The LICOX® System

Brain Tissue Oxygen Monitoring System

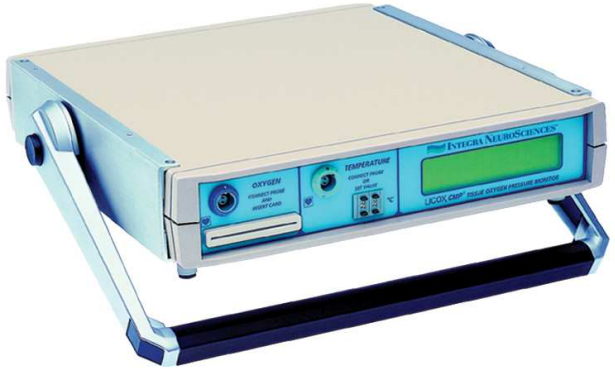
Product Presentation

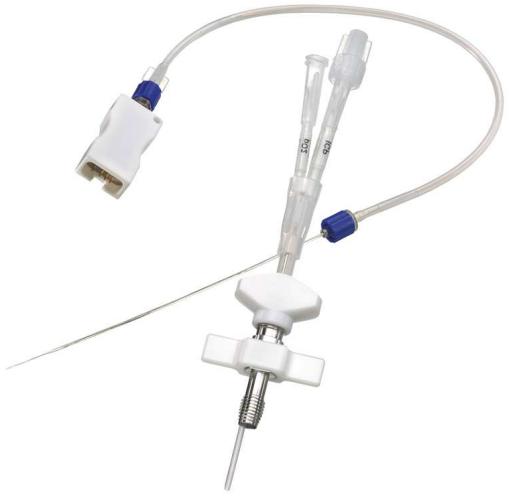
INTEGRA™ NeuroSciences

NS1581-09/07

What is the LICOX® system?

- Measures interstitial brain tissue oxygenation ($P_{bt}O_2$) in mmHg and brain temperature (°C)
- Probe inserted approximately 35mm below the dura into the white matter of the brain
- $P_{bt}O_2$ used in conjunction with current ICP/CPP monitoring methods





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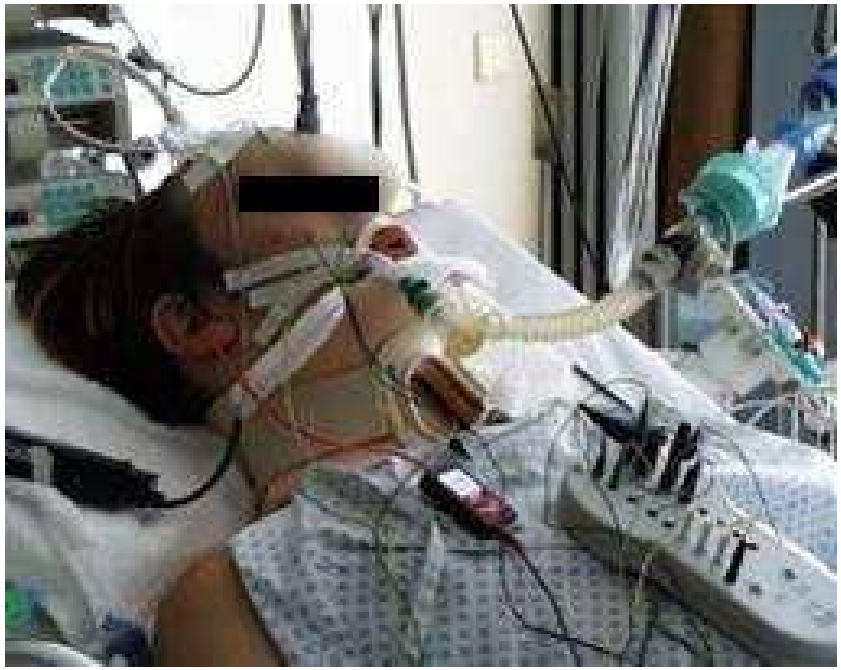
Who needs the LICOX® system?

- Patients at risk for developing cerebral hypoxia or ischemia
- Head trauma patients
- Aneurysm patients
- Subarachnoid hemorrhage patients
- Stroke patients



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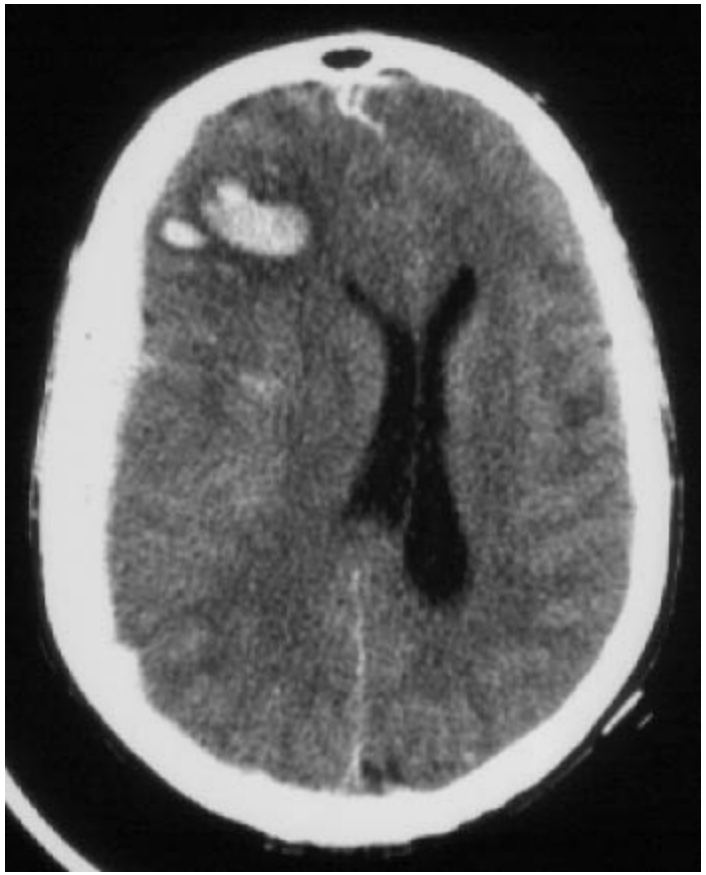
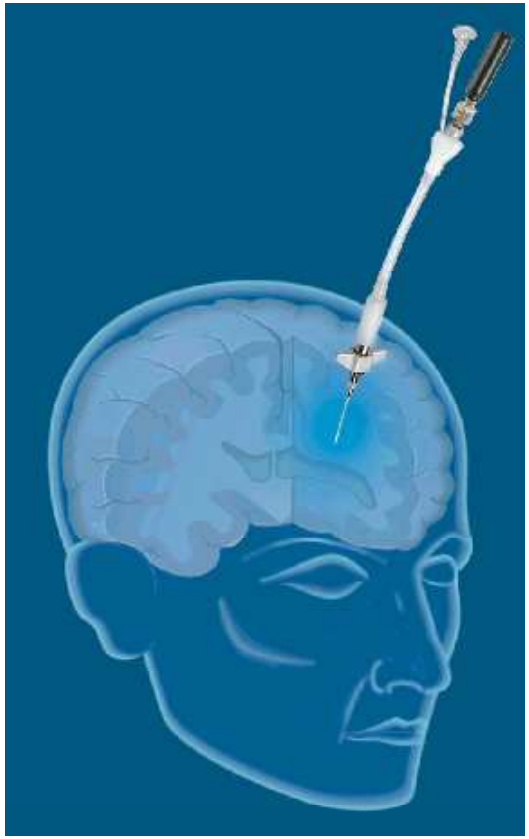
When is the LICOX® system placed?

- Within the first 24-48 hours of injury
  - The sooner cerebral hypoxia is detected, the better secondary injury can be prevented
- Generally, when an ICP catheter is required, a LICOX® probe should be considered



How is the LICOX® system placed?



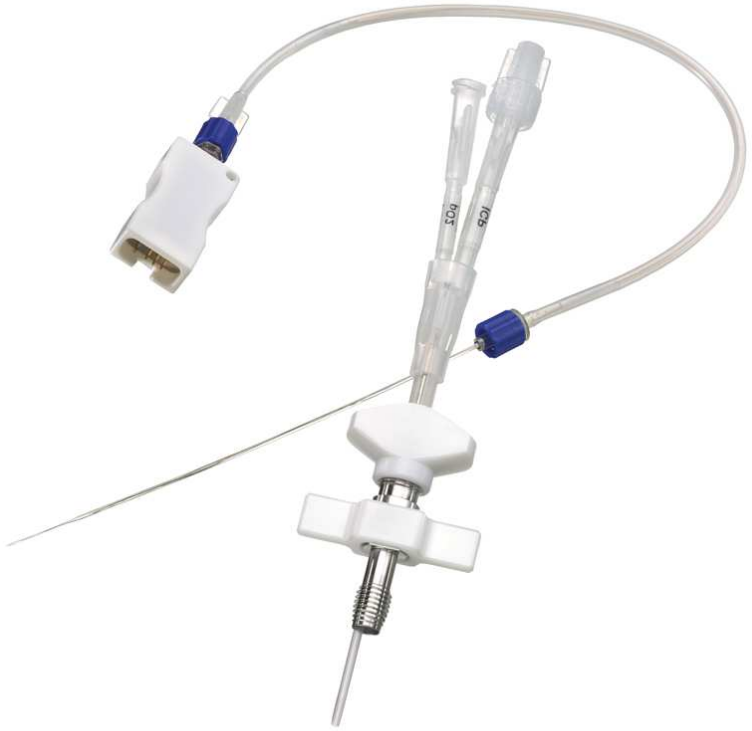
- Can be either *bolted* or *tunneled*
- Can be placed independently or with an ICP catheter
- Requires minimal additional effort
- Does not need to be zeroed prior to placement, SMART card is included with each O_2 probe with all calibration data
- Monitor need not be present when placing in the OR

Where is the LICOX® system placed?

- Placement is up to clinical discretion
- The idea is to prevent SECONDARY injury by ensuring living tissue is receiving adequate oxygen
- LICOX® probe can be placed in either the injured side or non-injured side of brain
- Should not be placed directly into a lesion

What are the probe options?

- BOLTED
  - Double Lumen – Camino® ICP channel and LICOX® PMO catheter channel (IP2P)
- TUNNELED
  - Licox® PMO combined oxygen and temperature catheter (IT2)
- Probe kits come with required drill bits and other accessories



How accurate are the probes?

Oxygen Accuracy:

- $P_{bt}O_2$ 0-20 mmHg accuracy is ± 2 mmHg
- $P_{bt}O_2$ 21-50 mmHg accuracy is ± 10%
- $P_{bt}O_2$ 51-150 mmHg accuracy is ± 13%

Temperature Accuracy: ± 0.2 °C

What about the nursing staff?

- Simple monitor set-up and use
- The monitor displays a digital oxygen and temperature reading
- Alarms are managed through a connection to the bedside monitor

What is a "normal" reading?

- Normal: 25-35 mmHg
- Risk of death increases
  - < 15 mmHg for 30 minutes
  - < 10 mmHg for 10 minutes
- $P_{bt}O_2 < 5$ mmHg
  - high mortality
- $P_{bt}O_2 \leq 2$mmHg - neuronal death[1]

1- Bardt T, Unterberg A, et al. Monitoring of brain tissue PO2 in traumatic brain injury: effect of cerebral hypoxia on outcome. *Acta Neurochirurgica*.1998;71(Suppl):153-156.

How is patient outcome affected?

- Its been found:
  - Head injured patients who undergo aggressive therapy to maintain ICP/CPP at normal levels still experience periods of severe brain hypoxia[1]
  - Interventions previously thought to improve tissue oxygenation may improve ICP and CPP but actually decrease $P_{bt}O_2$[2]

1. Bardt T, Unterberg A, et al. Monitoring of brain tissue PO2 in traumatic brain injury: effect of cerebral hypoxia on outcome. *Acta Neurochirurgica*.1998;71(Suppl):153-156.
2. Zauner A, Doppenberg E, et al. Extended neuromonitoring: new therapeutic opportunities? *Neurological Research*. 1998;20(Suppl 1):85-90.

How is patient outcome affected?

- The $P_{bt}O_2$ number can provide:
  - Notification of hypoxic episodes
  - Independent predictors of unfavorable outcome and death[1]
    - Treatments to maintain $P_{bt}O_2$ correspond to more favorable patient outcomes[2]

1. Zauner A, Doppenberg E, et al. Extended neuromonitoring: new therapeutic opportunities? *Neurological Research*. 1998;20(Suppl 1):85-90.
2. Valadka A, Gopinath S, et al. Relationship of brain tissue PO2 to outcome after severe head injury. *Critical Care Medicine*. 1998;26(9):1576-1581.

Is the LICOX® system cost-efficient?

- Added costs the Licox® system are justified by significantly improved outcomes
- Implementation of new protocols using $P_{bt}O_2$
  - Improve patient care[1]
  - Better utilize resources[1]
  - Probable reduction of
    - Ventilator days[1,2]
    - ICU days[1,2]
    - Overall hospital days[1,2]

1. Spain D, McIlvoy L, Fix S, et al. Effect of clinical pathway for severe traumatic brain injury on resource utilization. *The Journal of Trauma*. 1998;45(1):101-105.
2. Simons R, Eliopoulos V, Laflamme D, Brown D. Impact on process of trauma care delivery 1 year after introduction of trauma program in a provincial trauma center. *The Journal of Trauma*. 1999;46(5):811-816.

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How is the LICOX® system different than a Jugular Venous Bulb?

- Jugular bulb oximetry, $SjvO_2$, measures oxygen saturation of venous blood
  - Measures global oxygen reduction
  - Cannot identify regional cerebral ischemia
  - may lead to secondary injury[1,2]

1. Clay H. Validity and reliability of the SjO2 catheter in neurologically impaired patients: A critical review of the literature. *Journal of Neuroscience Nursing*. 2000;32(4):194-203.

2. Mayberg T, Lam A. Jugular bulb oximetry for the monitoring of cerebral blood flow and metabolism. *Neurosurgery Clinics of North America*. 1996;7(4):755-765.

How is LICOX® different than a Jugular Venous Bulb?

- $SjvO_2$ measurements are shown to be unreliable
  - Good quality data are only obtained about 50% of the placement time[1,2,3]
  - $SjvO_2$ is difficult to use in children due to small vein size[4]

1. Clay H. Validity and reliability of the SjO2 catheter in neurologically impaired patients: A critical review of the literature. *Journal of Neuroscience Nursing*. 2000;32(4):194-203.
2. Kiening K, et al. Monitoring of cerebral oxygenation in patients with severe head injuries: Brain tissue PO2 versus jugular vein oxygen saturation. *Journal of Neurosurgery*. 1996;85:751-757
3. Meixensberger J. et al. Multimodality hemodynamic neuromonitoring - Quality and consequences for therapy of severely head injurted patients. *Acta Neurochirugica*. 1998;71(Suppl):260-262.
4. Palmer S, et al. The impact on outcomes in a community hospital setting of using the AANS traumatic brain injury guidelines. *The Journal of Trauma*. 2001;50(4):657-664.

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A few institutions that have published clinical studies with the LICOX® systems:

- Mission Hospital
  - Mission Viejo, CA
- Harborview
  - Seattle, WA
- Creighton University
  - Omaha, NE
- University of Pennsylvania Hospital
  - Philadelphia, PA

Thank you for your time!

Please contact us anytime should you have any further questions.

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References

Bardt T, Unterberg A, et al. Monitoring of brain tissue PO2 in traumatic brain injury: effect of cerebral hypoxia on outcome. *Acta Neurochirurgica*.1998;71(Suppl):153-156.

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Palmer S, et al. The impact on outcomes in a community hospital setting of using the AANS traumatic brain injury guidelines. *The Journal of Trauma*. 2001;50(4):657-664.

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Prasad S. et al. Cerebral oxygenation in major pediatric trauma: Its relevance to trauma severity scores and outcomes. Paper presented at: 35th Annual Meeting of the American Pediatric Surgical Associtation; May 27-30, 2004; Ponte Vedra Beach, Fla.

Simons R, Eliopoulos V, Laflamme D, Brown D. Impact on process of trauma care delivery 1 year after introduction of trauma program in a provincial trauma center. *The Journal of Trauma*. 1999;46(5):811-816.

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Stiefel, M., et al. Reduced mortality rate in patients with severe traumatic brain injury treated with brain tissue oxygen monitoring. *J Neurosurg*. 2005;103:805-811.

Valadka A, Gopinath S, et al. Relationship of brain tissue PO2 to outcome after severe head injury. *Critical Care Medicine*. 1998;26(9):1576-1581.

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