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Using the Integrated Pulmonary Index to Predict Extubation Failure

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Background

At any particular moment about 40 percent of all patients in the intensive care unit are breathing with the help of a mechanical ventilator.[1] Reducing the length of time patients are on mechanical ventilation decreases the risk of complications, but premature removal from mechanical ventilation can increase mortality and hospital length of stays.[2] Clinicians rely on weaning predictor indexes to identify a patient's readiness to breathe independently. The Rapid Shallow Breathing Index (RSBI) is the standard measurement used to assess a patient's readiness to extubate, but it only uses two respiratory parameters in its algorithm. A new index has recently become available that utilizes four respiratory parameters. The Integrated Pulmonary Index (IPI) utilizes
- end-tidal carbon dioxide levels
- respiratory rate
- blood oxygen saturation
- heart rate

to display a value on a scale from 1 (critical respiratory insufficiency) to 10 (optimal respiratory status), see Figure 1. By trending this number, clinicians can see early changes in the patient's respiratory status that may not be indicated by the current value of any of these four parameters individually and determine the optimal index for a successful extubation.

Purpose

Although end tidal CO2 monitoring has a well established role in detecting sedation-related respiratory depression, there is very little data assessing IPI's association with weaning or extubation outcomes in adult mechanically ventilated patients. On average 10-20% of patients fail extubation and require reintubation.[3] Having a tool that could help predict extubation outcomes in adults could help reduce these rates and prevent poor patient outcomes. The focus of this observational study was to monitor the IPI during the weaning and extubation process to determine if a specific number, or less than a specific number, was associated with extubation success.

Methods

This observational study was conducted at Providence St. Vincent Medical Center in the cardiovascular and medical intensive care units. Institutional review board approval was obtained. Study participants were connected to a stand-alone ETCO2 monitor (Figure 2) at the time of intubation or upon arrival to the ICU or CICU units if intubated. A non-invasive SPO2 sensor was placed on their finger and an ETCO2 sensor inserted in line with the ventilator circuit. The monitor continuously measured the IPI index.

IPI data points were collected five times:
- A baseline at 1 hour after intubation or upon arrival to critical café unit from operating room already intubated
- Prior to start of spontaneous breathing trial (SBT)
- Prior to extubation
- At 1 hour post extubation
- At 4 hours post extubation

IPI scores were stored on a flash drive inserted into the back of the machine and then downloaded to an Excel spreadsheet for interpretation and review.
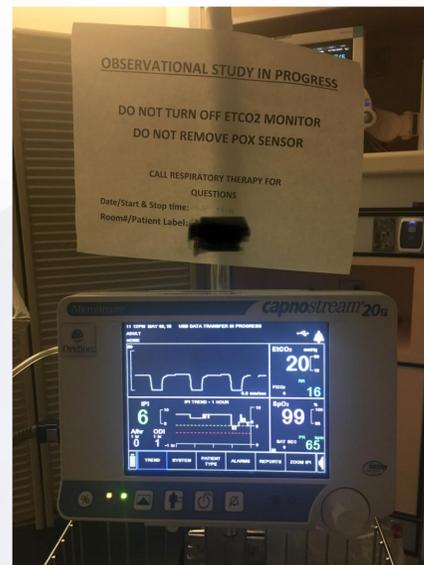

IPI	Patient Status
10	Normal
8-9	Within normal range
7	Close to normal range; requires attention
5-6	Requires attention and may require intervention
3-4	Requires intervention
1-2	Requires immediate intervention

**Figure 1.
Integrated Pulmonary Index Scale**

**Figure 2.
Monitoring Unit**

Mean IPI score data point

Successful Extubation: 8.64, 8.48, 8.56, 8.94, 9.12
Reintubation: 4, 4, 6, 6, 6

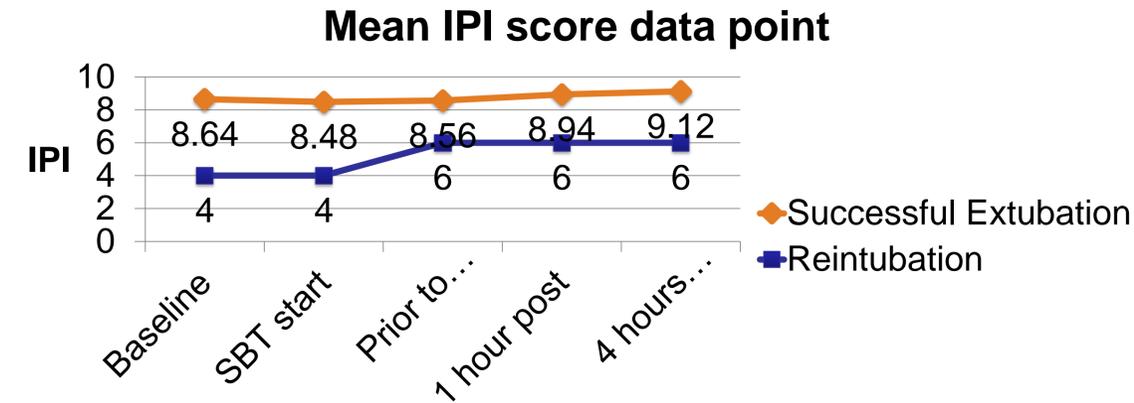Baseline, SBT start, Prior to…, 1 hour post, 4 hours…

Figure 3. Mean Integrated Pulmonary Index over Time

Results

The primary outcome measured was successful verses unsuccessful extubation. Successful extubation was defined as freedom from mechanical ventilation at 4 hrs. postextubation. The subject was considered an extubation failure if they were re-intubated and returned to mechanical ventilation within four hours after the initial discontinuation from ventilation. IPI was successfully recorded on 40 subjects. Of the 40 study participants, 39 (97.5%) were successfully extubated, and 1 (2.5%) required re-intubation, after the initial discontinuation of mechanical ventilation. Mean IPI over time for the 2 groups (extubation failure or success) is plotted in Figure 3.
IPI measurements remained relatively stable for subjects who successfully extubated 8.48 - 9.12, whereas the IPI for the patient who failed extubation was at least 2 index points lower for every data point.

Discussion/Conclusions

The study assessed the correlation between IPI values and extubation outcomes. The IPI remained relatively stable among the subjects who were successfully extubated, however it was decreased for the failed extubation. With the typical extubation failure rate being 10-20%, one "expects" 4-8 of the 40 subjects enrolled to fail extubation, but only one subject required reintubation. This is a 97.5% successful extubation rate. These results strongly support the use of continuous IPI monitoring during the weaning process for determining a patient's readiness for a successful extubation.

References

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