Clinical decision support recommending ventilator settings during noninvasive ventilation

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Abstract

NIV therapy is used to provide positive pressure ventilation for patients. There are protocols describing what ventilator settings to use to initialize NIV; however, the guidelines for titrating ventilator settings are less specific. We developed an advisory system to recommend NIV ventilator setting titration and recorded respiratory therapist agreement rates at the bedside. We developed an algorithm (NIV advisor) to recommend when to change the non-invasive ventilator settings of IPAP, EPAP, and FiO₂ based on patient respiratory parameters. The algorithm utilized a multi-target approach; oxygenation, ventilation, and patient effort. The NIV advisor recommended ventilator settings to move the patient's respiratory parameters in a preferred target range. We implemented a pilot study evaluating the usability of the NIV advisor on 10 patients receiving critical care with non-invasive ventilation (NIV). Respiratory therapists were asked their agreement on recommendations from the NIV advisor at the patient's bedside. Bedside respiratory therapists agreed with 91% of the ventilator setting recommendations from the NIV advisor. The POB and VT values were the respiratory parameters that were most often out of the preferred target range. The IPAP ventilator setting was the setting most often considered in need of changing by the NIV advisor. The respiratory therapists agreed with the majority of the recommendations from the NIV advisor. We consider the IPAP recommendations informative in providing the respiratory therapist assistance in targeting preferred POB and Vt values, as these values were frequently out of the target ranges. This pilot implementation was unable to produce the results required to determine the value of the EPAP recommendations. The FiO₂ recommendations from the NIV advisor were treated as ancillary information behind the IPAP recommendations.

Keywords Patient-ventilator asynchrony · Non-invasive ventilation · Clinical decision support · BIPAP

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1 Introduction

Objective titration of ventilator settings during invasive mechanical ventilation has previously been developed to provide safety, comfort and liberation assistance [1]. The titration of ventilator settings has been applied via open or closed loop systems, either relying on clinicians or models to predict patient needs [1]. These automated ventilator setting titration systems are in various stages; development [2], validation [3, 4], or established commercialized products [5–7], but all have been developed and tested during intubated mechanical ventilation. While similar to intubated mechanical ventilation, non-invasive ventilation (NIV) has unique attributes and constraints that require different rule sets and limits.

Non-invasive ventilation is frequently used in a hospital critical care setting for patients with various etiologies. [8] Standardization of NIV clinical protocols generated by hospitals and units typically involve the use and reference of the national respiratory society guidelines for treating patients with acute respiratory failure [9, 10]. These guidelines have facilitated researchers to define protocolized care during the NIV initiation process [11, 12]; however, protocolized care for the titration of NIV settings yet remains subjective.

We have previously developed ventilator setting titration system that advises ventilator pressure settings based on non-invasive estimations of patient effort [13, 14]; and additionally, an oxygenation settings advisor both tooled for intubated mechanical ventilation [15]. Since leaked airflow during NIV is prevalent, flow, volume, and pressure measurements are less precise [16]. Leak correction algorithms can estimate the actual flow and have proven sufficient for flow data processing algorithms to remain accurate [17].

An advisory system simultaneously targeting oxygenation, ventilation, and patient effort during NIV has yet to be developed. We postulated patients have the same needs during NIV as during intubated mechanical ventilation. We developed an advisor recommending NIV ventilator setting changes based on the oxygenation, ventilation, and patient effort strategy tailored for NIV use.

We hypothesized respiratory therapists would agree with the recommendations from the NIV advisor when evaluating a patient at their bedside. To test this hypothesis we performed a prospective clinical study of respiratory therapists providing critical care for 10 patients receiving NIV therapy determining if the respiratory therapist agreed with the recommendation from the advisor.

2 Methods

2.1 Clinical decision support system

The NIV advisor recommends inspiratory positive airway pressure (IPAP), expiratory positive airway pressure (EPAP), and the fraction of inspired oxygen (FiO_2) settings on a dedicated NIV ventilator. The NIV advisor rules are based on the clinical decision support systems developed for intubated ventilation with NIV therapy modifications and leak correction factors for use in an NIV setting [13, 15, 17]. The NIV advisor operates to deliver care in three areas; provide adequate oxygenation into the patient, provide safe ventilation for the patient, and provide appropriate relief to the respiratory muscles. Required inputs to operate the NIV advisor are the ventilator settings, the oxygen saturation, and the patient airway pressure and flow waveforms to calculate power of breathing per minute (POB), tidal volume per kilogram ideal body weight (V_T per kg), minute ventilation (MV), leak flow, and estimated intrinsic positive end expiratory pressure (PEEPi). The V_t per kg and mv were calculated using leak correction modifications on the flow measured proximal to the face-mask. With the same leak corrected flow, we estimated the patient's POB by using a neural network validated for use during NIV in the presence of leaks [17, 18]. The PEEPi was estimated using a modification of the time-constant method [19].

The NIV advisor gives recommendations for managing ventilation and oxygenation support by attempting to have the patient achieve a preferred target range for MV, POB, V_T per kg, and SpO_2 . The preferred ranges targeted by the NIV advisor are: MV 5–15 L/min, POB 5–10 J/min, V_T per kg 5–8 mL/kg, and SpO_2 88–95%. When these parameters are out of range, changes to the appropriate ventilator settings are recommended. Additionally, the NIV advisor has caution ranges when the parameters deviate far from the preferred target ranges. The default caution ranges are listed in the legend of Table 1. Both ranges, the preferred target and caution, can be modified by the respiratory therapist for patient individualization.

The ventilation support aspect of the NIV advisor is a modification of a ventilation advisor [13]. The NIV advisor makes ventilation recommendations on how to titrate the NIV IPAP setting. To make such recommendations a rule-based system is used with inputs of V_T per kg, POB, and MV.

The oxygenation support aspect of the advisor is a modification of a clinical decision support tool we call the Oxygenation Advisor [15]. The Oxygenation advisor is a clinical decision support tool to be used during invasive ventilation to make recommendations to the clinician on

how to titrate positive end expiratory pressure (PEEP) and FiO_2 . To make such recommendations a rule-based system is used with inputs of non-invasive mean arterial blood pressure (MAP), PEEP, FiO_2 , SpO_2 , and non-invasive estimations of plateau pressure (P_{plt}). The Oxygenation Advisor required modification for application from intubated ventilation to NIV. The inputs into the NIV oxygenation advisor are estimated PEEPi, EPAP, and FiO_2 . The goal of the oxygenation facet of the NIV advisor is to get SpO_2 in the target range while not creating PEEPi as well as not exceeding safe EPAP and FiO_2 bounds. The specific ventilator adjustments for the EPAP and FiO_2 settings, as well as the IPAP setting, are defined in the online supplemental material—ventilator setting changes.

The NIV advisor has four distinct sequential operations to generate the ventilator recommendations, outlined here and described in detail in the online supplemental material. (1) The NIV advisor evaluates the leak flow and asynchrony of the patient to determine if changing the settings are appropriate. If the leak or asynchrony are classified ‘high’, then the NIV advisor recommends to the respiratory therapist to resolve the immediate problem. High leak was defined as a leak measured by the NIV ventilator being greater than 40 L/min. High asynchrony was determined by an NIV asynchrony algorithm indicating when the patient has difficulty breathing with the ventilator. (2) The NIV advisor determines the recommended EPAP setting change by evaluating the PEEPi and the oxygenation saturation. The EPAP setting is titrated to ensure adequate oxygenation increasing the EPAP setting as needed. The preferred clinical range of the oxygen saturation is 88–95%. (3) The NIV advisor determines the recommended IPAP setting change with priority given to the tidal volume and minute ventilation over the power of breathing. This is done by comparing the tidal volume, minute ventilation, and power of breathing with the preferred clinical range. The preferred clinical range for tidal volume per kilogram is 5–8 mL/kg, minute ventilation is 5–15 L/min, and power of breathing per minute is 5–10 J/min. (4) The NIV advisor determines the recommended FiO_2 setting. The FiO_2 setting is titrated to ensure adequate oxygenation to the preferred oxygen saturation clinical range, which is 88–95%. The NIV advisor was not allowed to recommend IPAP > 20 cmH₂O, EPAP > 10 cmH₂O, or FiO_2 > 0.60. The NIV advisor was embedded in a computer laptop for real time operation.

2.2 Data collection

With IRB approval from the University of Florida, the NIV advisor was tested on 10 patients receiving NIV therapy at the Surgical Intensive Care Unit of UFHealth, Shands, Gainesville FL. The laptop with the embedded

NIV advisory system program was connected to the NIV ventilator (V60 Philips, Respironics), a respiratory monitor (NM3 Philips, Respironics), and a physiological monitor (Intellivue, Philips Respironics). At periodic intervals (15 min) a study investigator referred to the advisory system to evaluate its recommendation. Upon receiving the IPAP, EPAP, and FiO_2 setting recommendation the respiratory therapist was queried for their agreement with the recommendation. Any reason for disagreement with the recommended NIV setting was recorded.

Inclusion criteria for the study required all patients to be 19–89 years of age, females non-pregnant, and hemodynamic stability while receiving NIV in a critical care setting.

The respiratory therapist agreement was determined by their rate of agreement with the NIV advisor. The respiratory therapist received three recommendations simultaneously from the NIV advisor; IPAP, EPAP, and FiO_2 .

Interpreting the recommendations was categorized into three categories, additionally the respiratory therapists’ response was categorized into three categories. The recommendation itself could be valid, invalid, or irrelevant. If the ventilator setting was outside the range recommended by the NIV advisor, then the recommendation was considered invalid. The recommendation was considered irrelevant if the NIV advisor recommended a ventilator setting below the unit’s minimum ventilator setting thresholds. The respiratory therapist could agree, disagree, or ignore each of the three recommendations. We defined the recommendation to be ignored if the respiratory therapist agreed with (or wouldn’t disagree with) the recommendation but did not change the setting because they prioritized a different recommendation. The ‘agree’ classification was defined as the respiratory therapist thought the ventilator setting change would benefit the patient. Finally, the ‘disagree’ classification was defined as the respiratory therapist thought the ventilator setting change would not benefit the patient. As this was a pilot implementation no statistical or power analysis was performed.

3 Results

The average $\pm$ standard deviation for age, height, and weight for the patient population was considered normally distributed and respectively was 64 ± 17 years old, 170 ± 10 cm tall, and 86 ± 38 kg. The gender distribution was 6 females and 4 males. The patient diagnoses were chronic obstructive pulmonary disease = 4, congestive heart failure and pulmonary edema = 3, and hypoxemic respiratory failure = 3.

Table 1 Ventilator setting recommendations and agreement

Patient #	Respiratory parameters						Ventilator settings								
	POB	V _T	MV	F	SpO ₂	Leak	IPAP Current-new -agree			EPAP Current-new -agree			FiO ₂ Current-new -agree		
1 COPD	3.8	7.9	10	32	97	1	8	6	A	5	5	A	0.3	0.3	A
	12	6.8	10	22	98	3	6	8	D	5	5	A	0.3	0.3	A
	11	8.3	14	29	98	1	6	6	A	5	5	A	0.3	0.3	A
	7	8.9	14	31	98	1	6	6	A	5	5	A	0.3	0.3	A
2 COPD	8	10.7	11	21	99	2	10	8	A	5	5	A	0.3	0.3	A
	7.2	9.4	10.3	52	98	7	8	6	A	4	4	A	0.3	0.3	A
3 HRF	10	16	18	21	97	15	15	11	A	5	5	A	0.4	0.3	IR
	11	14	16	21	97	14	11	7	A	5	5	A	0.4	0.3	IR
	8	12	12	17	99	5	7	5	A	5	5	A	0.4	0.3	IR
4 COPD	1.8	5.3	5.5	28	97	0	20	18	D	5	5	A	0.6	0.5	IG
5 CHF	4	11.5	11	17	97	4	18	16	A	5	5	A	0.4	0.3	IR
	3	9.5	9	19	97	1	16	12	A	5	5	A	0.4	0.3	IR
	1	10.2	9.6	18	97	1	16	12	A	5	5	A	0.4	0.3	IR
	4.7	10.5	9.7	16	97	1	12	8	A	5	5	A	0.4	0.3	IR
	2.9	9.5	8.8	16	97	0	10	6	A	5	5	A	0.4	0.3	IR
	2.1	7.5	7.9	18	97	0	8	4	A	5	5	A	0.4	0.3	IR
	2.2	15.4	12.4	16	97	0	8	4	A	8	6	A	0.4	0.3	IR
6 HRF	1	7.5	13.5	32	96	34	12	10	A	10	10	A	1.0	0.6	IN
	1	7.9	13	30	95	34	12	10	A	10	10	A	1.0	0.6	IN
	1	8.9	16	25	84	36	12	10	A	12	10	IN	1.0	0.6	IN
7 COPD	4.1	9.7	11.3	20	100	44	15	11	IG	10	10	A	0.8	0.6	A
	5.3	11.1	13	18	95	35	15	11	IG	10	10	A	0.6	0.6	A
	6.4	9.9	12.3	24	88	41	15	11	IG	10	10	A	0.4	0.6	A
8 HRF	1	10.9	9	18	99	15	15	11	A	5	5	A	0.6	0.5	A
	1	9.9	12	25	97	17	12	8	A	5	5	A	0.4	0.3	IR
	4	11	9	22	98	13	10	6	A	5	5	A	0.4	0.3	IR
	7.8	10	12	27	99	12	10	6	D	5	5	A	0.4	0.3	IR
9 CHF, PE	2	7.6	10	28	100	0	16	14	IG	10	8	IG	0.6	0.5	A
	1	8	11	19	99	0	16	14	IG	10	8	D	0.5	0.4	IG
	1	7	6	22	100	0	16	14	A	10	8	D	0.5	0.4	A
	1	7	8	25	100	0	14	14	A	10	8	D	0.4	0.3	IR
	1	7	8	19	100	1	14	10	A	10	8	D	0.4	0.3	IR
10 HRF, PN	7.8	7.0	14	24	96	0	16	16	A	8	6	IG	0.5	0.4	A
	10.5	5.8	15.3	26	90	10	16	18	A	8	8	A	0.4	0.4	A
	10.3	5.7	13.4	21	96	0	16	18	IG	8	6	A	0.4	0.3	IR

Respiratory parameter color scheme	Ventilator setting color scheme	
Parameter in CAUTION range	Respiratory Therapists AGREES (A) with NIV advisor Recommendation	Recommendation from the NIV advisor is INVALID (IN)
Parameter NOT IN OPTIMAL range	Respiratory Therapists DISAGREES (D) with NIV advisor Recommendation	Recommendation from the NIV advisor is IRRELEVANT (IR)
Parameter IN OPTIMAL range	Respiratory Therapists IGNORES (IG) the Recommendation from the NIV advisor	

Yellow shading indicates parameter out of optimal range, orange shading indicates parameter far out of range, gray shading indicates agreed recommendations, blue shading indicates ignored recommendation, light green indicates disagreed recommendations, and dark green indicates the parameters are beyond the advisors limits. The default target ranges for the NIV advisory system are: tidal volume per kilogram 5–8 mL/kg, minute ventilation 5–15 L/min, oxygen saturation 88–95%, and power of breathing per minute 5–10 J/min. The default caution ranges for the NIV advisory system are: tidal volume <4 or >9 mL/kg, minute ventilation <3 or >18 L/min, oxygen saturation <80%, and power of breath-

Table 1 (continued)

ing < 3 or > 12 J/min

COPD chronic obstructive pulmonary disease, *HRF* hypoxemic respiratory failure, *CHF* congestive heart failure, *PE* pulmonary edema, *PN* pneumonia, *POB* power of breathing per minute (J/min), *VT* tidal volume per kilogram (vt/kg), *MV* minute ventilation (L/min), *F* breathing frequency (min⁻¹), *SpO₂* oxygen saturation (%), *leak* leak flow in patient-ventilator circuit (L/min), Ventilator Settings Current – current ventilator setting, Ventilator Settings New – recommended ventilator setting, Ventilator Settings Agree – (A) agree/(D) disagree/(IG) ignore/(IR) irrelevant/(IN) invalid. *IPAP* inspiratory positive applied pressure, *EPAP* expiratory positive applied pressure, *FiO₂* fraction of supplied oxygen

The NIV advisor was implemented to collect 35 IPAP, 35 EPAP, and 35 FiO₂ recommendations for a total of 105 recommendations, as shown in Table 1. The respiratory therapist disagreed with 7 recommendations, 10 recommendations were ignored, 16 recommendations were irrelevant, and 68 recommendations were accepted. Further inspection of the 68 agreements indicate that 29 of the agreements occurred when a new ventilator setting was recommended, and 39 agreements occurred when the recommendation was to maintain the current ventilator setting.

Of the 75 recommendations agreed or disagreed with the agreement rate was 91% [68/75]. However, of all the valid recommendations the agreement rate was 68% [68/101] and of all the relevant recommendations there the agreement rate was 80% [68/85].

The IPAP rate of agreement between the NIV advisor recommendations and the respiratory therapist was strong; the recommendations were accepted 26 times and rejected 3 times [rate of agreement = 26/29 (90%)]. The disagreement in patient #1 was due to the elevated power of breathing value; the respiratory therapist chose to keep the IPAP setting at 6 cmH₂O which was an acceptable decision. The disagreement in patient #4 was stated as occurring because the respiratory therapist wanted to fully rest the patient even though the power of breathing was low. NIV therapy was used because they were short of breath, the NIV advisor was implemented immediately following the initiation of NIV. Consequently, the respiratory therapist wanted to provide more rest time for the patient. The disagreement in patient #8 occurred because the NIV advisor wanted to lower the tidal volume, however the respiratory therapist was not worried about a tidal volume of 10 mL/kg. Earlier that day the power of breathing and respiratory rate had risen after the IPAP setting was decreased and the respiratory therapist expected those to rise further if the IPAP setting was further decreased.

The EPAP rate of agreement between the NIV advisor recommendations and the respiratory therapist was strong; the recommendations were accepted 28 times and rejected 4 times [rate of agreement = 28/32 (88%)]. All of the EPAP disagreements were in patient #9. The NIV advisor recommended to decrease the EPAP setting because no PEEP_i was detected and the oxygen saturation was sufficiently high. Patient #9 was admitted with pulmonary

edema. The respiratory therapist had the desire to keep the EPAP setting at 10 cmH₂O and titrate therapy with the IPAP and FiO₂ settings.

The FiO₂ rate of agreement between the NIV advisor recommendations and the respiratory therapist was strong; the recommendations were accepted 14 times and rejected 0 times [rate of agreement = 14/14 (100%)]. The FiO₂ recommendations were not appropriate for patient #6 because the settings were out of the limits of the NIV advisor. This patient required high level respiratory therapist care and was later intubated to improve oxygenation. The algorithm was programmed to continue decreasing the FiO₂ to 30% however the respiratory therapists caring for the patients in the study stopped weaning FiO₂ at 40%.

During implementation of the NIV advisor the POB, Vt, and SpO₂ values were frequently out of the preferred target ranges. In our study, each data point acquired included at least one input (POB, Vt, MV, and SpO₂) that was out of the preferred target ranges. On average 2.3 of the 4 inputs were out of the preferred target range. When out of the preferred target range the POB value trended to be below the target range, while the VT, MV, and FiO₂ values trended to be above the target range. The recommendation from 35 implementations of the NIV advisor was to not change any settings 3 times, change one setting 5 times, change two settings 21 times, and change all three settings 6 times. When the NIV advisor recommendation suggested changing multiple ventilator settings at once the respiratory therapist usually prioritized the one ventilator setting they deemed most critical.

4 Discussion

It appears that the advisor was well received by the bedside respiratory therapist to titrate IPAP, EPAP, and FiO₂ ventilator settings. The 91% agreement rate is similar to the agreement rate reported for other clinical decision support systems [3, 7], including commercially available clinical decision support systems [5]. We report a discrepancy in the agreement rate because we observed an overall agreement rate of 68%; however, we expect an agreement rate of 91% is more accurate. The higher agreement rate is calculated by removing the irrelevant and invalid recommendations and can be achieved with modifications to the study protocol.

The modifications will prioritize the respiratory therapists' targets and have individualized patient thresholds.

We classified the responses to the NIV advisor recommendations as agree, disagree, and ignore. From the study results we are unable to determine the true meaning of the ignore recommendations. We interpret the ignored recommendations not as recommendations that were incorrect, but rather as recommendations that were secondary priorities and will be addressed in the future. We also classified the recommendations as valid, invalid, and irrelevant. We interpret the recommendations that were invalid and irrelevant could have been valid if the protocol implementing the NIV advisor was modified.

We deem the IPAP recommendations from the NIV advisor acceptable and informative. Based on the results the rate of agreement was not perfect, there were three recommendations that were not accepted by the respiratory therapist. While most of the recommendations were accepted it was not perfectly accepted and should not be considered absolute. The first IPAP disagreement occurred because the patient was in a state of transition when the NIV advisor was initiated and the respiratory therapist wanted to wait until the patient more fully stabilized in their response to the ventilator. As seen in the table the patient did more fully stabilize confirming the observation of the respiratory therapist. The second IPAP disagreement occurred when the respiratory therapist re-intubated the patient due to poor blood gas lab results. The third IPAP disagreement occurred when the V_T was too high, and the POB was in the preferred range. The respiratory therapist ignored the suggestion to reduce IPAP to lower tidal volume, which may be an example of the respiratory therapist making a judgement call based on their perception of the situation which doesn't seem to match the data obtained from the system. We assert the IPAP recommendations are informative because of the high frequency that the POB and VT are out of the preferred range. We presume the POB and VT were frequently out of the preferred target range because of the leak prone environment, the V_t represented in mL, and the lack of a POB calculation; which creates a scenario where the respiratory therapist is inadequately equipped to accurately set the IPAP setting to achieve the target POB and VT range.

We are less certain how to classify the EPAP recommendations of the NIV advisor from the results of this pilot implementation. For 28 of the 35 EPAP setting recommendations the respiratory therapist agreed with the NIV advisor recommendation. There were eight recommendations to change the EPAP setting; 2 were agreed with, 2 were ignored, and 4 were disagreed with. The disagreement with EPAP recommendations occurred for the same purpose each time; to avoid the use of oxygen in high concentrations (hyperoxia) the NIV advisor targets an SpO_2 value of 95%

or less [20]. While the rate of agreement was high, only two of the accepted recommendations were to change the EPAP setting. This causes us to question if the EPAP setting should have the PaO_2/FiO_2 ratio as an alternative basis for EPAP recommendations. The respiratory therapist reportedly used the EPAP setting of 10 cmH₂O when there was a concern for oxygenation and PEEPi and used 5 otherwise.

We deem the FiO_2 recommendations from the NIV advisor acceptable but secondary. The FiO_2 recommendation is considered acceptable because there are not disagreements recorded for the FiO_2 recommendations. In several instances the recommendations to change from 0.4 to 0.3 were ignored, but this was based on the personal preference of the respiratory therapist. The hospital unit's protocol for respiratory therapists that used the NIV advisor during this implementation study states that an FIO_2 ratio of 0.4 can be considered a minimum ventilator setting for FIO_2 . While there was a low rate of disagreement, the respiratory therapist typically postponed changing the FiO_2 setting to first change the IPAP setting. The low rate of disagreement with the FiO_2 recommendations might have occurred because the respiratory therapist wanted to prioritize IPAP over FiO_2 ventilator setting changes or the SpO_2 value might not have been out of the target range. While SpO_2 values greater than 95 might lead to detrimental outcomes [20] this might only be a problem during intubated ventilation and not NIV.

The target ranges for the NIV advisor can be changed by the respiratory therapist during operation at the patient's bedside. For this study none of the respiratory therapists changed the target ranges.

There are several limitations to this study. This study makes recommendations based on real-time calculations of POB, V_t per kg, MV, SpO_2 , leak flow, and PEEPi. Leak compensation techniques were used to correct and more accurately assess the parameters but may not be perfect. When large leaks were found that were likely to overwhelm the leak compensation algorithm, the NIV advisor recommends first to reduce the leaks before any other recommendations are given. Our study is limited in our interpretation of the results because this pilot implementation did not measure the potential clinical impact of following the recommendations. While the results indicate positive acceptance of the recommendations, they are inadequate to draw conclusions on the clinical impact recommendations can have. Another limitation to this study is that it is a single site implementation. This single site implementation might cause issues such as: the hospital NIV protocol might deviate from other hospital NIV protocols and the NIV population might not be as is typically seen in other hospital NIV populations.

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regularly and collectively to advance the project from start to finish; searched the literature, designed the study, analyzed the data, assisted in preparing the manuscript, and extensively reviewed the manuscript. RP, PE, and PS collected data and added clinical input while reviewing the manuscript. NE and CT analyzed data and performed the statistical analysis.

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Compliance with ethical standards

Conflict of interest NE is an employee/owner of Convergent Engineering, but has no vested interest related to this work. The authors state no conflict of interest in the research presented in this manuscript. The authors have not and do not anticipate receiving additional salaries or compensations for their contribution with this project.

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