

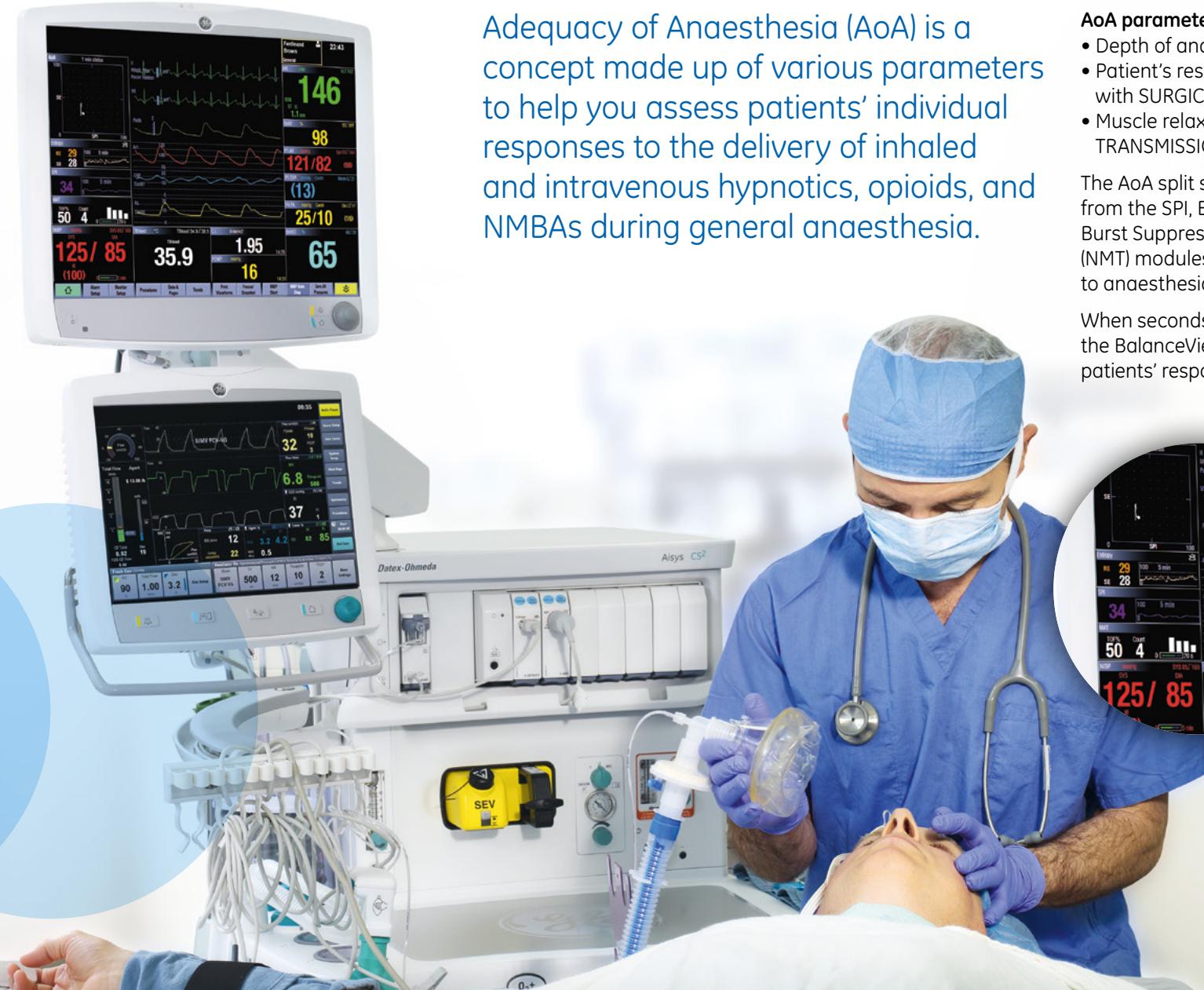
# Adequacy of Anaesthesia (AoA)

Clinical brochure



# Adequacy of Anaesthesia (AoA)

Adequacy of Anaesthesia (AoA) is a concept made up of various parameters to help you assess patients' individual responses to the delivery of inhaled and intravenous hypnotics, opioids, and NMBAs during general anaesthesia.



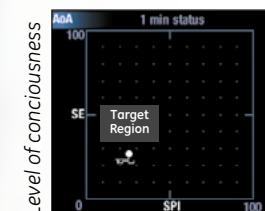
**AoA parameters provide continuous non-invasive measurement of:**

- Depth of anaesthesia with SPECTRAL ENTROPY™
- Patient's response to surgical stimuli and analgesic medications with SURGICAL PLETH INDEX (SPI)™
- Muscle relaxation/recovery with NEUROMUSCULAR TRANSMISSION (NMT)

The AoA split screen view incorporates values and trends obtained from the SPI, Entropy (State Entropy SE, Response Entropy RE and Burst Suppression Ratio BSR) and Neuromuscular Transmission (NMT) modules, providing a holistic view of the patient's response to anaesthesia.

When seconds counts in an intensive and multitasking environment, the BalanceView is guidance for prompt visualization of the patients' responses to changes of anaesthesia conditions and may help save valuable time on responsiveness to analgesia/depth of anaesthesia optimization for each individual patient.

The “white dot” that moves drastically away from the target zone may indicate inadequate hypnosis or analgesia level.



Nociception-Antinociception Balance. Current data support SPI target range 20-50. Target at present reflects only the user preference.

## Spectral Entropy™

The GE Healthcare Entropy module, E-ENTROPY, and accessories are indicated for adult and pediatric patients older than 2 years within a hospital for monitoring the state of the brain by data acquisition of electroencephalograph (EEG) and frontal electromyograph (FEMG) signals during general anaesthesia. The spectral entropies, Response Entropy (RE) and State Entropy (SE), are processed EEG and FEMG variables. The Entropy measurement is to be used as an adjunct to other physiological parameters.

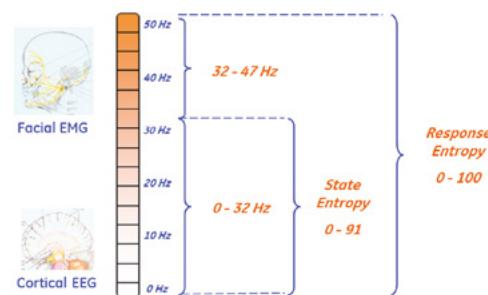


SE varies between 0 (deep anaesthesia) - 91 (awake)  
RE varies from 0 (deep anaesthesia) to 100 (awake/moving)



Entropy monitoring provides two indexes:

- **State Entropy (SE):** Steady and robust signal. The State Entropy value is always less than or equal to Response Entropy. The estimation of the hypnotic effect of anaesthetic drugs on the brain during general anaesthesia may be based on the State Entropy value. SE is not affected by sudden reactions to the facial muscles because it is based on the EEG signal.
- **Response Entropy (RE):** is sensitive to the activation of facial muscles, (i.e., FEMG). Its response time is very fast; less than 2 seconds. FEMG is especially active during the awake state but may also activate during surgery. Facial muscles may also give an early indication of emergence, and this can be seen as a quick rise in RE.

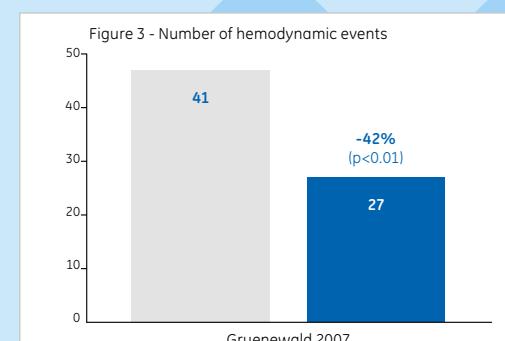
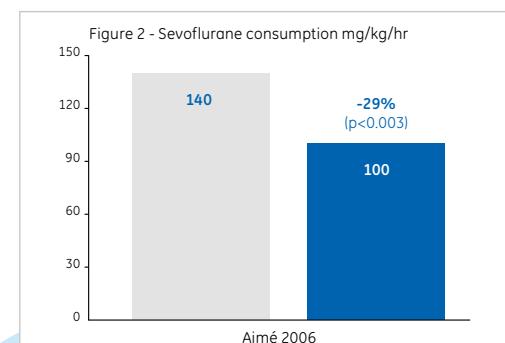
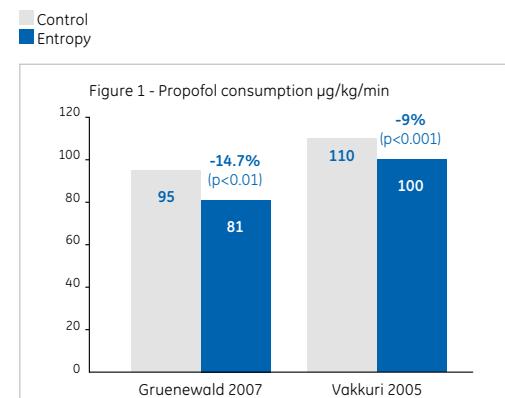


The recommended range for both RE and SE is from 40-60, therefore a decrease of SE below 40 may indicate a too deep anaesthesia while an increase above 60 may indicate the need for adjusted titration.

The Entropy measurement is to be used as an adjunct to other physiological

parameters such as the EEG raw signal which can help for in depth and more comprehensive analysis of state of brain.

In adult patients, Response Entropy (RE) and State Entropy (SE) may be used as an aid in monitoring the effects of certain anaesthetic agents, which may help the user titrate anaesthetic drugs (inhaled and intravenous hypnotics) according to the individual needs of adult patients. Furthermore in adults, the use of Entropy parameters may be associated with a reduction of anaesthetic use and faster emergence from anaesthesia. Studies have shown that such optimization leads to a significant reduction in the consumption of anaesthetic agents (See Figures 1 and 2) as well as fastened emergence. Additionally, Gruenewald et al. have seen that propofol-remifentanil Entropy-guided anaesthesia may lead to a lower frequency of hemodynamic unwanted events such as hypertension/hypotension, tachycardia and bradycardia. (See Figure 3)



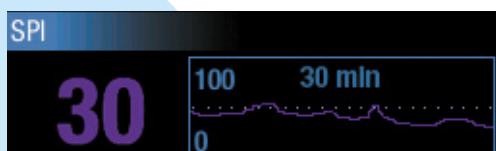
1. M-Entropy guidance vs Standard Practice during propofol-remifentanil anaesthesia: a randomised controlled trial. Gruenewald et al. Anaesthesia 2007 Dec; 62(12): 1224-9
2. Spectral Entropy Monitoring Is Associated with Reduced Propofol Use and Faster Emergence in Propofol-Nitrous Oxide-Alfentanil Anaesthesia Vakkuri A. et al. Anesthesiology 2005; 103:274-9.
3. Does Monitoring Bispectral Index or Spectral Entropy Reduce Sevoflurane Use? Aimé et al. Anesth Analg 2006; 103:1469 -77.

## Surgical Pleth Index (SPI)

**The Surgical Pleth Index (SPI) is indicated for monitoring the patient's response to surgical stimuli and analgesic medications. The SPI is indicated for unconscious and fully anaesthetized adults over 18 years of age and is to be used as an adjunct to other physiological parameters. SPI is a physiologic parameter derived from hemodynamic information in the photoplethysmographic waveform obtained from a patient's finger using GE Healthcare SpO<sub>2</sub> modules and sensors.**



SPI is calculated from the beat-to-beat Pulse Rate (PR) and the plethysmogram amplitude (PPGA)



SPI varies between 100 (high reactivity) to 0 (no reactivity)

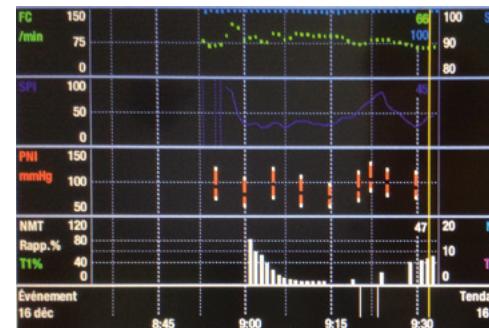


By observing the SPI value and trend, clinicians can monitor real time adult patient's responses to surgical stimuli and analgesic medications therefore saving valuable time for optimization analgesia delivery.

The optimal SPI target has not been recommended yet as more studies need to prove the clinically relevant range of SPI measurements. However, in several studies, a range of [20; 50] has been considered for guiding opioids titration<sup>1,2</sup>.

SPI may represent the balance between nociception and antinociception and as such, the variation from its baseline is another critical element to consider. Gruenewald et al.<sup>3</sup> demonstrated that ΔSPI of 10 was found to be the threshold for movement in patients receiving low remifentanil dosage. It may be reasonable to assume that if SPI increases from baseline by 10 or more during surgical stimulation an inadequate analgesia level can be present. Further clinical validation is needed to validate these preliminary findings.

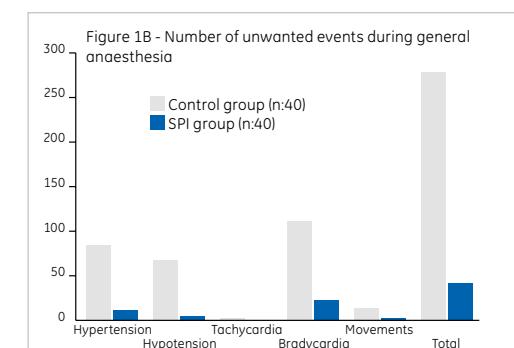
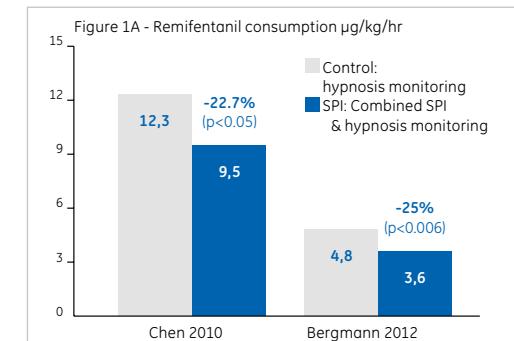
Chen et al.<sup>4</sup> compared SPI-guided analgesia to standard clinical practice and concluded that SPI-guided remifentanil titration resulted in a significant reduction of opioids consumption and reduced incidence of unwanted events such as hypertension, hypotension, tachycardia and movement during surgery (Figures 1A and 1B). Further, SPI showed the highest



Patient case screenshot: SPI rapid increase seemed to indicate real time patient's response to surgical stimuli, while ECG variation was minimal and NIBP output was reliant to manual activation

prediction probability when compared to other common variables (HR, MAP, BIS) for indicating maximum stimulation during surgery.

Bergmann et al.<sup>6</sup> also demonstrated that SPI-guided remifentanil titration additional to the already given maximal sufentanil concentration, seemed to result in much lower rate of adverse hemodynamic events during sternotomy and sternal spread. SPI seemed to help finding the specific patient additional remifentanil dose without substantial risk of hyperalgesia<sup>6</sup>.



1. Comparison of surgical stress index-guided analgesia with standard clinical practice during routine general anaesthesia: a pilot study. Chen X et al. Anesthesiology 2010; 112:1175–83.

2. Surgical stress index as a measure of nociception/antinociception balance during general anaesthesia. Wennervirta et al. Acta Anaesthesiol Scand 2008; 52: 1038–45

3. Influence of different remifentanil concentrations on the performance of the surgical stress index to detect a standardized painful stimulus during sevoflurane anaesthesia. Gruenewald et al. Br J Anaesth 2009

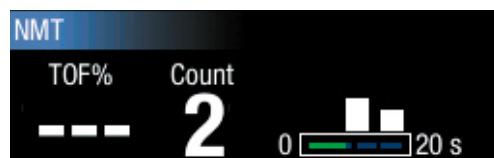
4. Comparison of Surgical Stress Index-guided Analgesia with Standard Clinical Practice during Routine General Anaesthesia. Chen X. et al. Anesthesiology 2010; 112:1175– 83.

5. Surgical pleth index-guided remifentanil administration reduces remifentanil and propofol consumption and shortens recovery times in outpatient anaesthesia. Bergmann I. and al. BJA Advance Access published December 5, 2012

6. Remifentanil added to sufentanil-sevoflurane Anaesthesia suppresses hemodynamic and metabolic stress responses to intense surgical stimuli more effectively than high-dose sufentanil-sevoflurane alone. Bergmann et al, BMC Anesthesiology 2015

## Neuromuscular Transmission (NMT)

**Quantitative NMT monitoring gives a clear picture of the individual dosage needs and facilitates optimal administration of NMBAs and antagonists.**



Electromyography (EMG) is the process of recording the specific electrical muscular fibers activity in response to ulnar nerve stimulation.

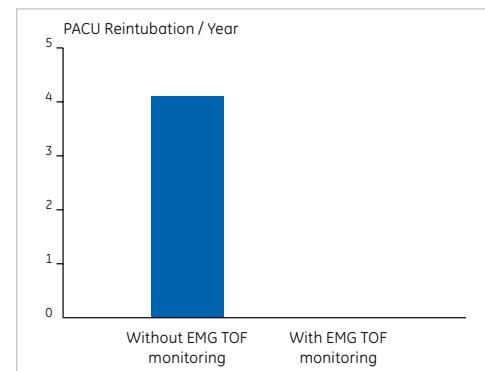
Kinemyography (KMG) uses a mechanoSensor and quantifies the evoked mechanical response by measuring the motion of the thumb by a piezoelectric sensor, which converts the physical motion to an electrical signal.

Post-Operative Residual Curarization incidence in post-anesthesia care units is estimated to be approximately 40%<sup>1</sup>. Such residual effects (even at levels of recovery as high as a TOF ratio of 0.7-0.8) have clinical consequences and complications that can prolong hospitalization. Current recommendations prone the use of short- or intermediate-acting NMBAs, routine reversal of NMBs, and monitoring neuromuscular transmission whenever relaxants are used, especially before and after NMB reversal<sup>2,3</sup>.

Adequate recovery from neuromuscular block, indicated by  $\text{TOF} > 90\%$ , can be reliably determined only with a quantitative measurement. EMG TOF ratio is an alternative gold standard, after Mechanomyography (MMG), for detecting neuromuscular block in clinical setting and is not interchangeable with Acceleromyography (AMG) TOF<sup>4</sup>. Liang et al. demonstrated that AMG overestimates recovery by at least 0.15. Therefore, residual neuromuscular block,

defined as an EMG or MMG TOF ratio of  $< 0.90$ , cannot be excluded immediately on reaching an AMG TOF ratio of 0.90 or indeed 1.00<sup>4</sup>.

Studies have shown that the implementation of quantitative EMG neuromuscular monitoring resulted in a significant reduction in the incidence of incompletely reversed patients in the PACU<sup>5</sup>.



1. *Residual neuromuscular block: lessons unlearned. Part I: definitions, incidence, and adverse physiologic effects of residual neuromuscular block.* Murphy and Brull. Anesth Analg. 2010 Jul;111(1):120-8

2. *Residual neuromuscular block: lessons unlearned. Part II: methods to reduce the risk of residual weakness.* Brull et al. Anesth. Analg. 2010 Jul 111(1): 129-40

3. *Monitoring and pharmacologic reversal of a nondepolarizing neuromuscular blockade should be routine.* Miller et al. Anesth. Analg. 2010 Jul; 111(1): 3-5

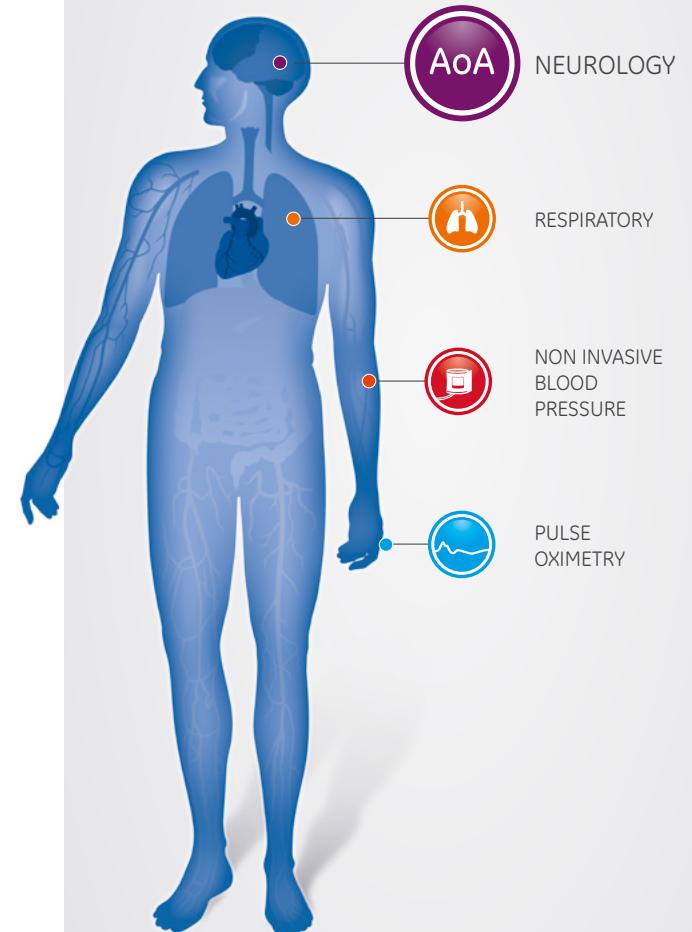
4. *An ipsilateral comparison of accelerometry and electromyography during recovery from nondepolarizing neuromuscular block under general anaesthesia in humans.* Liang et al. Anesth Analgesia 2013 Aug; 117(2):373-9

5. *The implementation of quantitative electromyographic neuromuscular monitoring in an academic anaesthesia department.* Todd et al. Anesth Analg. 2014 Aug; 119(2):323-31



# Clinical parameters & accessories

Monitoring Solutions



Please contact your local GE sales representative  
for the most current information

[www.gehealthcare.com](http://www.gehealthcare.com)

GE Healthcare provides transformational medical technologies and services to meet the demand for increased access, enhanced quality and more affordable healthcare around the world. GE works on things that matter - great people and technologies taking on tough challenges. From medical imaging, software & IT, patient monitoring and diagnostics to drug discovery, biopharmaceutical manufacturing technologies and performance improvement solutions, GE Healthcare helps medical professionals deliver great healthcare to their patients.

GE Healthcare  
P.O. Box 900, FIN-00031 GE, Finland  
GE Direct United Kingdom  
+ 44 800 0329201

**Imagination at work**

Marketing Communications GE Medical Systems. Société en Commandite Simple au capital de 85 418.040 Euros. 283 rue de la Minière – 78533 Buc Cedex France.  
RCS Versailles B 315 013 359  
A General Electric company, doing business as GE Healthcare.  
Entropy, GE and GE Monogram are trademarks of General Electric Company.

The SPI (SSI) measurement is to be used for unconscious and fully anaesthetized adult (>18 years old) patients during general anaesthesia. SPI is available with CARESCAPE Modular Monitors with GE SpO<sub>2</sub> technology. SPI measurement site should always be the finger. SPI Software option for CARESCAPE Monitors is not available in USA or its territories and may not be available in other markets depending on the regulatory approval status - Check with your local representative. Entropy parameter is validated for adult and children aged 2 years and above and is to be used as an adjunct to other physiological parameters. Consult the CARESCAPE monitor user manual and parameters' quick guides for detailed instructions

©2015 General Electric Company. All rights reserved. JB30708XE(1)