <i>anisy</i> about that."