A Flow Measurement Guide
for Industry Bioengineers

PEDIATRIC HYDROCEPHALUS

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Transonic Applications

Transonic began partnering with outside companies shortly after its inception in 1983 to develop innovative devices. Soon, a robust Transonic/Customer synergy developed between Transonic and device manufacturers and this vital Customer/Manufacturer relationship has become part of Transonic's DNA. It lies at the heart of the development of all Transonic products.

Our applications range from utilizing standard products straight off the shelf to creating such novel designs that they would not be recognized as a Transonic product. Together with our collaborators, Transonic has striven to push the limit on flow measurements including ultra-low flow applications in novel measurement mediums. Transonic customized Flowsensors and Flowboards are being used in a wide range of products and applications including:

Mechanical Circulatory Support Devices including:

1. Heart Lung Machines
2. Extracorporeal Membrane Oxygenation (ECMO) circuits
3. Artificial Hearts (AH)
4. Ventricular Assist Devices (VADs)

Renal Replacement Devices: Hemodialysis Machines

Organ Preservation Devices

Treatment Delivery /Therapy Devices

1. Anesthesia Delivery / Pain Management Systems including:
2. Organ Infusion Pumps
3. Urodynamic System / Urometer
4. Pediatric Hydrocephalus
5. Endometrial Ablation
6. Ocular Surgery

Many More Possibilities

A sampling of the broad spectrum of Transonic application will be presented along with the solutions that Transonic offers for each application.

Monitor Shunt Flows Non-invasively

More than 125,000 US patients suffer from hydrocephalus – a condition demanding lifelong treatment using an implanted shunt systems to drain excess cerebrospinal liquid (CSF). Treatment costs for hydrocephalus shunts reach into the billions of dollars with about half of these expenses going toward revision of malfunctioning shunts.

These costs are elevated due to the absence of non-invasive and accurate technology to evaluate a shunt's performance. This leads to delayed treatment or unnecessary intervention in nearly two-thirds of admissions. This is particularly true in children, since this group has a high risk of shunt malfunction (25 to 40% chance of failure in the first year of implantation)[2,3].

A patient presents at the hospital with signs and symptoms of shunt malfunction from three possible causes.

1. The shunt is clogged, there is no flow and the shunt should be replaced.
2. Flow in the shunt is too low or too high and the valve setting needs to be adjusted.
3. The patient symptoms stem from reasons NOT related to shunt flow performance, but have similar clinical signs (infection, common cold, loss of appetite, persistent headache, nausea, lethargy, etc.).

Understanding baseline flow conditions in shunted patients is critical for interpreting results from individual tests at different periods, and in different patients. Flow through the shunt may vary with position, time, and variations caused by individual lifestyle.

A no flow condition detected by a Flowsensor may result from;

1) Position, time, or individual lifestyle;
2) Patient shunt independence, or;
3) Blockage of the shunt. Low flow through the shunt can mean impending blockage and clinical symptoms, variation in shunt performance (flow through shunt may be intermittent), or infection of the CSF (meningitis) which will result in changes in the CSF content, making the CSF more viscous, causing a decrease in the baseline flow rate.

Transonic Flow Solution (Investigative)

An implantable CSF shunt Flow Monitor can accurately measure CSF output within ± 15% or ± 2 mL/hr, diagnoses blockage or lack of flow, and records real-time continuous flow data in patients external ventricular drains (EVDs).[4] This information could be used to diagnose blockage versus lack of flow, and record real-time continuous flow data in patients with EVDs, providing physicians the ability to calculate a host of new diagnostic parameters.

An investigative, implantable Flowsensor placed in-line with a shunt system could also be used to noninvasively detecting shunt malfunctions, thus decreasing the number of diagnostic tests performed, obviate the need for potentially harmful diagnostic techniques, and decrease the length of hospital stay. CSF flow monitoring can also be used to optimize adjustment of shunt valves.

References:

1. Chervu S *et al,* "Quantitative evaluation of cerebrospinal liquid shunt flow. J Nucl Med 1984; 25:91–95
2. Drake JM, Sainte-Rose C: The Shunt Book, ed 1.,Cambridge, MA: Blackwell Science, 1995
3. Drake JM *et al,* "Cerebrospinal liquid flow dynamics in children with external ventricular drains," Neurosurg 1991; 28:242–250.
4. Pennell T, Yi JL, Kaufman BA, Krishnamurthy S, "Noninvasive measurement of cerebrospinal liquid flow using an ultrasonic transit time flow sensor: a preliminary study." J Neurosurg Pediatr. 2016r;17(3):270-7. (Transonic Reference # 10749A)