



Hummingbird® ICP Monitoring

When **accuracy** and **ease of use** matter, Hummingbird is the **ONLY** choice.

The next generation of advanced neuromonitoring is here



**Hummingbird Solo ICP
Monitoring**



**Hummingbird Quad ICP
Monitoring with Drainage**



**Hummingbird ICP Control
Module**

Shortcomings of current ICP Monitoring



Challenging setup and procedural workflow
Inaccurate readings due to drift
Troubleshooting difficulty
Expensive capital equipment

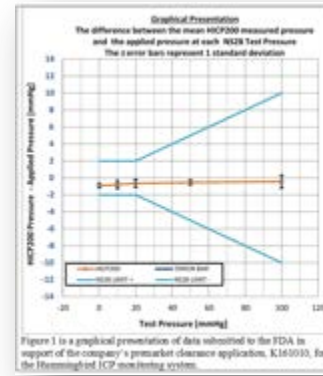
Differentiated Offering for ICP Monitoring



Next-Gen ICP Technology

Unique air bladder mechanism of action

- *Unique external transducer allows system to be disconnected and re-zeroed in situ.*



Drift-Free Accuracy

External transducer provides **most accurate** readings of any ICP system

- *Automatic, hourly recalibration*
- *Only system to exceed NS28 industry guidelines*



Cost-Efficient

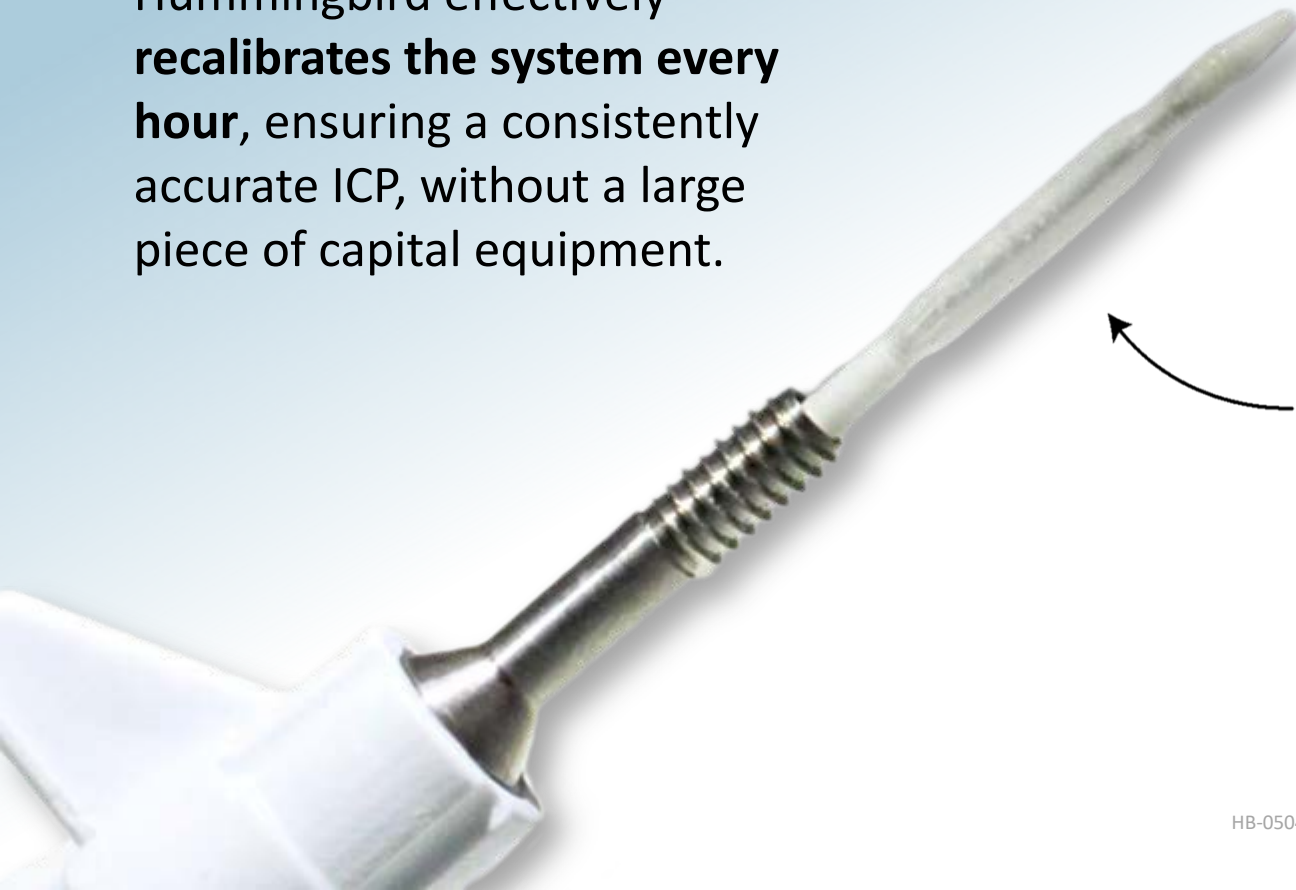
No expensive capital equipment required

- *ICP control module seamlessly transmits ICP reading to >10 patient monitors*

Hummingbird is **Unique**

Hummingbird's principle operation uses a unique air bladder sensor to measure ICP with a proprietary feature termed **Accuracy Optimization Algorithm (AOA)**.

Hummingbird effectively **recalibrates the system every hour**, ensuring a consistently accurate ICP, without a large piece of capital equipment.



- ✓ Filled with **20 microliters of air**
- ✓ ICP detected in **parenchyma**
- ✓ **No** use of fiber optics to break
- ✓ Ability to be **re-zeroed in situ**
- ✓ **ICP** reading **independent** of **patient position**
- ✓ **Automatic recalibration** every hour

Simplest, Most Accurate, and Cost-Efficient choice for ICP Monitoring

Drift-free accuracy¹

**Automatic recalibration
every hour**

MR conditional bolt

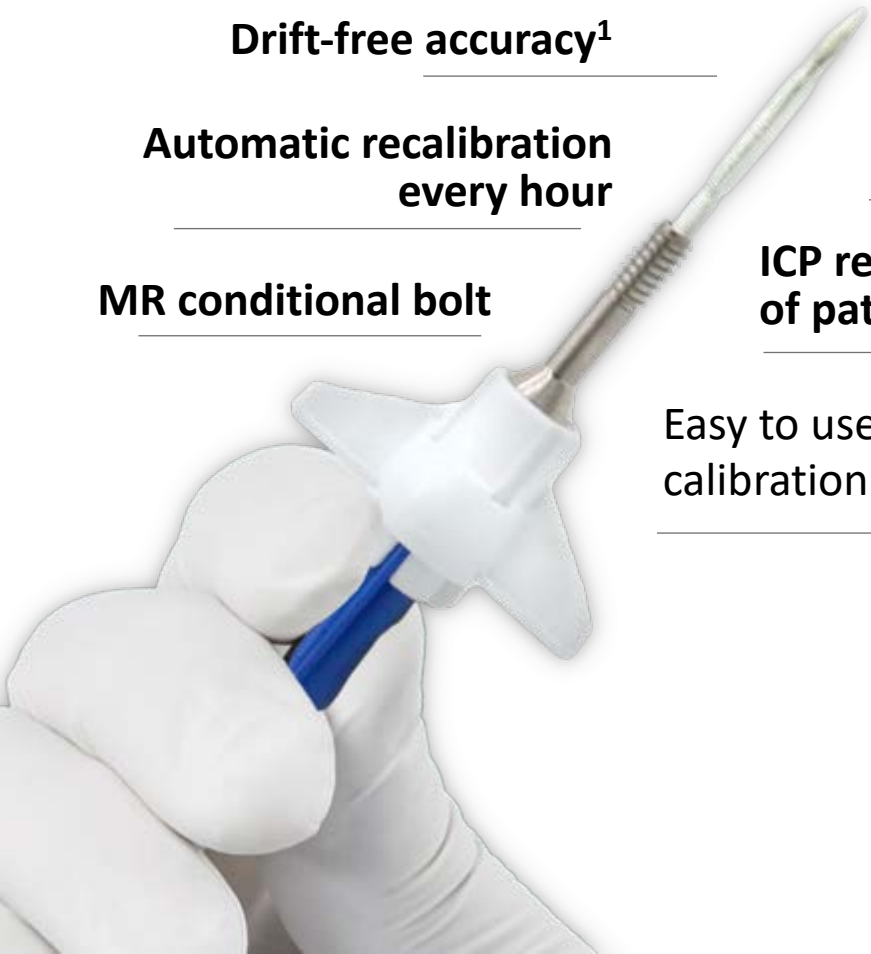
**Re-zero and troubleshoot
in situ**

**ICP reading independent
of patient positioning**

**Easy to use with one-touch
calibration**

**Bolt-Based system for
accurate parenchymal ICP
measurement**

Hummingbird Solo's unique air
bladder addresses historic shortcomings of other
ICP monitoring system



Most Versatile Choice Available For Multimodal Monitoring

Drift-free accuracy¹

Automatic recalibration
every hour

Re-zero and troubleshoot
in situ

ICP reading independent
of patient positioning

Precise angulation of
lumens to keep probes
separated

Single access point

Parenchymal ICP measurement

CSF Drainage

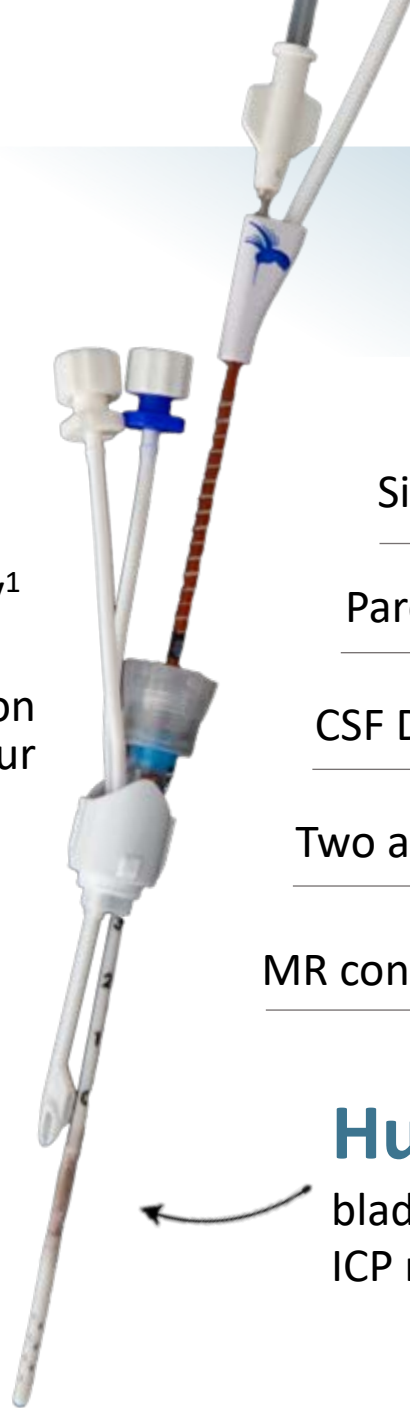
Two additional probes

MR conditional bolt

**Advance multimodal monitoring
system by combining:**

- CSF drainage
- Parenchymal ICP monitoring
- Your choice of two probes
through a single twist-drill hole

Hummingbird Quad's unique air
bladder addresses historic shortcomings of other
ICP monitoring system



Treatment Flexibility

Drift-free accuracy¹
with automatic
recalibration
every hour

**Parenchymal ICP
monitoring**

**Your choice of two additional
probes, such as:**

- PbtO₂
- Microdialysis
- Cerebral blood flow
- EEG

CSF drainage

Superior threading prevents
bolt dislodgement

External transducer
allows system to be
disconnected and
re-zeroed in situ

Bolt Stop
included for
added stability
and placement
confidence

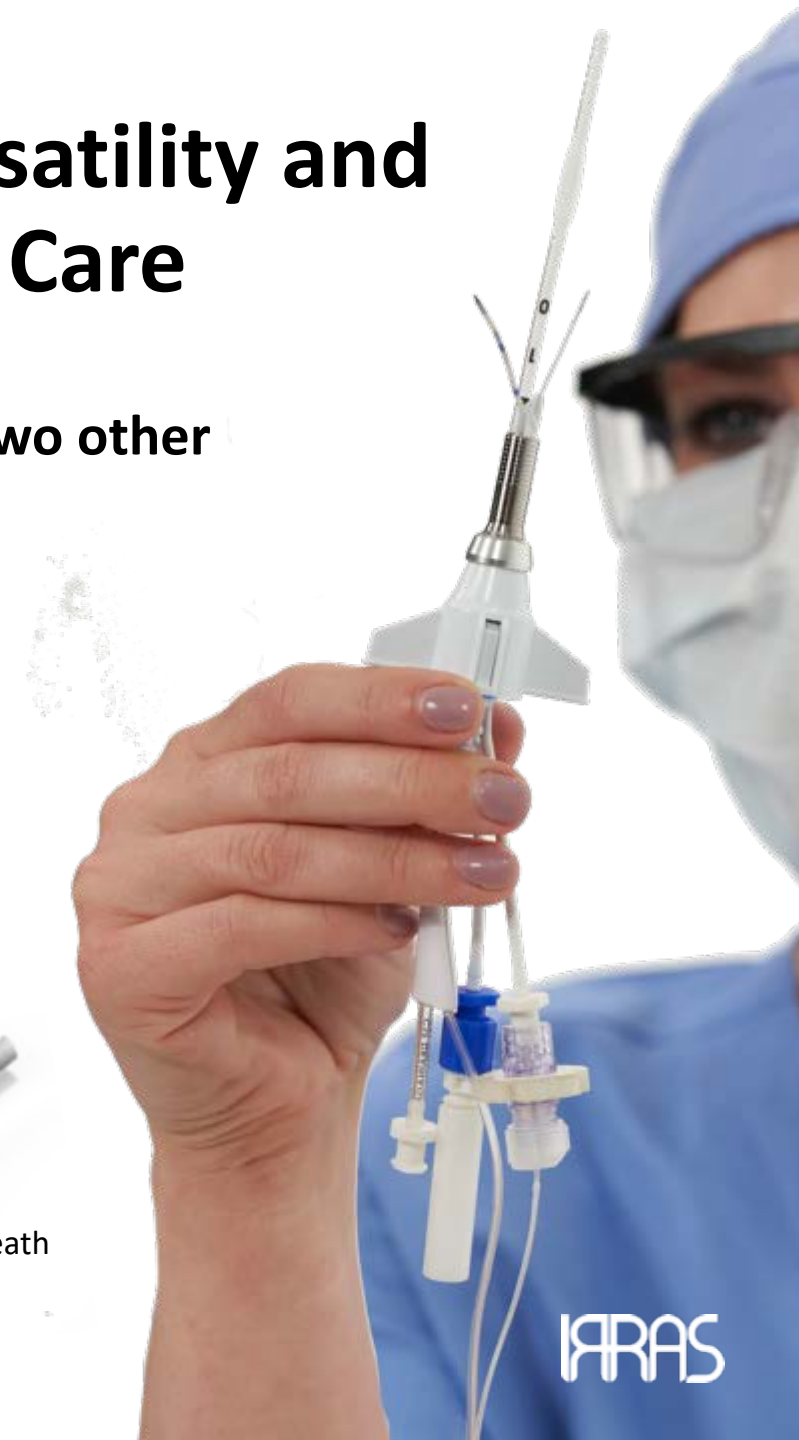
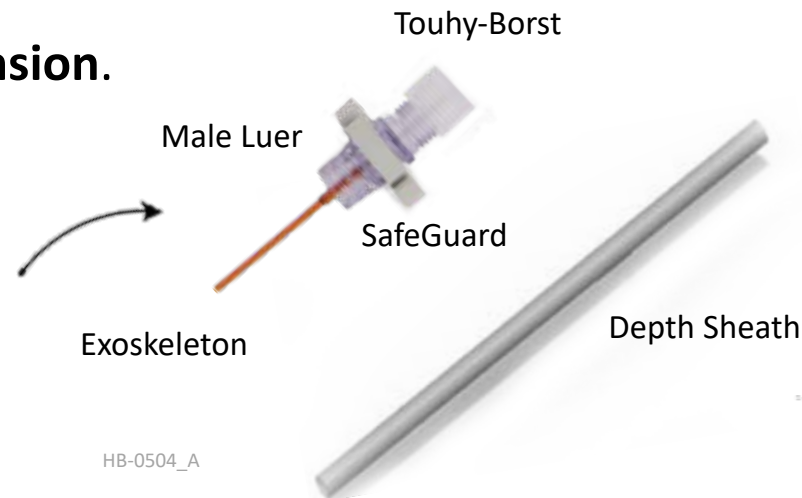
Provides Unsurpassed Versatility and Accuracy for Neurocritical Care

Tailor your treatment with flexibility to drain CSF, measure ICP, and two other desired parameters:

- Thermal diffusion to measure regional **cerebral blood flow**.
- Electroencephalography (**EEG**) to measure electrical activity or spreading depolarization
- Microdialysis** to measure cerebral metabolism.
- Measurement of **brain tissue oxygen tension**.

Probe Insertion Tool

is included to confirm accurate placement of additional probes.



Single-button zeroing

Single-button system priming

Automatic recalibration
every hour

Simple design supports faster set-
up and procedural workflow



Intuitive user interface

Informative troubleshooting
error code indicator

Seamlessly transmits ICP data to
Patient Monitor

**Unique external
pressure transducer**
allows system to be disconnected
and re-zeroed in situ

Easy to Use



Insert & Zero

Insert bolt and catheter & **Zero** System



Connect

Connect catheter



Prime

Press **Prime** System button


Hummingbird[®]
ICP Monitoring

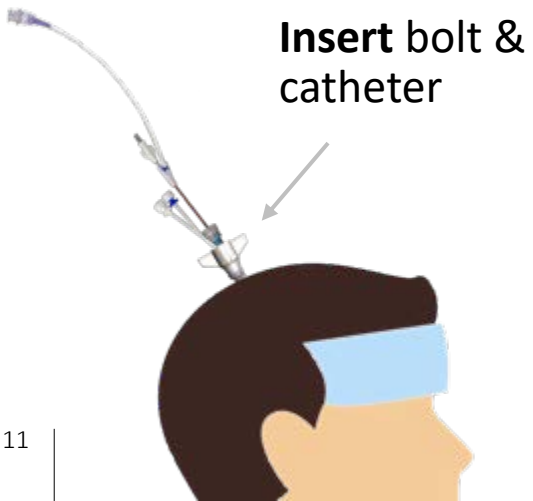


Zero systems

Press **Prime** System button

Connect catheter

Insert bolt & catheter

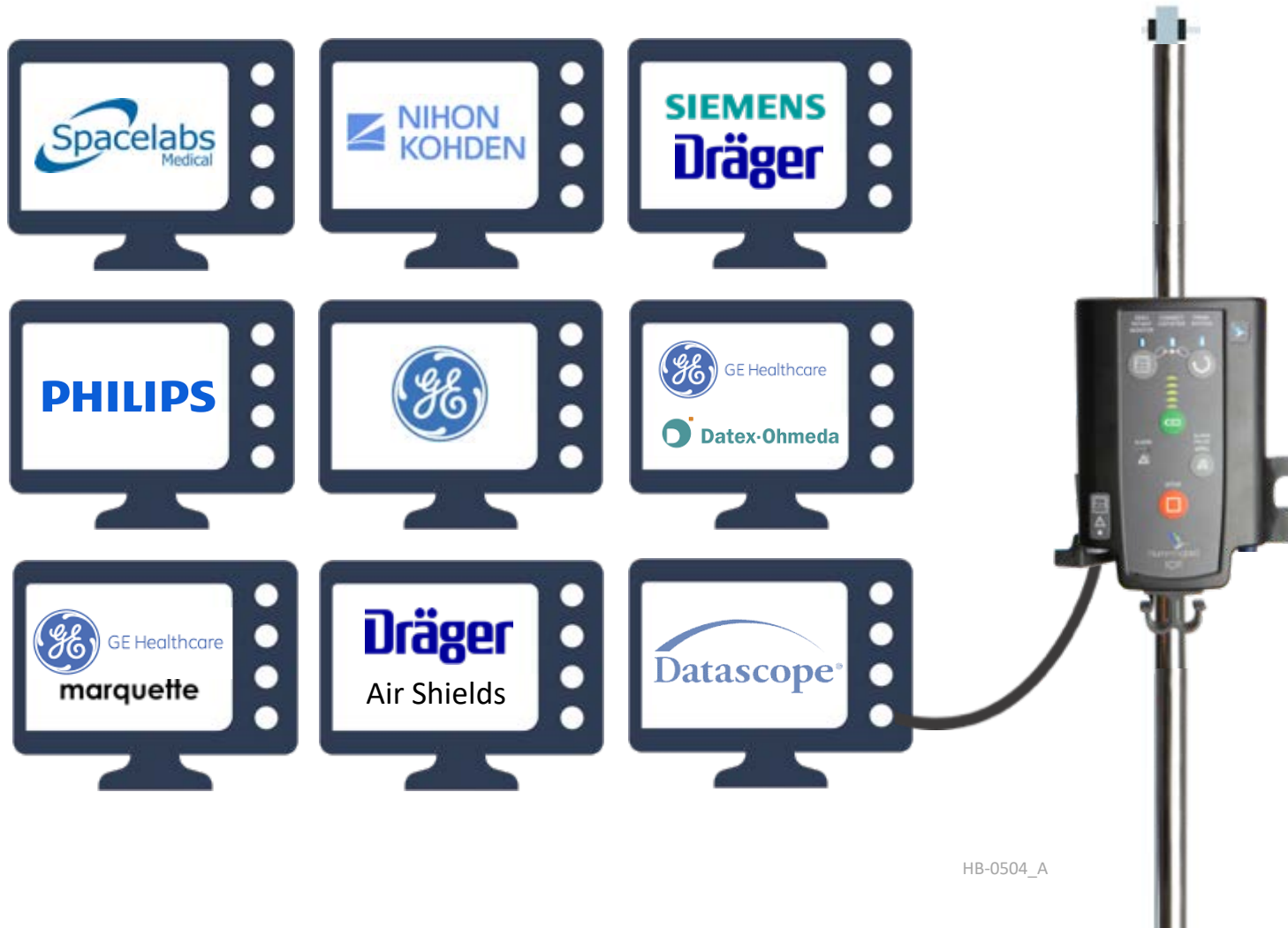


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Hummingbird provides a **Cost-efficient Solution**

Improve healthcare economics with a cost-efficient solution



Hummingbird transmits ICP and waveform seamlessly to patient monitors

Reduce cost burden
of large, standalone capital
equipment from other
expensive ICP monitoring
systems.

Hummingbird is Simple

Quick 3-step setup simplifies training, set-up, and procedural workflow.

Insert & Zero



Insert Bolt and Catheter



Zero Systems

Connect



Connect Catheter

Prime



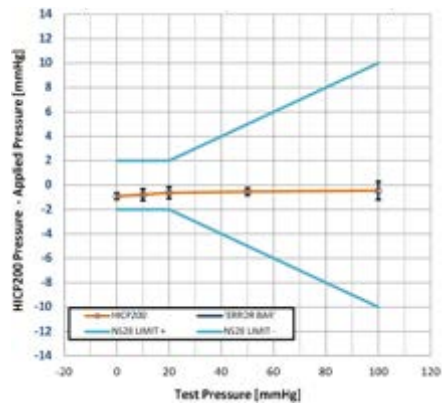
Press Prime System button

ICP reading transmitted to bedside monitor

Hummingbird is **Accurate**

Increase the confidence in your ICP reading with drift-free accuracy

Drift-Free Accuracy



Offers the only commercially available system that exceeds NS28 standards for ICP accuracy

In Situ Recalibration



Automatically recalibrates in situ every hour, which ensures an accurate ICP reading

External Transducer



Unique external pressure transducer allows system to be disconnected and re-zeroed in situ

ICP Reading Independent of Patient Positioning



Accurate ICP measurements independent of patient positioning.

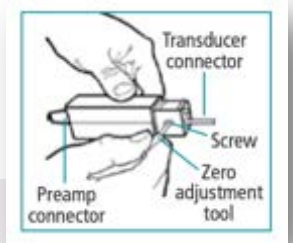
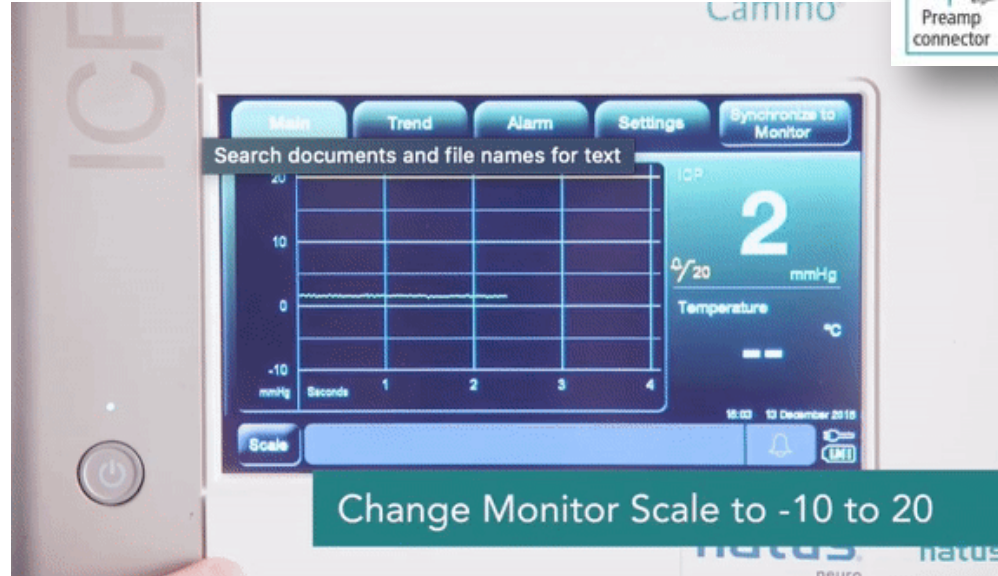
This is what ease of use looks like for Camino®

Camino In-Servings Videos



- 14 training videos for device setup
- ~45 minutes of content

Tedious Zeroing Workflow



Steps Required:

- Manually Change Monitor Scale to -10 to 20
- Use Setting Tabs to Change Display from Line to Fill
- Number Lags Behind Graph Display
- Use Zeroing Tool to Zero System

This is what **ease of use** looks like for *Hummingbird*®



Hummingbird Steps:

I **Insert & Zero**

Insert bolt and catheter & **Zero** System (with one button!)

C **Connect**

Connect catheter

P **Prime**

Press **Prime** System button

Historic Challenges with Current ICP Monitoring Technology



ICP Accuracy due to Drift



Tedious Setup



Bolt Dislodgement



Bolt vs. Tunneling



MR Compatibility



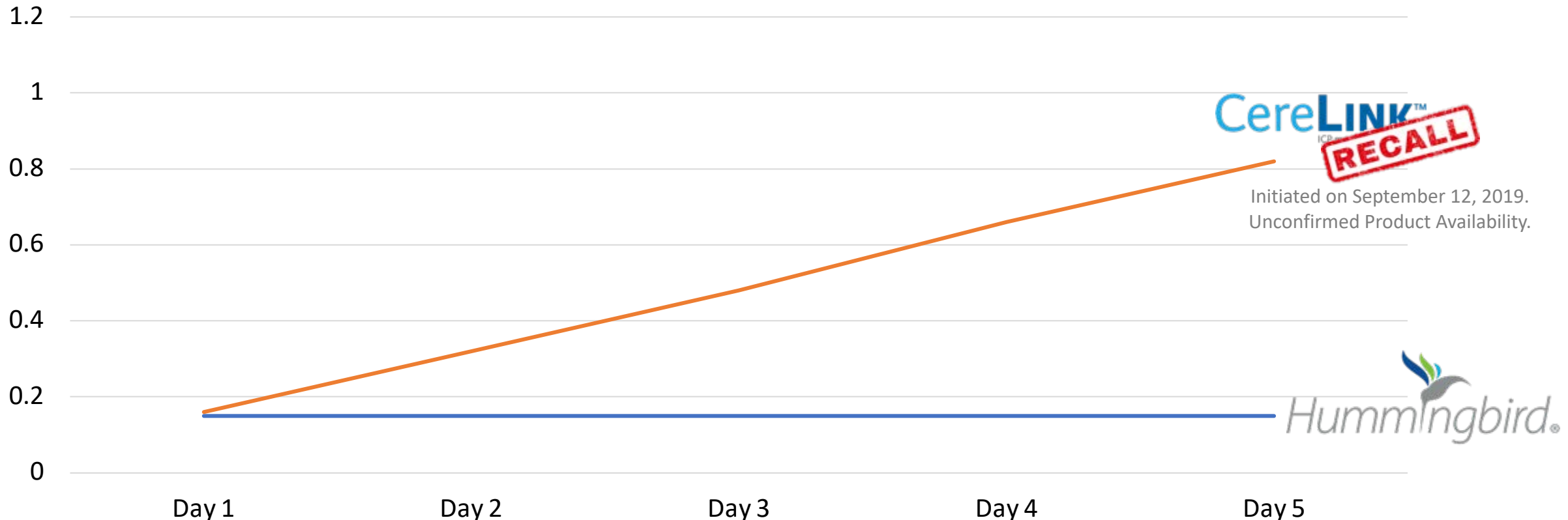
Troubleshooting Difficulty



6x More Accurate than Codman ICP Express (CereLink)^{1,2}



Cumulative Drift over 5 Days



± 5mmHg over 30 days²



± 0.15 mmHg over the entire course of treatment³

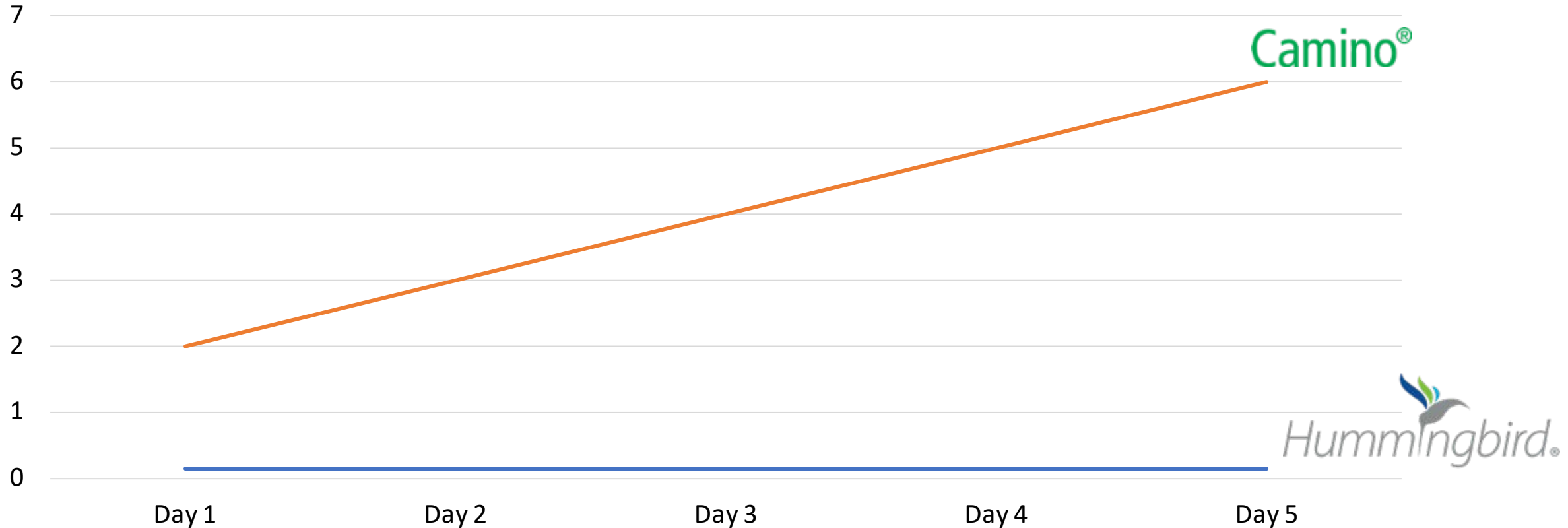
1. Hummingbird data on file at IRRAS
2. Codman Microsensor Basic Kit FDA 510(k) Notification
3. System re-calibrates automatically in-situ



40x More Accurate than Camino^{1,2}



Cumulative Drift over 5 Days



Camino®

± 2 mmHg per 24-hour period²
 ± 1 mmHg per day after initial 24-hours²



± 0.15 mmHg over the entire course of treatment³

1. Hummingbird data on file at IRRAS
2. Camino® Micro Ventricular Bolt Pressure Monitoring Kit IFU
3. System re-calibrates automatically in-situ

HB-0504_A



Only Hummingbird's ICP Accuracy Exceeds Industry Standard



ONLY parenchymal monitoring sensor that can be re-zeroed in situ and recalibrates automatically, resulting in zero drift

- Results in most accurate parenchymal ICP measurement

ONLY ICP monitoring system that exceeds NS28 standard set by Association for Advancement of Medical Instrumentation (AAMI) and American National Standard Institute (ANSI)

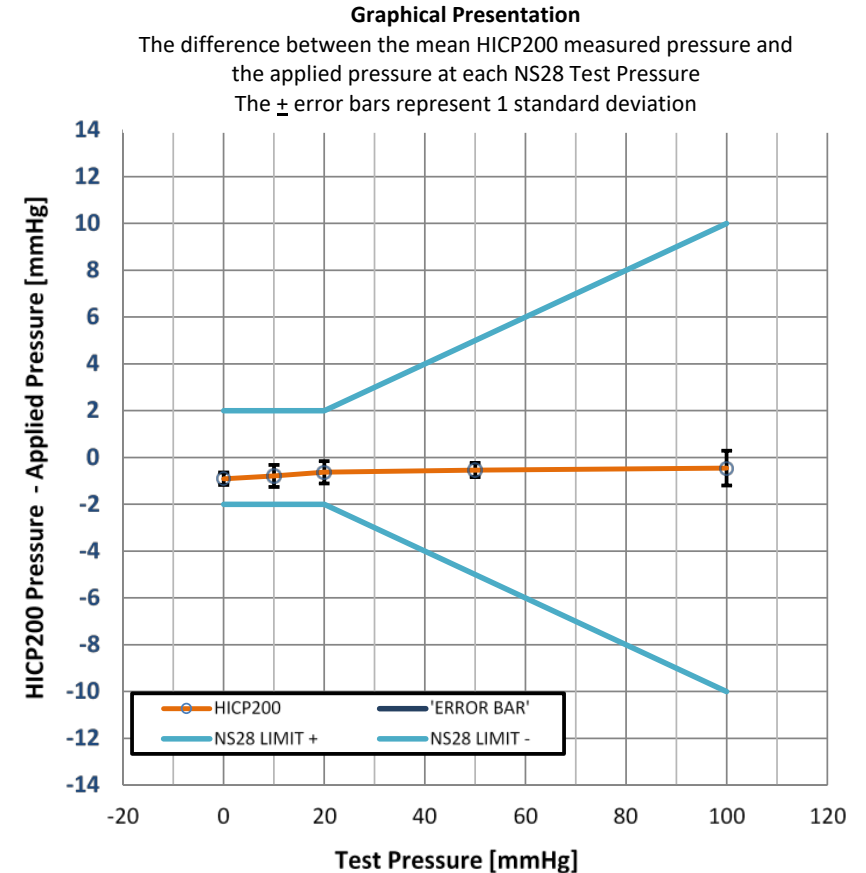


Figure 1 is a graphical presentation of data submitted to the FDA in support of the company's premarket clearance application, K161010, for the Hummingbird ICP monitoring system.

Troubleshooting



Unique **external transducer** allows system to be disconnected and **re-zeroed** in situ.

If problems are seen, just disconnect the external transducer and start again.

- ✓ Hummingbird provides the user information to assist in understanding what is occurring



Battery depleted



Kinked cable



Stuck button

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Ease of Use: Only Hummingbird ICP keeps the procedural workflow simple and easy

Insert & Zero



Insert Bolt and Catheter



Zero Systems

Connect



Connect Catheter

Prime



Press Prime System button

ICP reading transmitted to bedside monitor




Hummingbird[®]
ICP Monitoring

MRI Conditional



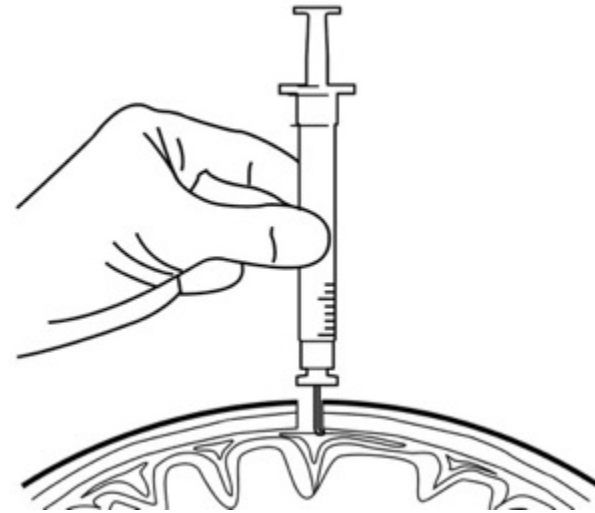
Hummingbird ICP offers a MR conditional solution for all bolt and catheter options.

MRI Conditional; **1.5T and 3.0T**

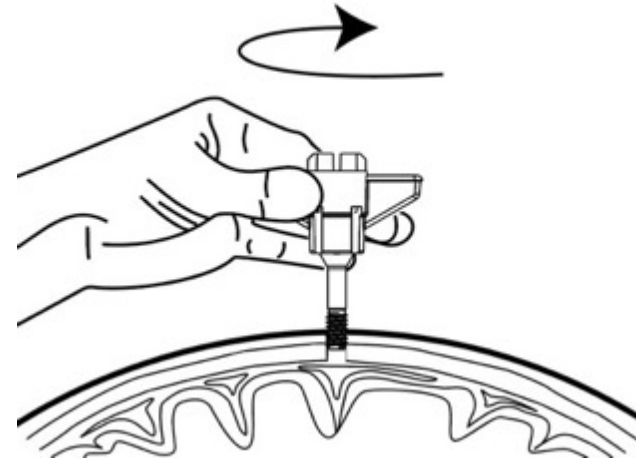




Bolt Dislodgement



We provide a tool to measure skull thickness to assist with prevention of bolt dislodgement.



Additionally, for every 360 degree turn our bolts are designed to insert 1mm.



The Hummingbird Quad includes a variety of Bolt Stops which provides stability and additional protection

Skull Thickness Caliper



Bolt-based Approach Reduces Complications Compared to Traditional Tunneling


Hummingbird®
ICP Monitoring



Clinical Data Demonstrates Bolt-based technology may help:

- Lower risk of infection¹
- Reduced length of stay²
- Decreased healthcare costs³
- Minimized risk of accidental pullouts of drainage catheter⁴
- Reduced morbidity³

1. Fried HI, Nathan BR, Rowe AS, Zabramski JM, Andaluz N, Bhimraj A, Guanci MM, Seder DB, Singh JM (2016) The insertion and management of external ventricular drains: an evidence-based consensus statement : a statement for healthcare professionals from the Neurocritical Care Society. Neurocrit Care 24:61–81
2. Huyette DR, Turnbow BJ, Kaufman C, Vaslow D, Whiting B, Michael Y. Accuracy of the freehand pass technique for ventriculostomy catheter placement: retrospective assessment using computed tomography scans. Journal of Neurosurgery 2008;108(1):88–91.
3. Schodel P, Proescholdt M, Ullrich OW, Brawanski A, Schebesch KM (2012) An outcome analysis of two different procedures of burr-hole trephine and external ventricular drainage in acute hydrocephalus. J Clin Neurosci 19:267–270
4. chodel P, Proescholdt M, Brawanski A, Bele S, Schebesch KM. Ventriculostomy for acute hydrocephalus in critically ill patients on the ICU-Outcome analysis of two different procedures. British Journal of Neurosurgery 2011;(October) [Epub ahead of print] PMID: 21970781.

The next generation of advanced neuromonitoring is here



Hummingbird Solo ICP Monitoring



Hummingbird Quad ICP Monitoring
with Drainage



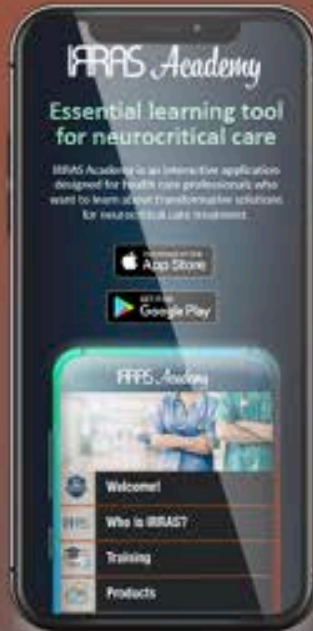
Hummingbird ICP Control Module

IRRAS

Connect with Us

IRRAflow®

Hummingbird®
ICP Monitoring



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