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Letting the patient decide: A case report of sedative self-administration during mechanical ventilation

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Introduction

It is common practice for critical care nurses to administer sedative medications to mechanically ventilated patients in the intensive care unit (ICU) in order to promote comfort, decrease oxygen consumption, facilitate nursing care, and ensure patient safety.^{1,2} However, overuse of these medications can cause significant adverse physiological and psychological sequelae and subsequently lead to prolonged mechanical ventilation, increased length of ICU stay, and increased rates of organ failure and reintubation.^{1, 3–7} Current clinical practice guidelines advise that patients should be kept as awake and alert as possible to facilitate greater patient control and independence.⁸ Nurses rely on a variety of scales to assess pertinent domains related to sedation such as consciousness, agitation, anxiety, sleep, motor activity, and patient-ventilator synchrony.⁹ While these scales are used in practice to guide sedative administration, consensus regarding the most appropriate way to utilize the scores to determine when and how much sedation to administer to achieve optimal sedation levels is not consistent among nurses.

Patient-controlled analgesia (PCA) has been used in practice for many years to promote effective patient self-management of pain; however, it is not known if parallel benefits exist when patient-controlled sedation is used to promote effective self-management of anxiety and other distressing symptoms associated with mechanical ventilation. A randomized pilot trial was conducted to evaluate whether patient self-administered sedation with dexmedetomidine (Precedex) (PST-DEX) is safe, feasible, and acceptable for self-management of anxiety during ventilator support. Dexmedetomidine is an ideal drug for self-administration of sedation because it has both sedative and analgesic properties. Dexmedetomidine has a rapid onset of action and distribution phase. Based on the pharmacokinetic profile and previous preliminary research with this medication and approach,^{10,11,13} the PST-DEX study protocol was developed to accommodate every 20-minute self-administration and titration of the basal infusion every two hours. Its lack of active sedating metabolites makes dexmedetomidine preferable to sedation with midazolam in patients with renal dysfunction.¹⁰ In addition, dexmedetomidine does not cause respiratory depression and patients on dexmedetomidine can be readily aroused to baseline consciousness with stimulation, allowing for interactions with healthcare providers and active participation in care.¹¹ This case report describes the experiences of one patient enrolled in the pilot trial¹² who was assigned to the experimental PST-DEX intervention, completed the study protocol, and provided feedback.

Overview of the Feasibility and Acceptability Randomized Pilot Trial

Alert, adult intubated patients who were expected to require mechanical ventilation for at least 48 hours were screened for possible enrollment from three ICUs in two hospitals in Minneapolis, Minnesota. Table 1 contains inclusion and exclusion criteria for the 2-group feasibility and acceptability randomized pilot trial. Additional details on this parent study are reported elsewhere.¹² After consent was obtained, to avoid selection bias patients were randomly assigned to one of two groups, PST-DEX (intervention group, n=17) or usual ICU care (control group, n=20). Subjects enrolled to usual ICU care received no study intervention and continued on their prescribed sedation regimens which were directed by physician order and administered by nurses per unit policy. In this specific practice setting, the most common sedation management strategy employed involved the administration of continuous sedative infusions rather than routine intermittent sedative boluses. For subjects in the PST-DEX group, the LifeCare PCA Infusion System (Hospira, Lake Forest, Illinois, USA) was used to administer dexmedetomidine in the PCA + continuous infusion mode. Patients were given a loading dose (0.5 mcg/kg) followed by a continuous basal infusion of 0.2 mcg/kg/hour, up to a maximum infusion of 0.7 mcg/kg/hour.^{12,13} Patients were allowed three self-boluses of dexmedetomidine per hour (0.25 mcg/kg) with a 20-minute lockout.^{12,13} Thus, it was possible that patients could have partial doses and/or denied doses, depending on how frequently they depressed the button. The PST-DEX patients were instructed to depress the push-button device when feeling anxious or if they desired medication for relaxation. Patient care nurses increased or decreased the basal infusion rate based on the number of bolus attempts from the patient in the prior two hours. Patients remained in the study for up to five days, or until they withdrew, were extubated, transferred from the ICU, or died. Acceptability was determined by patients' self-reported satisfaction

and ability to administer dexmedetomidine. A 100-mm visual analog scale to assess patients' anxiety (VAS-A) was used daily.^{14–15} Conclusions from the pilot trial were positive, indicating self-administering sedative therapy is feasible, acceptable by patients, and safe in that no PST-DEX patients self-extubated and none were removed from the study due to adverse safety events.¹²

A case report of one patient's experience with PST-DEX

The patient in this case study exemplar, PD, was chosen because PD's experience models the clinical intent for which the PST-DEX intervention was proposed. PD was intubated, but hemodynamically stable and able to interact and follow commands upon study enrollment. PD remained alert and interactive post-extubation and was able to describe the experience with the intervention.

PD was a 64-year-old white female admitted to the surgical ICU from an outside community hospital after developing sepsis and post-operative renal failure following the surgical repair of the perforated diverticulitis. Other significant medical history included Lyme disease and an inguinal hernia. PD's severity of illness score (Acute Physiology and Chronic Health Evaluation III) at the time of ICU admission was 104 (range 0–299). Vital signs and laboratory values upon ICU admission that contributed to the patient's overall severity of illness score can be found in Table 2. PD arrived at the unit needing 7 liters of oxygen via an OxyMizer® mask, but required endotracheal intubation and initiation of mechanical ventilatory support due to respiratory distress secondary to septic shock on the afternoon following PD's ICU admission.

PD was assessed for study eligibility by research staff during the morning of the fifth day of ICU care and fourth day of mechanical ventilation. PD was noted to be negative for delirium based on the Confusion Assessment Method for the ICU (CAM-ICU) and had sufficient strength to depress the push-button PST-DEX infusion device. PD consented to participate in the study, and was enrolled and subsequently randomized to PST-DEX. Continuous midazolam (0.5 mg per hour) and hydromorphone (0.2 mg per hour) were infusing at the time of study enrollment, as shown in Figure 1. At that time, PD provided an anxiety rating on the VAS-A of 25 mm (0–100 mm scale). At 1400 hours, PD's continuous midazolam infusion was discontinued, but hydromorphone remained as a continuous infusion, and per study protocol PD was given a weight-based loading bolus dose of dexmedetomidine 60 mcg, administered over 10 minutes. The continuous dexmedetomidine basal infusion began at 1410, immediately after the loading bolus dose, and was set at 24 mcg/hr (0.2 mcg/kg/hour). A 20% decrease in heart rate (HR) and a 14% decrease in mean arterial pressure (MAP) were observed after 30 minutes of the continuous dexmedetomidine infusion, however, these fluctuations remained within the established study safety protocols during bolus infusion and the initiation of continuous infusion (HR range: 65–81 beats per minute; MAP range: 81–102 mmHg).

PD's basal infusion rate, as depicted in Figure 2, was decreased from 24 mcg/hr to 12 mcg/hr (0.1 mcg/kg/hr) at the end of Day 1, per protocol.^{12,13} The continuous dexmedetomidine infusion remained at this rate for the duration of PD's enrollment in the

study. The continuous hydromorphone infusion was discontinued during PD's second day on the study protocol. During the study protocol, PD received nurse-administered doses of hydromorphone and midazolam as needed. PD required a total of 5.5 mg of hydromorphone and 5 mg of midazolam during 42.5 hours of being on the PST-DEX protocol.

The following morning (Day 2), PD was reassessed by research personnel, was again noted to be CAM-ICU negative, and had sufficient strength to depress the push-button of the PST-DEX infusion device, making PD eligible to remain in the study. PD rated the VAS-A as 15 mm, which was a decrease of 10 mm from the previous day. PD self-administered three bolus doses on Day 2 and required a single 1 mg dose of midazolam, which was given by nursing staff. PD was extubated at 0612 on Day 3, but from midnight to extubation, PD self-administered eight bolus doses and was denied four bolus doses before being extubated around 0600 hours, at which time PD was officially removed from the study protocol. Additional delirium and anxiety data for Day 3 was not gathered, as PD was extubated before research staff could obtain the assessments. After study completion, PD required subsequent doses of lorazepam, as well as an additional 10 bolus doses of hydromorphone within 12 hours.

All patients randomized to PST-DEX were approached by research staff to complete an investigator-developed Post-PST-DEX Satisfaction Survey with three Likert-scale questions that assessed their ability to self-administer the medication, ability to control anxiety, and level of relaxation experienced during the protocol. Patients could add free-form comments to each question. PD was able to verbally complete the Post-PST-DEX Satisfaction Survey on Day 3 at 1130 hours. At the time, PD's continuous hydromorphone infusion had been restarted. PD was sitting in a chair and PD's husband was present in the room. Research staff wrote PD's survey responses verbatim on the Post-PST-DEX Satisfaction Survey form. PD rated her ability to self-administer the medication for relaxation, ability to control anxiety, and level of relaxation experienced during the PST-DEX protocol all as "very satisfied" and provided the following comments: "Absolutely nothing negative," "worked great," "could finally concentrate on my breathing," "relaxed enough that I could take a nap," and "such a shame they take it away when you are extubated."

Discussion

Patient self-administered sedative therapy with dexmedetomidine is a feasible, safe, and acceptable method of sedative delivery for a select group of mechanically ventilated patients.¹² This exemplar case of PD's experience with an experimental protocol provides support for the use of PST-DEX for individual patients with a high likelihood to benefit from this innovative sedation self-management strategy. Dexmedetomidine allowed the patient to be interactive yet comfortable in PD's postoperative period, which advances the goal of current clinical practice guidelines.⁸ Of note, nurse-administered supplemental sedative medications were minimal over protocol enrollment. PD required less midazolam while on the PST-DEX protocol compared to pre-enrollment doses, but once the protocol concluded (after PD was extubated), subsequent doses of lorazepam had to be administered. Narcotic analgesic requirements were stable or slightly decreased while the patient was on PST-DEX, and after PST-DEX protocol concluded, PD required additional hydromorphone boluses. In

addition, PD's VAS-A scores decreased while on the protocol from 25 to 15. This suggests that a lighter level of sedation did not increase PD's analgesic medication needs.

Basic hemodynamic monitoring is essential with any administration of dexmedetomidine due to potential hypotensive and bradycardic effects from α_2 adrenoreceptor agonism. While slight fluctuations in PD's HR and MAP were noted, these values remained within the established study safety protocols both during bolus infusion and the initiation of continuous infusion and neither of these hemodynamic changes were clinically significant and did not require intervention. This clinical trial excluded patients with hemodynamic instability, and this protocol would need to be carefully considered and used with extreme caution for patients with acute hypotension and/or bradycardia.

Current clinical practice guidelines⁸ provide direction for *clinicians* surrounding sedation administration for patients receiving mechanical ventilatory support. There is no opportunity for patients themselves to participate in their own sedation management. While patient controlled analgesia has been established as an effective intervention to promote patient self-management of pain, there is a paucity of research that examines the application of this novel approach to sedative self-administration.¹⁶ In a recent study, critically ill patients were asked about their sedation preferences after extubation and their responses varied; some patients were pleased with their treatment while others desired either more or less sedation.¹⁷ The heterogeneity of their responses demonstrates the importance of considering the individual patient's perception of their sedation needs throughout their critical illness trajectory.¹⁶ In this case exemplar, PD self-administered more sedative medication during both overnight periods. Of note, PD attempted a number of bolus doses in response to an acute episode of agitation in the overnight hours prior to extubation. PST-DEX helped this patient to manage acute anxiety, and it took the place of the basal sedation that was being administered prior to study enrollment. Rather than waiting for a clinician to administer sedative medication for elevated acute anxiety, PST-DEX offered this mechanically ventilated patient control in being able to self-administer a bolus dose without delay. Lastly, PD vividly recalled her PST-DEX experience post-extubation and rated this method of sedative delivery positively.

Summary

Dexmedetomidine shows promise as a drug choice for self-administered sedative therapy in select mechanically ventilated ICU patients.^{10,13} In this patient, PST-DEX was very well tolerated, providing relaxation and comfort, which resulted in positive remarks from the patient. The clinical course of this patient suggests that PST-DEX helped manage individually perceived anxiety in order to remain alert, realizing the goal of early extubation and postsurgical recovery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Total dose of concomitant intravenous sedative and opioid medications per 4 hours blocks during study enrollment.

Please note: After the patient was intubated (three days prior to enrollment), intravenous midazolam was initiated at 2 mg per hour and maintained at that rate for 40 hours. This rate was decreased to 0.5 mg per approximately 24 hours until the time of study enrollment.

Figure 2.

Total dexmedetomidine received by hour (in mcg/kg/hr) while on study protocol.

Table 1

Inclusion and exclusion criteria for randomized pilot trial

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Age 18 • Intubated for respiratory failure • Expected to require mechanical ventilation for at least an additional 48 hours • Ability to depress PST-DEX button (ie, adequate hand strength) • No indication of delirium as assessed by the CAM-ICU (Confusion Assessment Method for the Intensive Care Unit) 	<ul style="list-style-type: none"> • Aggressive ventilatory support (eg, end expiratory pressure > 15 cm of water, prone ventilation, use of high-frequency oscillator ventilator) • Hypotension requiring vasopressors (systolic blood pressure < 85 mmHg), second or third degree heart block, or bradycardia (heart rate < 50 beats/min.) • Permanent condition preventing the use of push button device (eg, paralysis) • Pregnancy or lactation • Acute hepatitis or liver failure • General anesthesia 24 hours prior • Acute stroke or uncontrolled seizures • Acute myocardial infarction • Severe cognition or communication problems (eg, coma as main reason for intubation, deafness without signing literacy, dementia, or severe delirium)

Table 2

PD's ICU admission Illness Severity (APACHE III) details

APACHE III score: 104	
ICU Admission Vital Signs	
Heart Rate: 129 beats per minute	
Blood Pressure: 60/49 mmHg	
MAP: 54 mmHg	
Temperature: 35.7°C	
Respiratory Rate (prior to intubation): 40 breaths per minute	
ICU Admission Assessments	
Urine Output: 575 mL in previous 24 hours	
Mental Status: confused but obeys commands	
ICU Admission Labs	
Hematocrit: 20.6%	Bilirubin: 4.6 mg/dL
White Blood Cell Count: $41.7 \times 10^9/L$	Glucose: 172 mg/dL
Serum Creatinine: 2.26 mg/dL	Acid-Base Status
Blood Urea Nitrogen: 91 mg/dL	pH: 7.22
Sodium: 133 mmol/L	pCO ₂ : 37 mmHg
Albumin: 2 g/dL	pO ₂ : 154 mmHg

APACHE III, Acute Physiology and Chronic Health Evaluation III; ICU, intensive care unit; MAP, mean arterial pressure; pCO₂, partial pressure of carbon dioxide; pO₂, partial pressure of oxygen