Identifying Changes in Ventilation Leading to Oxygen Desaturation during Procedural Sedation

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Introduction

Nurse administered moderate sedation of patients undergoing colonoscopy is commonly used in the United States as it increases the patient's comfort and tolerance of the procedure. Moderate sedation is defined as a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either issued alone or accompanied by light tactile stimulation.

Despite the presence of trained personnel who observe recommendations to monitor the adequacy of pulmonary ventilation and respiratory rate (RR), at least one episode of hypoxemia (oxygen saturation ≤ 90%) occurs in 44-70% of patients depending on the level of sedation, patient population, and type of endoscopic procedure.[1] Qadeer et al. [1] found that 35% of hypoxemic events during procedural sedation for endoscopy were not preceded by apnea or changes from baseline in RR or end-tidal CO2. We analyzed data collected from patients undergoing moderate sedation for colonoscopies to learn whether hypoxemic events could be explained by previous changes in RR, reduced tidal volume (Vt), or both.

Methods

After obtaining consent from 160 patients undergoing procedural sedation for colonoscopy, we recorded RR, Vt, and SpO2 using the NM3 (Philips Medical, Wallingford, CT) and respiratory inductance plethysmography belts (Braebon Medical, Ogdensburg, NY). Sedation was administered as an initial 50 mcg intravenous bolus of fentanyl, followed by 10-80 mg boluses of propofol, dosed according to clinical judgment. Caregiving clinicians were blinded to the data we collected, but had full access to clinical standard of care monitors. All patients received supplemental oxygen.

During data analysis, a hypoxemic episode was defined as oxygen saturation ≤ 90%. For all identified hypoxemic episodes, we evaluated the preceding ventilation data and calculated average baseline and trough values and percent change for both RR and Vt to determine if the hypoxemia could be explained primarily by a change in RR, Vt, or both.

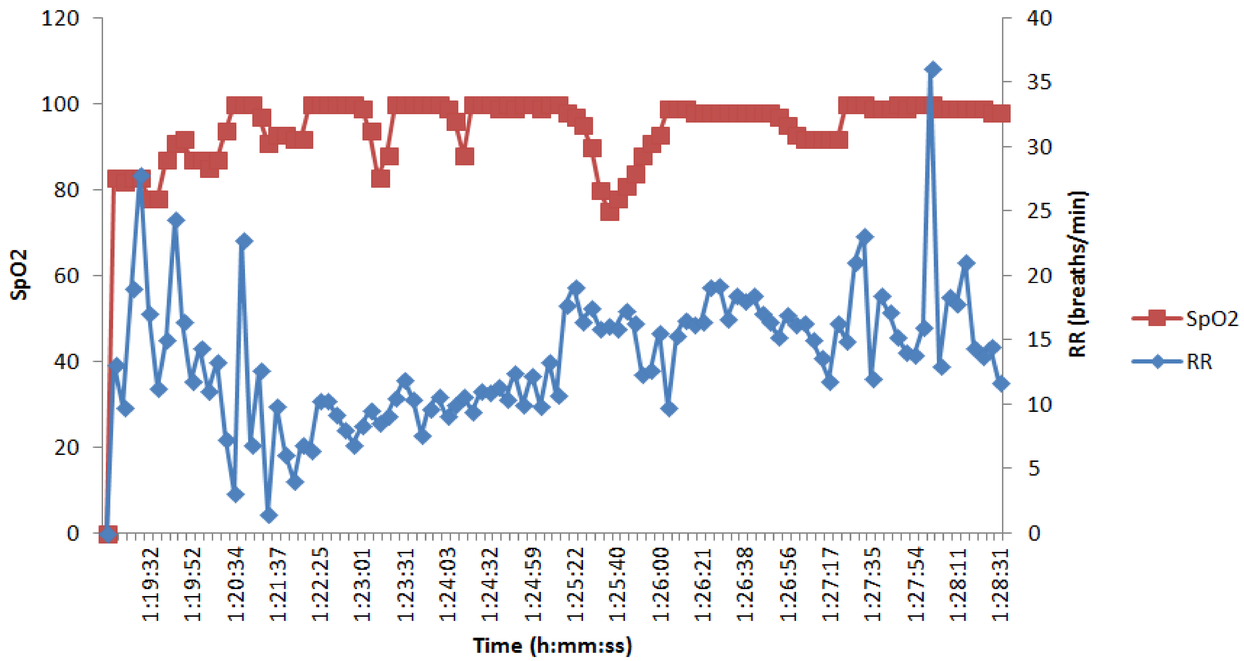

Figure 1. This is a typical patient file illustrating respiratory rate and SpO2 data vs. procedure time. The graph has been shortened to focus on the data with hypoxemic events. This patient had three oxygen desaturation events (SpO2 ≤ 90) from 1:23:14 to 1:25:30. A large drop in respiratory rate precedes the desaturations. We calculated the average high and low values for both respiratory rate and tidal volume before hypoxemic events to determine which had a greater impact on desaturations.

Results

There were a total of 40 hypoxemic episodes during the study, with 18% of patients having at least one hypoxemic event. 97.5% of hypoxemic events were preceded by at least a 10% decrease in RR and/or Vt, 87.5% of hypoxemic events were preceded by at least a 20% decrease in RR and/or Vt, and so on. The table displays the percentage of oxygen desaturation events that were predicted by different percent changes in RR and Vt.

% Change which predicts desaturation	% of desaturation events predicted		
	RR only	Vt only	Both
-10%	90%	67.5%	97.5%
-20%	70%	52.5%	87.5%
-30%	67.5%	40%	77.5%
-40%	40%	22.5%	50%
-50%	27.5%	15%	40%

Table 1. This table displays the percent of desaturation events that are predicted by different percent changes in respiratory rate, tidal volume, or both

Discussion

Nearly all of the hypoxemic episodes observed during procedural sedation were preceded by some reduction in RR or Vt. A decrease in RR precedes more desaturations than a decrease in Vt, but both RR and Vt combined give a better prediction of oxygen desaturation. Monitoring for a 10% change in RR and Vt will predict a large percent of hypoxemic episodes, but may result in many false positives. One weakness of this study is that we only analyzed the RR and Vt trends of procedures with hypoxemic events, and did not look at procedures without desaturations. Therefore, we did not calculate the percent of false positives for different percent decreases in RR and Vt. In future studies, we can calculate the percent of false positives to determine a percent change threshold to accurately predict hypoxemia.

References

1. Qadeer, Mohameed A., et al. "Capnographic monitoring of respiratory activity improves safety of sedation for endoscopic cholangiopancreatography and ultrasonography." *Gastroenterology* 136.5 (2009):1568-1576.