INTRODUCTION TO LiquoGuard® CSF MANAGEMENT

Since 2005, LiquoGuard® (Liquo = German for CSF) is available on the European market as well as many countries outside Europe. In 2011, we are introducing the new and improved LiquoGuard®7 which adds many features our customers have requested. In this paper, however, remains the same: simultaneous drainage and pressure measurement, automatically controlled to keep the pressure within a predefined corridor in order to enhance patient safety.

SAFETY: Common problems of conventional external CSF drainage systems are access level adjustment of the drip chamber, e.g., during patient movement, CS occlusions, and unannounced pressure sensor malfunctions (sensor drift). LiquoGuard® constantly monitors the normal CSF pressure pulsation and thus detects catheter occlusions and parenchymal sensor connectivity. LiquoGuard® supports lumbar and ventricular drainage catheters.

WORKLOAD REDUCTION: LiquoGuard® by design does not need any height adjustments (unlike drip chambers), thus saves time and allows the extra staff to focus on other essential tasks. The integrated documentation function reduces the nurses workload even further.

MOBILITY: Thanks to powerful Li-on rechargeable batteries, the system is independent of external power supply. LiquoGuard® is portable, weighs about 6.000 g (13 lbs), and can be attached to poles and tracks by means of a bracket.

VERSATILITY: Besides CSF drainage in trauma patients, LiquoGuard® is also used in NPH diagnostics. Fluid loss and inflation test and thorako-abdominal aorta surgery (TAAA). The LiquoGuard® system is a modular concept with basic version, additional options: documentation/history, printing,parenchymal ventricle, pediatric monitor connectivity (lumbar drainage and infusion test) and thorako-abdominal surgery (TAAA), lumbar drainage and infusion test, patient monitor connectivity.

SAFETY: Conventional CSF drainage may lead to unnecessary patient and medical staff exposure to CSF, having its, sustainable alarm system, help detect cerebral leaks and infections, and refer the signal to the alarm system. In a continuous CSF flow, LiquoGuard®7 can set a continuous "flow" alarm option to watch the drained volume.

WORKLOAD REDUCTION: In time consuming manual adjustment of exact CSF drainage flow.

MOBILITY: The LiquoGuard® sensor unit is easy to handle and can be attached to the lumbar catheter level using a specially designed fixation device for maximal patient comfort and mobility.

REVOLUTIONARY APPROACH TO VENTRICULAR CSF MANAGEMENT

LiquoGuard® works:
LiquoGuard® is the first CSF management system providing continuous pressure measurement and controlled CSF flow. The system determines CSF pressure (Pcsf) by two independent pressure measurement with zero offset, the tube set and fixed to the patient on the level of the Foramen Monro. Thus, the CSF pressure (Pcsf) is a good approximation to the intracranial pressure (ICP). For direct ICP measurement, LiquoGuard® allows connection of an adjustable pneumotach or a catheter tip sensor. This makes sense e.g. with frequent catheter occlusions or if a collapsed ventricle occurs. After processing the derived target pressure (Pset, cmH2O), CSF flow is automatically controlled to keep the pressure within a predefined corridor.

LiquoGuard® enhances patient safety:
In conventional ventricular CSF drainage, collapsed ventricles and catheter occlusions are most frequent issues. LiquoGuard® supports early identification of both situations. When the collapsed ventricle is collapsed, pressure pulsation is usually lost and CSF flow periods are monitored. During a catheter occlusion, the measured pressure drops below Pset. CSF flow stops and pulsation is also lost. LiquoGuard® monitors the CSF pressure pulsation and thus supports the user in detecting catheter occlusions and other pathological situations such as collapsed ventricles. LiquoGuard® features refined alarm criteria, further reducing unnecessary alarms.

Lumbar drainage and infusion test:
How LiquoGuard® works:
LiquoGuard® is the first CSF management system providing continuous pressure measurement and controlled CSF flow. The system determines CSF pressure (Pcsf) by two independent pressure measurement with zero offset, the tube set and fixed to the patient on the level of the Foramen Monro. Thus, the CSF pressure (Pcsf) is a good approximation to the intracranial pressure (ICP). For direct ICP measurement, LiquoGuard® allows connection of an adjustable pneumotach or a catheter tip sensor. This makes sense e.g. with frequent catheter occlusions or if a collapsed ventricle occurs. After processing the derived target pressure (Pset, cmH2O), CSF flow is automatically controlled to keep the pressure within a predefined corridor.

LiquoGuard® enhances patient safety:
In conventional ventricular CSF drainage, collapsed ventricles and catheter occlusions are most frequent issues. LiquoGuard® supports early identification of both situations. When the collapsed ventricle is collapsed, pressure pulsation is usually lost and CSF flow periods are monitored. During a catheter occlusion, the measured pressure drops below Pset. CSF flow stops and pulsation is also lost. LiquoGuard® monitors the CSF pressure pulsation and thus supports the user in detecting catheter occlusions and other pathological situations such as collapsed ventricles. LiquoGuard® features refined alarm criteria, further reducing unnecessary alarms.

THE 7 ADDITIONAL ADVANTAGES OF LiquoGuard®7

- Improved alarm criteria, new alarm "flow rate"
- Highly improved connectivity including connections to USB-stick, parenchymal ICP or catheter tip sensor, printer, internet (for development and device diagnosis)
- Improved recording and documentation and subsequent analysis possible
- Integrated bag holder, improved fixation bracket for poles and tracks

LIMITED EDITION

LiquoGuard®7

MOBILITY - INDIVIDUAL

LiquoGuard®7 in the worldwide first CSF management system providing a pathway through the system determines CSF pressure (Pcsf) by two independent pressure measurement with zero offset, the tube set and fixed to the patient on the level of the Foramen Monro. Thus, the CSF pressure (Pcsf) is a good approximation to the intracranial pressure (ICP). For direct ICP measurement, LiquoGuard® allows connection of an adjustable pneumotach or a catheter tip sensor. This makes sense e.g. with frequent catheter occlusions or if a collapsed ventricle occurs. After processing the derived target pressure (Pset, cmH2O), CSF flow is automatically controlled to keep the pressure within a predefined corridor.

LiquoGuard®7 features refined alarm criteria, further reducing unnecessary alarms.

- The LiquoGuard® alarm concept requires that alarms are always individually, expandable tied.

VERSATILITY: LiquoGuard® is the worldwide first CSF management system providing a pathway through the system determines CSF pressure (Pcsf) by two independent pressure measurement with zero offset, the tube set and fixed to the patient on the level of the Foramen Monro. Thus, the CSF pressure (Pcsf) is a good approximation to the intracranial pressure (ICP). For direct ICP measurement, LiquoGuard® allows connection of an adjustable pneumotach or a catheter tip sensor. This makes sense e.g. with frequent catheter occlusions or if a collapsed ventricle occurs. After processing the derived target pressure (Pset, cmH2O), CSF flow is automatically controlled to keep the pressure within a predefined corridor.

How LiquoGuard® checks itself:
The revolutionary dual and redundant concept from sensors and parenchymal sensor connectivity. LiquoGuard®'s dual pressure sensors, redundant converters, 2 microcontrollers, separate loudspeakers and closed system are shortened. During catheter occlusion, the measured pressure drops below Pset, CSF flow stops and pulsation is also lost. LiquoGuard® monitors the CSF pressure pulsation and thus supports the user in detecting catheter occlusions and other pathological situations such as collapsed ventricles. LiquoGuard®7 features refined alarm criteria, further reducing unnecessary alarms.

How LiquoGuard® checks itself:
The revolutionary dual and redundant concept from sensors and parenchymal sensor connectivity. LiquoGuard®'s dual pressure sensors, redundant converters, separate loudspeakers and closed system are shortened. During catheter occlusion, the measured pressure drops below Pset, CSF flow stops and pulsation is also lost. LiquoGuard® monitors the CSF pressure pulsation and thus supports the user in detecting catheter occlusions and other pathological situations such as collapsed ventricles. LiquoGuard®7 features refined alarm criteria, further reducing unnecessary alarms.

How LiquoGuard® checks itself:
The revolutionary dual and redundant concept from sensors and parenchymal sensor connectivity. LiquoGuard®'s dual pressure sensors, redundant converters, separate loudspeakers and closed system are shortened. During catheter occlusion, the measured pressure drops below Pset, CSF flow stops and pulsation is also lost. LiquoGuard® monitors the CSF pressure pulsation and thus supports the user in detecting catheter occlusions and other pathological situations such as collapsed ventricles. LiquoGuard®7 features refined alarm criteria, further reducing unnecessary alarms.
**SAFETY:** CSF flow is controlled by the desired intracranial or intra-tube pressure (ICP or Pcsf in mmHg). When pressure alarm limits, the CSF flow is limited to the pre-selected max. flow rate (ml/h). With standard settings, pressures below zero can never be generated (no aspiration). But with advanced settings, a weak negative pressure can be tolerated without alarm; LiquoGuard® even allows such a pressure as target.

**WORKLOAD REDUCTION:** There is no drip chamber and thus no need for time-consuming manual height adjustments. Also, no calibration of the pressure sensor is needed, since it is already delivered pre-calibrated.

**MOBILITY:** CSF pressure measurement (ICP/Pcsf) and drainage is continued during transportation of the patient.

**VERSATILITY:** Continuous documentation of pressure and CSF volume helps in decision making for permanent CSF shunting, analyzing effects of medications, and calculating CSF loss. The recorded data can be examined on-screen using the "history" tab, or they can be imported to a PC for further evaluation.

---

**VENTRICULAR DRAINAGE**

**TECHNICAL INFORMATION**

- **Size (W x H x D):** 239 mm x 145 mm x 213 mm
- **Weight:** 3.620 g
- **Voltage:** 100-240 VAC
- **Pressure sensor Accuracy:** ± 0.375 mmHg (range of 0-75 mmHg)
- **Drift:** <1 mmHg in long-term tests
- **Interfaces:** USB (memory stick, printer), parenchymal sensor, patient monitor, ethernet

---

**THE COMPANY**

Möller Medical was founded in 1949 and is active mainly within the demanding OEM business; the company is developing components, systems and finished devices for human medicine, in vitro diagnostics (IVD) and precision engineering. Customers include many renowned medical device/IVD companies. All products are manufactured in-house. The LiquoGuard® has been developed and is manufactured completely by Möller Medical. LiquoGuard® has been approved for the European market since 2006, in 2011 we were introducing LiquoGuard®7.

Möller Medical is certified according to EN ISO 13485 and EN ISO 9001 and manufactures the products shown here with CE mark according to EU-directive 93/42/EWG.