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# Observational Cross-Sectional Study of $ETCO_2$ and Pulse Oximetry for Early Detection of Hypoxia in MAC Patient (Monitored Anaesthesia Care)

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**Abstract**
**Background and Aim:** *The study aims to identify whether $ETCO_2$ detects early hypoxia compared to monitoring of $SpO_2$, HR and RR (Standard Monitor) in patients undergoing surgical procedure under MAC.*
**Method:** *Total 336 patients belonging to Age group of 18-60 years, ASA grade 1 and grade 2, procedure lasting for <4hrs, undergoing sedation under MAC for day care surgery. Measurements of Spo2, HR, RR, ETCO2, NIBP done by applying monitors. Nasal cannula also put for supplemental Oxygen.*
**Result:** *Overall 92 episodes of disordered ventilation were detected out of which 67 were detected by ETCO2 (44- Hypoventilation and 23- Apnoea) and 25 were detected by Pulse Oximetry (4- Hypoventilation and 21- desaturation. Overall a mean delay of 51.04 seconds was seen in detection by Pulse Oximetry.*
**Conclusion:** *In the study it was concluded that patients under sedation, underwent frequent episodes of disordered ventilation leading to hypoxia. In such scenarios it was seen that ETCO2 monitoring provided a practical advantage of detecting hypoventilation and apnea earlier than Pulse Oximetry showing desaturation.*
**Keywords:** *Capnography, ETCO2, pulse oximetry.*

## Introduction

Monitored Anaesthesia Care (MAC) involves diagnostic and therapeutic procedures done under Local Anaesthesia with sedation and analgesia.[1] Monitoring is mandatory to preserve spontaneous respiration and airway reflexes.[2]

Therefore the standard of care should include,

1. Pre-Anaesthetic Check up.
2. Intra Op Monitoring.
3. Provision of sedation and/or analgesia with anxiolysis.
4. Monitoring of the effect of above on oxygenation, ventilation, circulation and temperature.
5. Monitoring of toxicity of any agent if any in case the surgical procedure is prolonged.
6. Titration and sedation of depth of analgesia using different scales and monitors (sedation scales, spo2, ETCO2, BIS, MAC etc).

Hence the AIM of study is to compare the efficacy of various monitoring techniques in early

detection of hypoxia and thus avoid the problems by treating them for safe conduct of the said procedures.

**Material and Methods**

After obtaining approval from institutional Ethics committee and written informed consent from all the patients, this prospective observational study including 336 adult patients aged 18-40 years of patients posted for surgery was done under MAC. ASA I and II were evaluated thoroughly during pre-Anaesthetic examination. Baseline investigations were done. Written, informed consent were obtained from patients/relatives and patients were explained about the procedure, type of sedation, sedation scale, post-operative monitoring till discharge.[3]

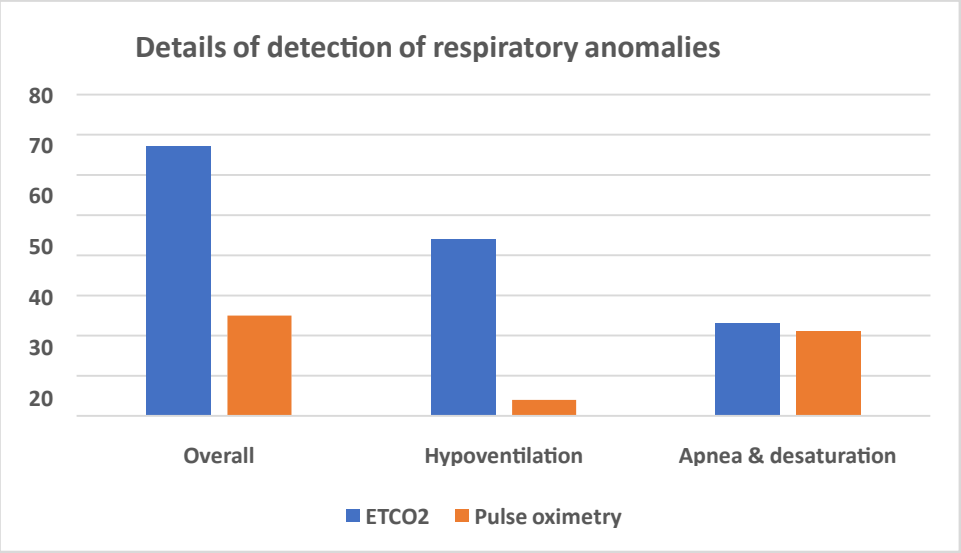
- Patients were admitted day before surgery and 6 hours of NBM prior to the procedure will be confirmed
- On arrival IV line was established.
- Baseline vital parameters were obtained by applying monitors, IV fluids 6-8 ml/ kg RL was started
- Study measurements- Spo2, HR, RR, ETCO2, NIBP using DATEX OHMEDA Patient's Monitor
- Administration of supplemental oxygen 2L/min was started by nasal cannula and readings for ETCO2 baseline were obtained.
- Monitoring and detection of episodes hypoxia or disordered ventilation by both the modalities i.e ETCO2 and pulse oximetry was done and compiled and depicted in tabular and graphic form with Statistical test applied where ever necessary.

**Results**

**Table** - Proportion of detection of episodes of hypoxia

| Method | Overall | Hypoventilation | Apnea& desaturation |
|---|---|---|---|
| $ETCO_2$ | 67 | 44 | 23 |
| Pulse oximetry | 25 | 04 | 21 |

**Graph** - Proportion of detection of episodes of hypoxia




This table and graph shows that ETCO2 detected overall 67 episodes of disordered ventilation that lead to hypoxia, out of which 44 such episodes were of hypoventilation and 23 episodes were of

apnoea. Similarly pulse oximetry detected overall 25 such episodes out of which 4 were of hypoventilation and 21 were of desaturation/apnoea.

**Table -** Comparison of time of detection (in seconds) of disordered ventilation

| Method | Mean | SD | Difference | p value |
|---|---|---|---|---|
| **$ETCO_2$** | 132.09 | 189.22 | -55.23 | 0.028* |
| **Pulse oximetry** | 187.32 | 203.84 | | |

Mann whitney test; * indicates significant difference at p≤0.05

This table depicts a comparative demonstration of time required by ETCO2 and Pulse oximetry for detection of disordered ventilation. It shows ETCO2 takes a mean duration of 132.09 (SD ± 189.22) and pulse oximetry takes a mean duration of 187.32 (203.84). This result shows that p value < 0.028 is statistically highly significant.

Mann whitney test was applied and significant p value was calculated to be p≤0.05.

The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed.

The test statistic for the Mann Whitney U Test is denoted **U** and is the ***smaller*** of $U_1$ and $U_2$, defined below.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

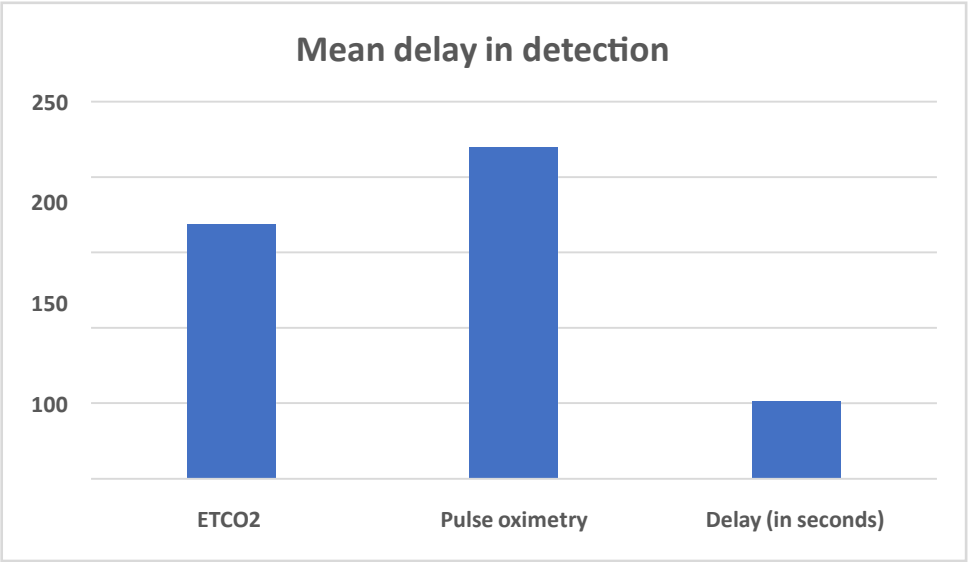
$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

where $R_1$ = sum of the ranks for group 1 and $R_2$ = sum of the ranks for group 2.

**Table -** Details of mean delay in detection

| Method | N | Mean time | SD |
|---|---|---|---|
| **$ETCO_2$** | 25 | 168.68 | 213.05 |
| **Pulse oximetry** | 25 | 219.72 | 316.64 |
| **Delay (in seconds)** | 25 | 51.04 | 186.74 |

**Graph -** Details of mean delay in detection



This table and graph depicts mean delay in detection in episodes of disordered ventilation when ETCO2 and pulse oximetry were compared. A mean delay in detection by pulse oximetry was found to be 51.04 seconds (SD ± 186.74).

**Discussion**

A comparative study was carried out between capnography and pulse oximetry for early detection of hypoxia on the basis above readings. The age group of patients taken in present study was 18-60 years.

In the study by **Heuss LT,**[4] **et al** on carbon dioxide accumulation during sedated colonoscopy: comparison of propofol and midazolam the age group taken was 49 to 75 years.

**Lam T**,et al[5] Continuous Pulse Oximetry and Capnography Monitoring for Postoperative Respiratory Depression and Adverse Events all the patients were of age > 18 years

**Khanna AK,** et al[6] Prediction of Opioid-induced respiratory Depression In patients monitored by capnography, age group taken was 44 to 72 years.

**Jay A. Anderson, DDS, MD**, et al[7] conducted a study titled "An investigation of capnography and pulse oximetry as monitors of paediatric patients sedated for dental treatment". The mean age group taken was 2 years 10 months.

The results obtained from the present study was in congruence with the above studies. Thus an inference can be drawn from the present study and related past studies that the monitoring technique can be extrapolated to varied age groups. Age may not have a significant impact on the outcome.

In the present study out of 336 patients out of which 235 were female and 101 were male. A greater predisposition was found towards female gender on account of majority cases being from Gynaecology and Obstetrics procedures. Cases were included sequentially hence it was seen that more number of MAC cases were conducted in Gynaecology OT.

In related studies no significant specifications about gender was shown.

Before the commencement of procedure patients were given sedation and a constant monitoring was done keeping a scrutiny on respiratory pattern of the patients. Any sign of disordered ventilation as and when detected by Capnography and Pulse oximetry along with the mean duration was taken note of.

As a consequence of above, Tables showing parameters of ETCOT, spo2 and Respiratory Rate were obtained.

Similar results as above were observed in study conducted by **G. Cacho1**, et al[8] titled "Capnography is superior to pulse oximetry for the detection of respiratory depression during colonoscopy"

This study aimed at examining the advantages of capnography over pulse oximetry monitoring during sedated colonoscopies. 50 patients undergoing colonoscopy were simultaneously monitored with pulse oximetry and capnography by using two different devices in each patient. Several sedation regimens were administered. Episodes of apnea or hypoventilation detected by capnography were compared with the occurrence of hypoxemia. Twenty-nine episodes of disordered respiration occurred in 16 patients (mean duration 54.4 seconds). Only 38% of apnea or hypoventilation episodes were detected by pulse oximetry. A mean delay of 38.6 seconds was observed in the events detected by pulse oximetry (two episodes of disturbed ventilation were simultaneously detected by capnography and pulse oximetry). From the above study it was concluded that apnea or hypoventilation commonly occurs during colonoscopy with sedation. Capnography is more reliable than pulse oximetry in early detection of respiratory depression in this scenario.

While in the present study overall 92 episodes of disordered ventilation were detected out of which 67 were detected by ETCO2 (44- Hypoventilation and 23- Apnoea) and 25 were detected by Pulse Oximetry (4- Hypoventilation and 21-

desaturation). Overall a mean delay of 51.04 seconds was seen in detection by Pulse Oximetry.

In another study conducted by **Jay A. Anderson, DDS, MD**, et al[7] titled "An investigation of capnography and pulse oximetry as monitors of paediatric patients sedated for dental treatment"

This study evaluated the use of capnography in conjunction with pulse oximetry for monitoring children during conscious sedation for dental treatment. 10 paediatric dental patients (mean age 2 years, 10 months) were sedated with 75 mg/kg of chloral hydrate.

There was an average of 11.8 desaturation periods per patient (range 4-23 desaturation periods). The end-tidal CO2 values ranged from 5 to 47 mm Hg for SAO2s below 96% and 5 to 45 mm Hg for normal SAO2s. However, there was a trend of decreasing respiratory rate as detected by capnography 30 and 20 sec prior to a desaturation. This study however stated that the time difference was too little to provide any practical advantage in these patients but there appeared to be a trend of decreasing respirations 30 sec prior to a desaturation.

The time difference found in present study was found significant. In addition to this the decrease in trend of respiration prior to desaturation was also noticed.

Following is a Table depicted in a systematic manner taking into considerations some relevant studies and their outcome.

**Table –** Relevant studies and their outcomes

| Sr No. | Name of observer | Means of detection of hypoxia | Results |
|---|---|---|---|
| 1) | G. Chacho, et al[8] | Pulse oximetry and capnography | Mean delay of 38.6 seconds by Pulse oximetry |
| 2) | Nahla Shaaban Khalil 2019, et al[9] | Pulse oximetry, capnography and Arterial Blood Gas Parameters | Spo2 and ETCO2 values positively correlates with paO2 and paCO2 |
| 3) | Jay A. Anderson, DDS, MD, et al[7] | Pulse oximetry and capnography | Decrease in RR detected by ETCO2 20-30 sec prior to desaturation |
| 4) | Bergese SD, et al[10] | Pulse oximetry and capnography | |
| 5) | Heuss LT, et al[4] | Pulse oximetry and capnography | Both pulse oximetry and ETCO2 showed nearly similar sensitivity |
| 6) | Vargo JJ, et al[11] | Pulse oximetry, capnography and pretracheal stethoscope | Mean duration 70 secs<br>ETCO2 before pulse oximetry |
| 7) | Lam T, et al[5] | Pulse oximetry and capnography | recognizing PORD (post op respiratory depression) was almost 6 times higher in the capnography versus the pulse oximetry group |
| 8) | Khanna, et al[6] | Pulse oximetry and capnography | No significant difference |
| 9) | Langhan ML, Ching K, et al[12] | Pulse oximetry and capnography | Mean time for detection<br>ETCO2=2.02 minutes<br>Pulse oximetry=4 minutes |
| 10) | Williams GW 2nd, George CA, et al[13] | Pulse oximetry, Capnography and Respiratory Volume Monitor (RVM) | instrument sensitivity = $\Delta EtCO2/\Delta MV = -0.71 \pm 0.11$ |

In all the above studies ETCO2 was observed to cut short the time of detection of hypoxia by its prior anticipation during the period of hypoventilation. This was apparently not the case

with pulse oximetry where maximum episodes of hypoxia were detected after hypoventilation took place. It also provides a relatively more accurate estimation of titration and regimes of sedatives to be used intra operatively comprehending the pattern of ventilation and depth of sedation. Above discussion emphasises coherently the need for Capnography as standard monitoring technique to be used along with Pulse Oximetry and not just as an adjunct to it.

**Conclusion**

The present study was undertaken to compare the efficacy of Pulse Oximetry and ETCO2 for detection of hypoxia in patients undergoing surgical procedures under Monitored Anaesthesia Care.

It was concluded that patients under sedation, underwent frequent episodes of disordered ventilation leading to hypoxia. In such scenarios it was seen that ETCO2 monitoring provided a practical advantage of detecting hypoventilation and apnea earlier than Pulse Oximetry showing desaturation.

Thus Capnography (ETCO2) can be used as an integral part of monitoring in conjunction with Pulse Oximetry in surgical procedures that are carried routinely under Monitored Anaethesia Care.

**Bibliography**


1. Das S, Ghosh S. Monitored anesthesia care: An overview. J Anaesthesiol Clin Pharmacol. 2015;31(1):27-29. doi:10.4103/0970-9185.150525.
2. Siddiqui BA, Kim PY. Anesthesia Stages. [Updated 2020 Apr 29]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557596/.
3. Holton, Jace; Flattery, Bryan, JBI Database of Systematic Reviews and Implementation Reports: December 2016 - Volume 14 - Issue 12 - p 38-47.
4. Heuss LT, Sugandha SP, Beglinger C. Carbon dioxide accumulation during analgosedated colonoscopy: comparison of propofol and midazolam. World J Gastroenterol. 2012 Oct 14;18(38):5389-96. doi: 10.3748/wjg.v18.i38.5389. PMID: 23082055; PMCID: PMC3471107.
5. Lam T, Nagappa M, Wong J, Singh M, Wong D, Chung F. Continuous Pulse Oximetry and Capnography Monitoring for Postoperative Respiratory Depression and Adverse Events: A Systematic Review and Meta-analysis. AnesthAnalg. 2017 Dec;125(6):2019-2029. doi: 10.1213/ANE.0000000000002557. PMID: 29064874.
6. Khanna AK, Bergese SD, Jungquist CR, Morimatsu H, Uezono S, Lee S, Ti LK, Urman RD, McInty; PRediction of Opioid-induced respiratory Depression In patients monitored by capnoGraphY (PRODIGY) Group Collaborators. Prediction of Opioid-Induced Respiratory Depression on Inpatient Wards Using Continuous Capnography and Oximetry: An International Prospective, Observational Trial. AnesthAnalg. 2020 Oct;131(4):1012-1024. doi: 10.1213/ANE.0000000000004788. PMID: 32925318; PMCID: PMC7467153.
7. Iwasaki J, Vann WF Jr, Dilley DC, Anderson JA. An investigation of capnography and pulse oximetry as monitors of pediatric patients sedated for dental treatment. Pediatr Dent. 1989 Jun;11(2):111-7. PMID: 2503818.
8. Cacho G, Pérez-Calle JL, Barbado A, Lledó JL, Ojea R, Fernández-Rodríguez CM. Capnography is superior to pulse oximetry for the detection of respiratory depression during colonoscopy. Rev EspEnferm Dig. 2010 Feb;102(2):86-9.

doi: 10.4321/s1130-01082010000200003. PMID: 20361844.

9. TY - JOUR AU - Khalil, Nahla AU - Fathallah, Marwa PY - 2019/05/11 SP - 1 EP - 6 T1 - Comparison of Pulse Oximetry and Capnography Monitoring with Arterial Blood Gases Parameters among Postoperative Pediatric Cardiac Surgeries at a University Hospital VL - 1 DO - 10.33552/IJNC.2019.01.000520 JO - Iris Journal of Nursing & Care ER - .
10. Bergese SD, Mestek ML, Kelley SD, McIntyre R Jr, Uribe AA, Sethi R, Watson JN, Addison PS. Multicenter Study Validating Accuracy of a Continuous Respiratory Rate Measurement Derived From Pulse Oximetry: A Comparison With Capnography. AnesthAnalg. 2017 Apr;124(4):1153-1159. doi: 10.1213/ANE.0000000000001852. PMID: 28099286; PMCID: PMC5367492.
11. Vargo JJ, Zuccaro G Jr, Dumot JA, Conwell DL, Morrow JB, Shay SS. Automated graphic assessment of respiratory activity is superior to pulse oximetry and visual assessment for the detection of early respiratory depression during therapeutic upper endoscopy. GastrointestEndosc. 2002 Jun;55(7):826-31. doi: 10.1067/mge.2002.124208. PMID: 12024135.
12. Langhan ML, Ching K, Northrup V, Alletag M, Kadia P, Santucci K, Chen L. A randomized controlled trial of capnography in the correction of simulated endotracheal tube dislodgement. AcadEmerg Med. 2011 Jun;18(6):590-6. doi: 10.1111/j.1553-2712.2011.01090.x. PMID: 21676056; PMCID: PMC3117244.
13. Williams GW 2nd, George CA, Harvey BC, Freeman JE. A Comparison of Measurements of Change in Respiratory Status in Spontaneously Breathing Volunteers by the ExSpironNoninvasive Respiratory Volume Monitor Versus the Capnostream Capnometer. AnesthAnalg. 2017 Jan;124(1):120-126. doi: 10.1213/ANE.0000000000001395. PMID: 2738498.