



## Case report

# Post operative capnostream monitoring in patients with obstructive sleep apnoea symptoms – Case series<sup>☆</sup>



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## ABSTRACT

Obstructive sleep apnoea (OSA) patients on opioid analgesic have an increased incidence of postoperative respiratory complications; prevention of these may be possible with appropriate post-operative monitoring. We recruited 4 OSA patients who had general anaesthesia for orthopaedic and septoplasty surgery. They required Patient Controlled Analgesia (PCA) or oral opioids in the post-operative period, hence continuous Saturation of Oxygen (SpO<sub>2</sub>), End Tidal Carbon dioxide (EtCO<sub>2</sub>) monitoring on Capnostream monitor with Integrated Pulmonary Index (IPI) was organized in high dependency unit. Overnight data was collected every 30 s which included pulse rate, respiratory rate, EtCO<sub>2</sub>, SpO<sub>2</sub>, and IPI. The nursing staff was also asked to document if any intervention was carried out due to altered IPI. For first two patient events occurred during various hours but there were no significant events in early night even though increased opioid use at that time. During the period of desaturation nurse intervention required to increase the O<sub>2</sub> flow in the first patient but corrected spontaneously in the second patient. IPI index improved over a period of 2 min in most of the events. The duration of desaturation did not correspond with the IPI in only once, remaining period the clinical symptoms were consistent with fall in O<sub>2</sub> saturation. The microstream capnography with IPI may provide complete respiratory status of the patient because of its comprehensive parameters on one screen. Main limitation was duration of monitoring was limited to overnight. Capnostream monitoring with IPI may have a role in patients monitoring with OSA on PCA in the postoperative ward but more trials are necessary.

## 1. Background

Incidence of obesity and its associated co-morbidities has increased in Australia (Australian Bureau of Statistics; WHO website) [1]. Its rise has also brought increasing recognition of associated obstructive sleep apnoea (OSA), which is estimated to affect up to 25% of the general population [2]. OSA patients have an increased incidence of post-operative respiratory complications, the most frequent being oxygen desaturation [3,4].

Peri-operative use of opioid analgesic medications-including Patient controlled analgesia (PCA) further increases the risk of such complications [5,6]. Prevention of these adverse events may be made possible by appropriate post-operative SpO<sub>2</sub> and EtCO<sub>2</sub> monitoring [7]. O<sub>2</sub> supplementation is required whilst on PCA. Anaesthesia Patient Safety Foundation (APSF) advices that, while on O<sub>2</sub> supplementation, ventilation should be monitored for the detection of hypoventilation [8].

Monitors display many parameters, with different alarms; it's hard to keep a track of all them in busy wards. The lack of a single parameter and its dedicated alarm to detect deterioration of respiratory status, might delay the detection of such events by the medical staff. Such delays can significantly impact on patients outcomes.

The four parameters EtCO<sub>2</sub>, SpO<sub>2</sub>, respiratory rate (RR) and Pulse Rate (PR) are integrated to give one number called Integrated Pulmonary Index (IPI). IPI has been used as a single parameter for detection of respiratory events in sedated patients undergoing colonoscopy, Post Anaesthesia Care Unit (PACU) and weaning from ventilation [9–11]. However, there is scarce literature on its benefit in OSA patients who are on PCA or oral opioids.

Our aim was to evaluate the use of new Capnostream 20 monitoring (Covidien MA USA) in our high dependency unit for detection of post-operative adverse respiratory events in a four patients who required planned post-operative High Dependency Unit (HDU) admission due to established diagnosis of OSA or OSA symptoms. We also analysed

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**Table 1**  
Showing CO<sub>2</sub> alarm limits.

| Capnography alarm limits for patients on PCA |         |
|--|---------|
| Parameter                                    | Limits  |
| EtCO <sub>2</sub> high                       | 50 mmhg |
| EtCO <sub>2</sub> low                        | 20 mmhg |
| Respiratory rate high                        | 38 bpm  |
| Respiratory rate low                         | 6 bpm   |
| No breath alarm                              | 20 s    |

PCA indicates patient controlled analgesia; EtCO<sub>2</sub>-end tidal carbon dioxide; bpm-breaths per minute

the analgesia used during the HDU admission time and their effects related to the desaturations events, end tidal CO<sub>2</sub> and IPI trends in patients.

## 2. Methods

We recruited 4 patients from recovery room who had undergone general anaesthesia and were planned admission to HDU due to either established or high risk of OSA. Normally hospital protocol for OSA patients is to provide continuous SpO<sub>2</sub> monitoring who had General Anaesthesia (GA) requiring PCA. The recovery and ward staff were given in-service on the use of the monitor. The Capnostream and IPI alarm limits were highlighted to them and also asked to record type of intervention. See Tables 1 and 2 for alarm limits.

Patients were observed in the overnight HDU step down unit & were evaluated for the use of EtCO<sub>2</sub> and IPI. For the purpose of this case report the data was collected every 30 s and included pulse rate, respiratory rate, EtCO<sub>2</sub>, SpO<sub>2</sub>, and IPI. The nursing staff was also asked to document if any intervention was carried out due to altered IPI.

The four patients were:

- Patient A: 75 year old male post right knee replacement. Patient A had severe OSA Apnoea Hypopnoea Index (AHI) 51, with minimum oximetry saturation 66% and he was receiving Continuous Positive Airway Pressure (CPAP) treatment from the respiratory medicine department with settings of 7cmH<sub>2</sub>o. Neck circumference 43 with BMI 37. Other medical co-morbidities included hypertension, type 2 Diabetes mellitus, previous Cerebro-vascular accident (CVA) and Gout. Because of chronic back pain and previous failed spinal anaesthesia, patient regional block was avoided and post-operatively patient was put on Oxycodone PCA.
- Patient B: 60 year old male post left hip replacement. Patient B had severe type OSA (AHI of 35) and he was receiving CPAP treatment from the respiratory medicine. According to the patient the CPAP settings were of 5cmH<sub>2</sub>o; though its sub therapeutic level, which has benefitted him. Neck circumference 43 and BMI 43. Other comorbidities included hypertension, type 2 Diabetes mellitus. Patient was on Fentanyl PCA.
- Patient C: 48 year old female patient who is known hypertensive and Hashimotos' thyroiditis and formerly diagnosed with OSA however sleep results were unavailable. Arterial blood gas results were

**Table 2**  
Showing the IPI alarm limits.

| 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                 |

available; showing PaO<sub>2</sub> 64mmhg, PaCO<sub>2</sub> 47 mmhg, O<sub>2</sub> saturation 90%. She self-reported CPAP was recommended and used minimally due to some issues and new CPAP was commenced. STOPBANG screen score of 4/8 scoring for items: heavy snoring, observed apneas, day time tiredness and BMI 40. She was planned for Knee arthroscopy. Post operatively due to presence of OSA and likely high opioid requirement she was booked for a high dependency unit bed post-operatively. She had brought her CPAP machine. Oxycodone as needed was administered by registered nurse for pain.

- Patient D: 44 year old male undergoing septoplasty+inferior turbinateplasty, maxillary and antrum and ethmoidectomy. This patient didn't have spirometry or sleep study but had STOPBANG score of 4/8. BMI 41, Neck circumference 40. He was a current smoker and otherwise healthy patient. In the light of clinically moderate/high risk factors for OSA and undergoing airway procedure he was booked for a high dependency unit bed postoperatively. For analgesia, Oxycodone as needed was ordered.

Then in the recovery all patients were placed with nasal sampling line (Smart Capnoline Oridion USA) and connected to Capnostream 20 monitoring (Covidien MA US). On Capnostream monitoring the duration of the monitoring were 14:53 for patient A, 14:20 for patient B, 13:45 for patient C, 13:47 for patient D. Data was exported from the monitor by USB.

In HDU nursing staff were to follow South Australia Health standard "Recognising and Responding to Clinical Deterioration Guideline" for:

1. Ascertaining the accuracy of the measurements e.g. checking adequate O<sub>2</sub>sat probe contact with skin.
2. Frequency of Measurement and documentation of observations.
3. Escalation of care e.g. notifying rapid response systems, clinical communication.

Simple interventions nursing staff were instructed to do included, ensuring accuracy of the monitor function, increasing Fio<sub>2</sub> and waking patient up and instructing them to breathe deep, and if inadequate response was observed to escalate the care.

## 3. Results

Over the aimed 12–15 h period data was recorded every 30 s. The desaturation events were correlated with fall in IPI from 10 to 1.

The Graphs 1–4 display the Capnostream-20 monitoring trends for patient A–D. There were short periods- mostly 1–5 min- of incomplete data recording for each of the patients, generally due to monitoring probes disconnection from patient, e.g. O<sub>2</sub>sat probe falling, Capnostream disconnection, etc. and the data corresponding to such events were omitted from the report.

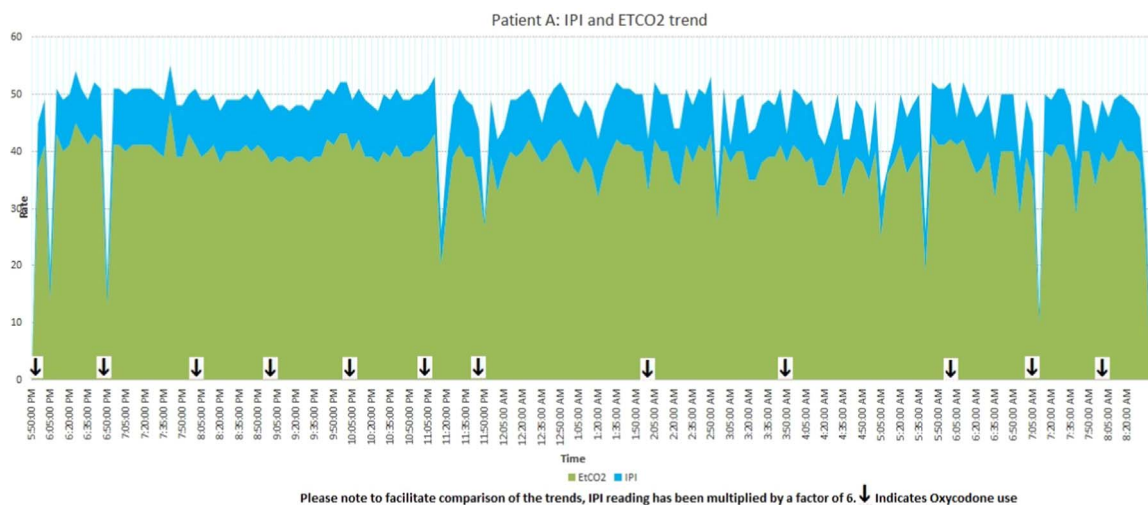
Data depicted on the graphs for each patient was shown every 5 minutely with the accepted advantage of reducing the number of data points and ease of interpretation of data and the potential disadvantage of losing some of clinically significant data points.

Data since 09:00 onwards showed IPI= > 7 without any incidents of desaturation below 90. Data between 2:00 till 3:08 were deleted due to malfunctioning of the IPI reading. The capnography also showed drop in its trends. The patients A and B were on PCA with total consumption of 19 mg of Oxycodone and 700 mcg fentanyl respectively in the post-operative period. Patients C and D were on Oxycodone on "as needed" basis and consumed 20 mg each on total. Of which 10 mg was administered in on arrival in the recovery room and 10 mg in the ward.

The episodes of IPI reading equal or less than 4 have been considered clinically significant and "requiring attention" for 3–4 and "requiring intervention" for 1–2.

Patient A: These episodes were high after 6 a.m. in this patient.

Patient B: These episodes were high during the 2 a.m. and 3 a.m.



**Graph 1.** Displaying the Capnostream-20 monitoring IPI and ETCO<sub>2</sub> trends for patient A.

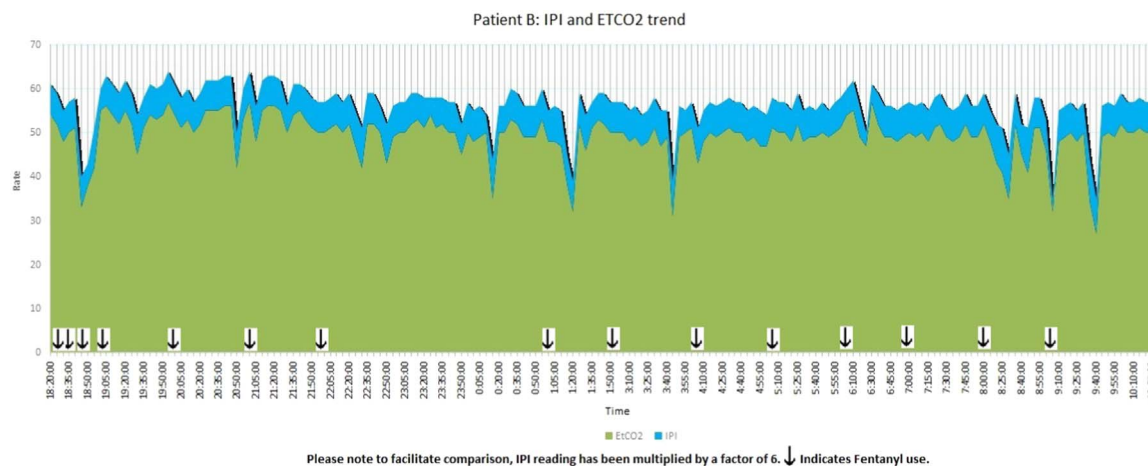
Patient C: Multiple episodes between 11 pm and 4:30 a.m.  
 Patient D: Only two episodes of low IPI during the early evening associated with low respiratory rate and low ETCO<sub>2</sub>. Overnight data can't be interpreted due to device malfunction.  
 For patient A and B events occurred during various hours for each patient but there were no significant events in early night even though increased opioid use at that time. Patients A & B were poorly compliant with CPAP use therefore they had O<sub>2</sub> delivered via nasal specs at the rate of 2 L/min. Due to nausea Patient C hadn't used CPAP. The patient D was not on CPAP and airway surgery would have precluded in using CPAP anyway. In Patient D, Post-operatively there was blood trickling from the nose and also the nasal sensor got blocked requiring replacement.

During the period of desaturation nurse intervention required to increase the O<sub>2</sub> flow in the elderly patient but corrected spontaneously in the second patient. IPI index improved over a period of 2 min in most of the events. The duration of desaturation did not correspond with the IPI in only once, remaining period the clinical symptoms were consistent with fall in O<sub>2</sub> saturation. There was satisfaction in the nursing staff in use of the monitor specially the IPI as a single parameter rather than so many numbers on the monitor. None of the four patients observed for this study, suffered from major adverse events like opioid induced respiratory depression from opioid use requiring opioid reversal.

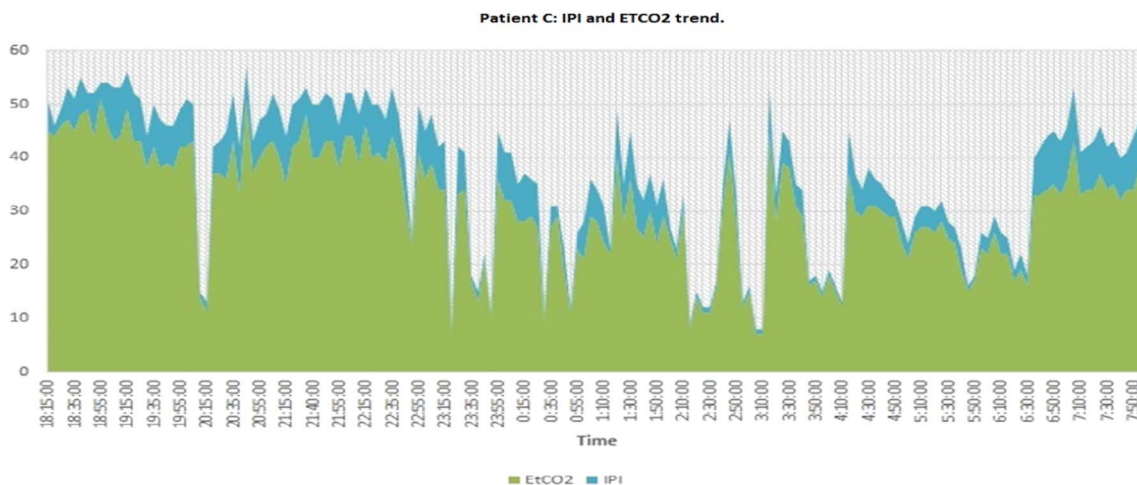
#### 4. Discussion

This case series evaluates the role of CAPNOSTREAM monitoring for postoperative detection of respiratory deterioration in patient with OSA symptoms. IPI reading generated by CAPNOSTREAM monitor was affected by the concurrent use of opioid analgesics amongst other factors. Early intervention by the nursing staff helped in preventing further progression of respiratory events. IPI was one of the single parameters nursing staff found to be easy to monitor. As IPI gets lower, they found that they might encounter an event. The time of event going to occur or already occurring remains hard to predict. One of the limitations of the study was the small sample size and based on this our opinion was IPI use needs further validation by conducting large scale studies ideally comparing its efficacy with the current standard monitoring. Other limitation was that sleep study results were not available in few patients but severity was assessed on presence of OSA symptoms in these patients. In patient D, spirometry was not available.

The overnight monitoring for adverse events might be sufficient in these cases. Gupta et al. demonstrated in their study the risk of respiratory complications were high on the day one [12]. They have shown an increased risk of postoperative complications (39% vs 18%), higher rate of transfer to ICU (24% vs 9%), and increased length of hospital stay in patients with obstructive sleep apnoea compared with control subjects matched for age, sex, and body mass index (BMI). Our case series though showed desaturation events but didn't culminate in any major adverse events reported by Gupta et al. One observation was



**Graph 2.** Displaying the Capnostream-20 monitoring IPI and ETCO<sub>2</sub> trends for patient B.



Please note to facilitate comparison of the trends, IPI reading have been multiplied by a factor of 6.

Graph 3. Displaying the Capnostream-20 monitoring IPI and EtCO<sub>2</sub> trends for patient A.

that patients on PCA had more IPI events however one of the patients who was on PRN bases had last opioid 7 h later still had significant IPI events. One thing in common is the IPI dip manifested in early hours of the morning. This occurred in first 24 h when patient had more opioid pain relief. Our observations were only for first postoperative night. We speculate its effect similar on subsequent day if patients are still on opioids. This further monitoring may be possible in orthopedics patient who may continue to have oral opioids on day 2 as well but airway surgery patient's do not require such pain relief and would consider discharge home. This is one of our limitations of the study.

Had these patients had CPAP on board, then there would be less likely of any adverse events or aggressive monitoring. It's important that those patients who were on CPAP prior to the surgery need to continue their treatment post-operatively. In the absence of CPAP effective respiratory monitoring may be necessary to prevent any fatal complications. Effective respiratory monitoring is critical to patient safety in clinical situations where hypoventilation, respiratory depression and cardio respiratory arrest are fatal complications which are preventable. Pulse oximetry monitoring may not be the adequate because O<sub>2</sub> desaturation may not occur for several minutes, when PCA patients who are on supplemental oxygen [13].

The microstream capnography with IPI may provide complete respiratory status of the patient because of its comprehensive parameters on one screen. The respiratory rate and the numerical value of EtCO<sub>2</sub>, helps us to know the adequacy of ventilation. EtCO<sub>2</sub> breath to

breath waveform indicates any respiratory condition such as hypoventilation, apnoea or airway obstruction. Respiratory rate alone as such will not provide factual information. EtCO<sub>2</sub> may be endorsed as a standard monitor especially in the patients like OSA thus preventing any adverse events.

In the postop ward the nurse and the attending physician must be able to take prompt action when IPI scores are low. In such situations there is provision to intervene in taking measures like increasing the positive pressure to attain better IPI scores. This may prevent further adverse events.

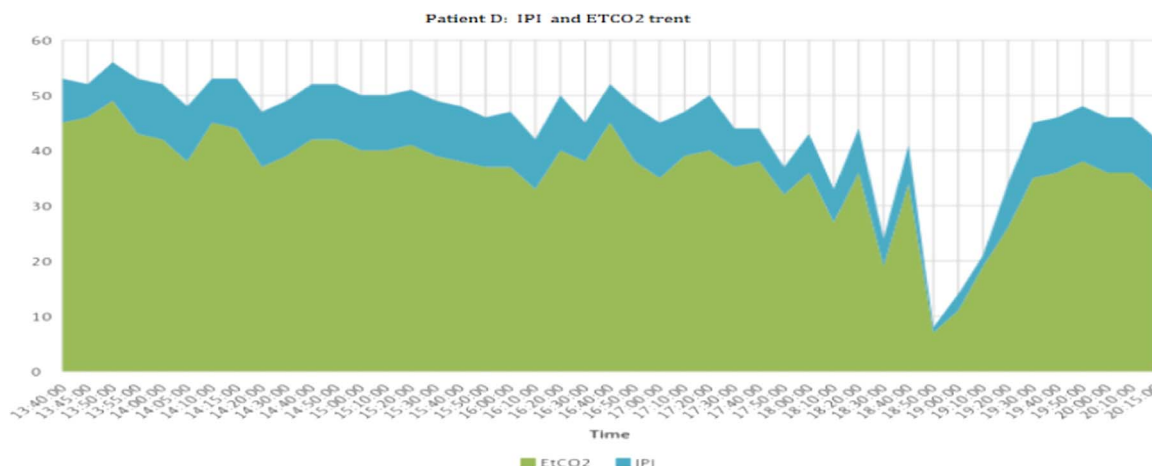
The advantage of Capnostream is that it integrates O<sub>2</sub> delivery and CO<sub>2</sub> sampling without requiring other sampling device for EtCO<sub>2</sub> or IPI. Opioid induced respiratory depression is fatal complication which can be prevented by adequate continuous electronic monitoring [14].

In future more data on EtCO<sub>2</sub> or IPI is required which can be robust in reducing false alarms without compromising patient safety.

Main limitations noted in these case analyses were: duration of monitoring was limited to overnight. And factors impacting on the accuracy of the parameters integrated in the IPI calculation e.g. errors in monitoring like malposition of oxygen saturation probe or capnogram or potential malfunction of the monitoring equipment.

### 5. Conclusion

Capnostream monitoring with IPI may have a role in patients



Please note to facilitate comparison of the trends, IPI reading has been multiplied by a factor of 6.

Graph 4. Displaying the Capnostream-20 monitoring IPI and EtCO<sub>2</sub> trends for patient D.

monitoring with established or suspected OSA in postoperative setting. It may be used as simplified respiratory status version monitoring, but more clinical trials are necessary.

### Conflict of interest

NIL.

### Financial disclosure statements

This case series is self-funded. We have no funding from any organization and have no commercial interest.

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