

# Analysis of the update delay over time for changes in the Index of Consciousness of the IoC-View monitor.

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## Abstract:

*A brain monitor of anaesthesia is used to prevent awareness and avoid overdosing of anaesthetics. The need to get the answers in the shortest time for monitoring the level of anesthesia is an important factor for determining the quality of the device during its implementation. This paper describes the study of the response time for the IoC-View anaesthesia brain monitor given different inputs in the Index of consciousness (IOC) over time.*

## Introduction

A brain monitor of anesthesia is used to prevent awareness and avoid overdosing anaesthetics. Overdosing increases recovery time for the patient<sup>1</sup>, anaesthetics drug costs and might cause postoperative cognitive dysfunction<sup>2</sup>.

The importance of having rapid response for patient monitoring systems is one of the competitive advantages in which a new product enters into the health care market. In general anesthesia, the continuous monitoring of the patient's level of consciousness provides important information of the patient's status during surgery or intensive care unit.

<sup>1</sup> Sinclair, Rhona C F.; Faleiro, Richard J., Delayed recovery of consciousness after anaesthesia, Continuing Education in Anaesthesia Critical Care & Pain, 2006, 6, 3, 114-118.

<sup>2</sup> Frederic Aubrun, Management of Postoperative Analgesia in Elderly Patients, Regional Anesthesia and Pain Medicine Volume 30, Issue 4, July-August 2005, Pages 363-379.

## Methods

The device used in this study is the IoC-View anaesthesia brain monitor, which is designed to measure the level of consciousness during general anaesthesia where correct balancing of anaesthetics or fast recovery is a concern. The IoC-View records the electroencephalogram (EEG) with three surface electrodes attached to the forehead of the patient.

The symbolic dynamics combined with spectral ratios and EEG Suppression Rate (ESR) designed an algorithm with superior suppression of facial EMG, hence providing the anaesthesiologist with correct information of the level of consciousness.

The definition of various cases to consider changes in the Index of Consciousness over time are made in this study:

- 1) *Maximum Index of Consciousness to short circuit (isoelectric EEG, IOC=0).*
- 2) *Short circuit (IOC = 0) to maximum level of consciousness.*
- 3) *Maximum level of consciousness to IOC = 73.*
- 4) *Index of consciousness = 73 to maximum level of consciousness.*

## Results and Discussion

### 1) Maximum Index of Consciousness (IOC) to short circuit (isoelectric EEG).

In the first experiment, the Index of consciousness decreases until zero in 41 seconds (99%). 50% of the declining level of consciousness decreases in 12 s and for 95% of the value of the IOC elapsed time is 32 s. See figure 1.

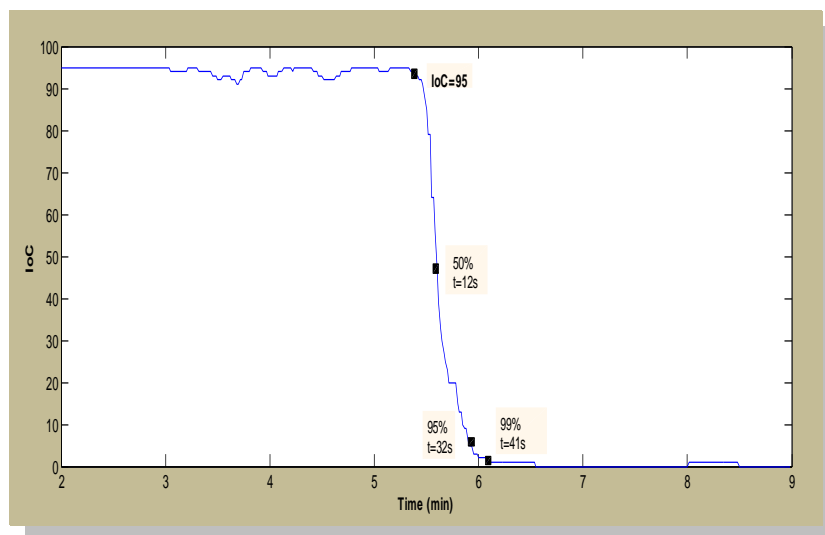
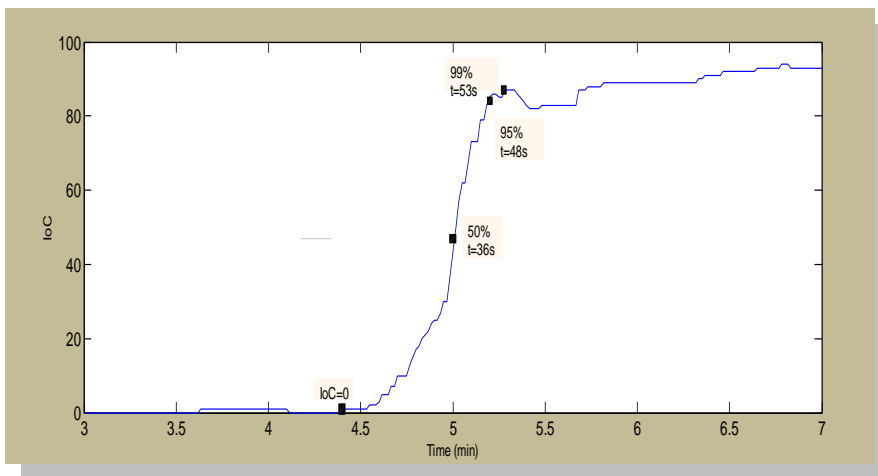


Fig 1. Maximum Index of Consciousness (IOC= 95) to short circuit (IOC=0).

Note that the slope of the curve is greater when the Index of Consciousness is less than 40. This represents the effect of the ESR subparameter on IOC algorithm during deep levels of anaesthesia.

**2) Short circuit (IOC = 0) to maximum level of consciousness.**

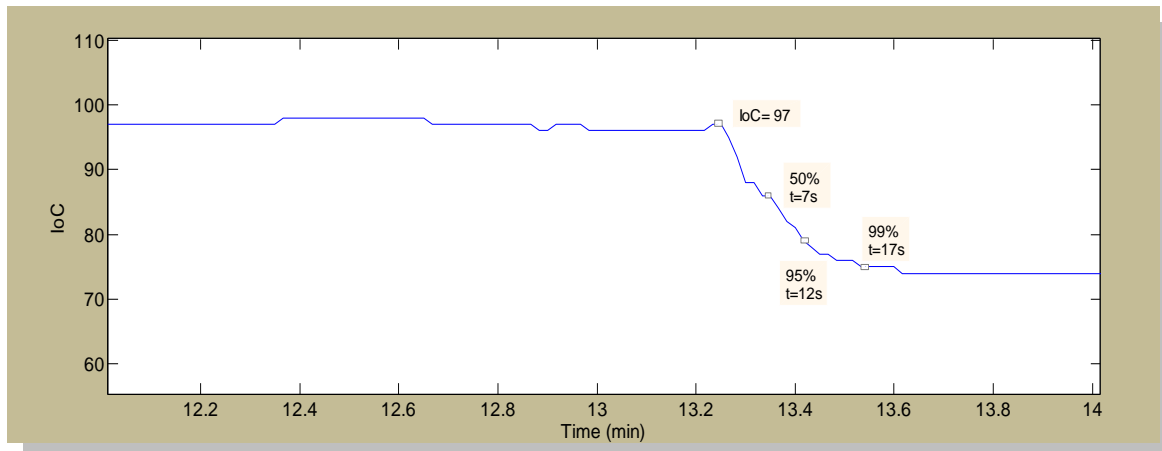
Otherwise, the time transurred between a short circuit and the maximum level of consciousness is around 53 seconds. The 50% and 95% percent update times of the IOC are 36 s and 48 s, respectively. See figure 2.



**Fig 2.** Visualization results of changing the Index of consciousness between the short circuit (IOC = 0) and the maximum level of consciousness (IOC = 87).

**3) Maximum level of consciousness to IOC = 73.**

The response of changing the Index of consciousness between 97 to 73 level is faster than the previous tests. The IoC-View changes into the 73 value in seventeen seconds, see figure 3. Also, 50% of the initial value decreases at 7 s and 99% decrement is given at 12 s.



**Fig. 3.** Visualization of changes in the Index of Consciousness from maximum level to IOC = 73.

**4)** *Index of consciousness = 73 to maximum level of consciousness.*

The time between changes in the Index of Consciousness was longer in this case. It was therefore decided to perform the test again taking into account the signal quality index (SQI) to compare its possible effect on the duration of changes between levels (See Fig. 4 and 5).

For the first test, it is noted that the duration of changes in the index of consciousness is 1 min 43 s, compared to the second test that lasts 54 s.

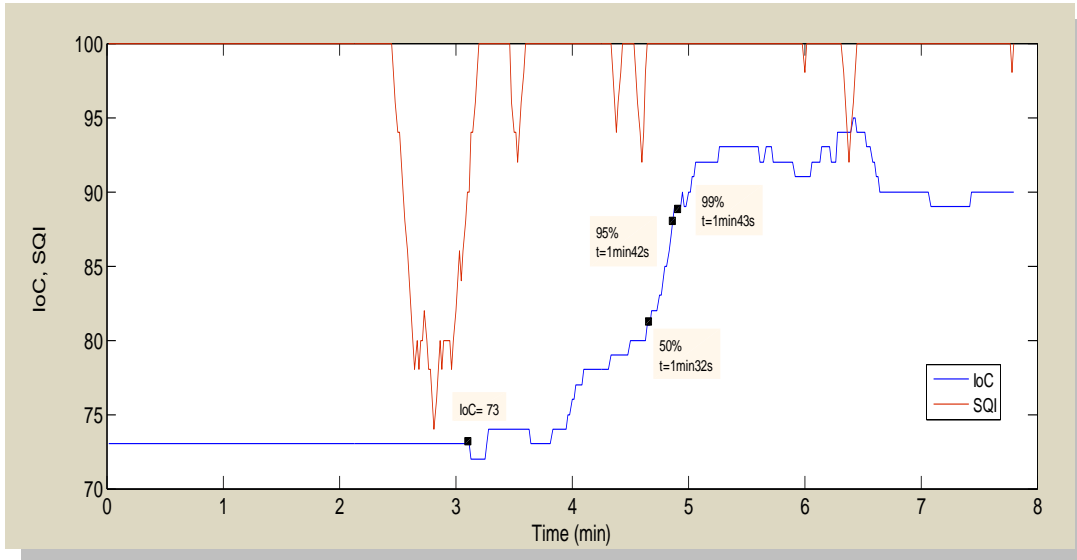


Fig. 4 Visualization of the Index of Consciousness (IoC) and the Signal Quality Index (SQI) where the signal is presenting lower quality (less than 100).

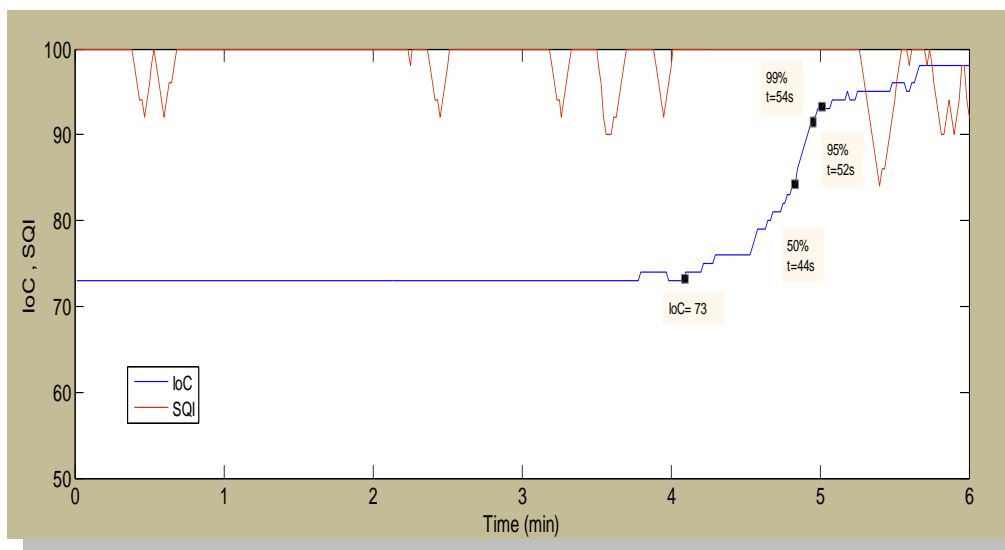


Fig. 5 Visualization of the Index of Consciousness (IoC) and the Signal Quality Index (SQI) where the signal is presenting better quality (close to 100).

In addition, when comparing the behavior of SQI in both tests, the impact on the IoC is considerable. Therefore, the variance in duration of changes in the Index of Consciousness is justified.

## Conclusions

In general, the results shown previously indicate that the 50% update time of the IOC is 7- 12 s. However, the update time is dependent on the SQI and the ESR. The ESR is calculated over a time window of 30 s, which means that the IOC reacts slower when the IOC is below 40, the range where the ESR is the dominating subparameter of the IOC algorithm.