

# Multimodality Monitoring Setup

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## PREPERATION

### 1. Gather Equipment

- Moberg
- IV Pole (**Figure 1**) with:
  - Raumedic and cables
  - Hemedex and cables
- 2 Philips sleds (red pressure modules; **Figure 2**).

### 2. Neurosurgery will place the following at bedside:

- Quadlumen bolt
- Raumedic PTO (ICP, PbtO<sub>2</sub>, Temp)
- Hemedex (Perfusion)
- Depth EEG

### 3. Once Neurosurgery has completed placement, plug in the Raumedic. Connect the Orange connector and the Blue connector from the Raumedic to the patients Raumedic catheter (**Figure 3**).

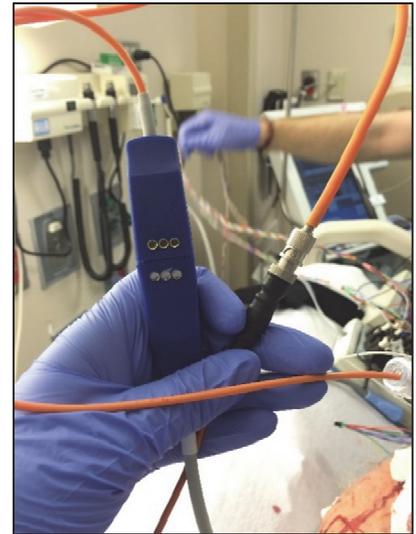
- Obtain INITIAL ICP prior to confirmatory CT and order sedation or HTS as needed prior to travel (**Figure 4a**).
- Disconnect Raumedic and wrap ALL MMM cables in Kerlix™ gauze to keep cables from accidentally catching/pulling (**Figure 4b**).



**Figure 1.** IV pole with Raumedic (top) and Hemedex (bottom)



**Figure 2.** Phillips Sleds



**Figure 3.** Raumedic PTO connectors.



**Figure 4.** A) Initial ICP 21.4, B) Kirlex™

**PREPERATION (continued)**

4. Connect all cables (ideally the patient will be in CT for this step; **Figure 5**).

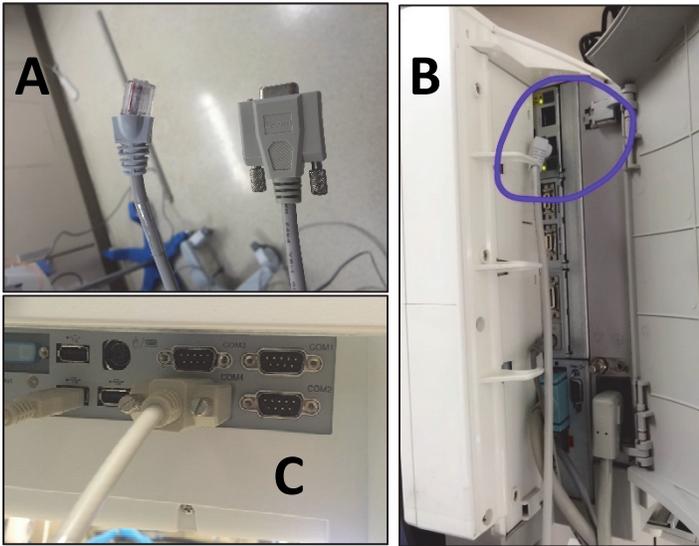
- Place Moberg near the RN computer in the room.
- Place Raumedic and Hemedex *behind* IV pole and bed – this will not need to be viewed on a regular basis.
- Install 2 Philips sleds.



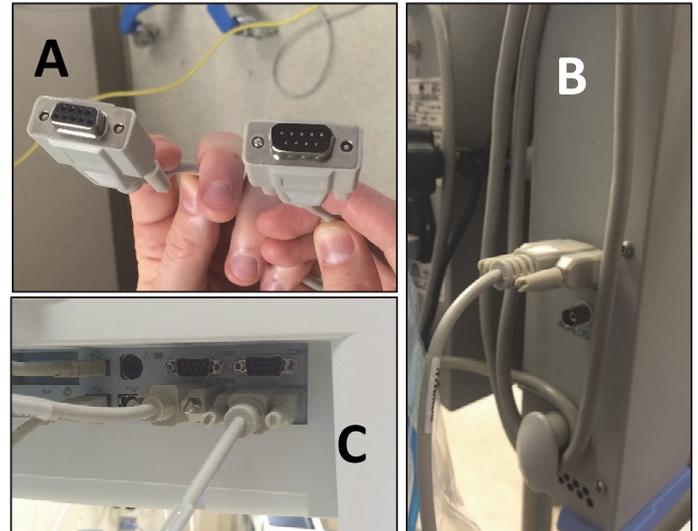
**Figure 5.** Ideal room arrangement. EEG (not shown) located on opposite side of the bed.

## CONNECTING THE MOBERG

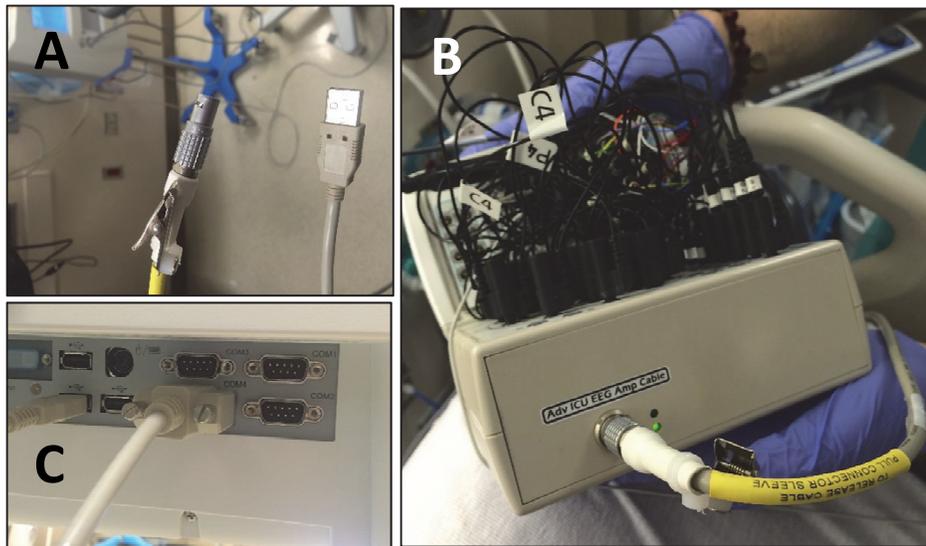
1. Connect RS232->LAN cable from one of the 4 RS232 ports in the back of the Moberg to the back of the Philips monitor (**Figure 6**).
2. Connect RS232->RS232 cable from one of the 4 RS232 ports in the back of the Moberg to the back of the Hemedex monitor (**Figure 7**).
3. Plug the EEG amplifier cable into one of the USB ports in the back of Moberg and route behind the bed to the opposite side of the room. Plug in the EEG amplifier and set aside (**Figure 8**).



**Figure 6.** A) Cables, B) Back of the Philips, C) Back of the Moberg.



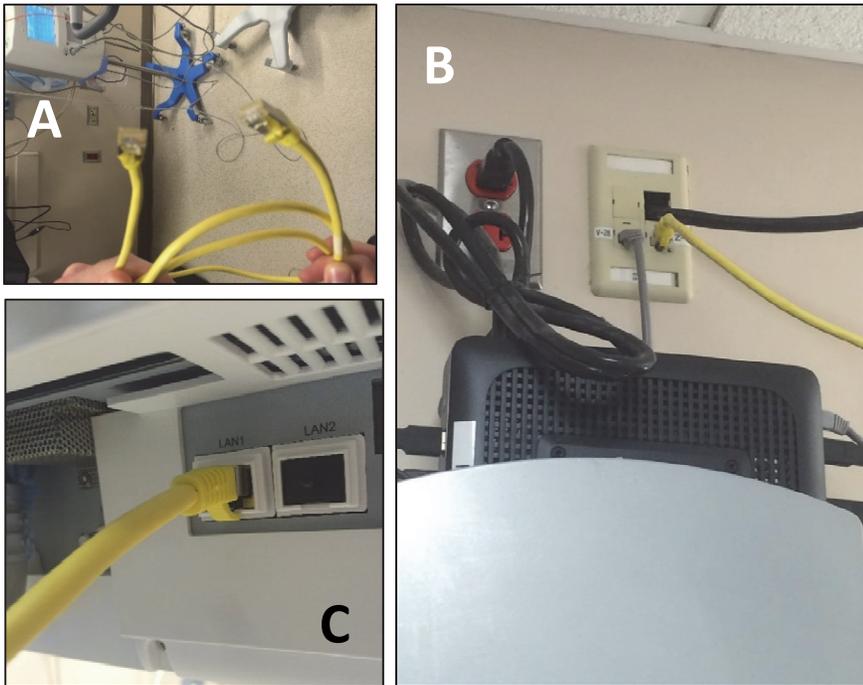
**Figure 7.** A) Cables, b) Back of the Hemedex, C) Back of the Moberg.



**Figure 8.** A) Cables, b) EEG Amplifier, C) Back of the Moberg.

**CONNECTING THE MOBERG (continued)**

4. Plug the LAN cable into LAN1 in the back of the Moberg to the LAN port (may be above the mounted computer in the room **(Figure 9)**).
5. Plug in the Moberg power cable into a RED outlet **(Figure 10)**
6. Wind any cable slack around the Moberg's wire basket **(Figure 11)**.



**Figure 9.** A) Cables, B) Network Port, C) Back of the Moberg.



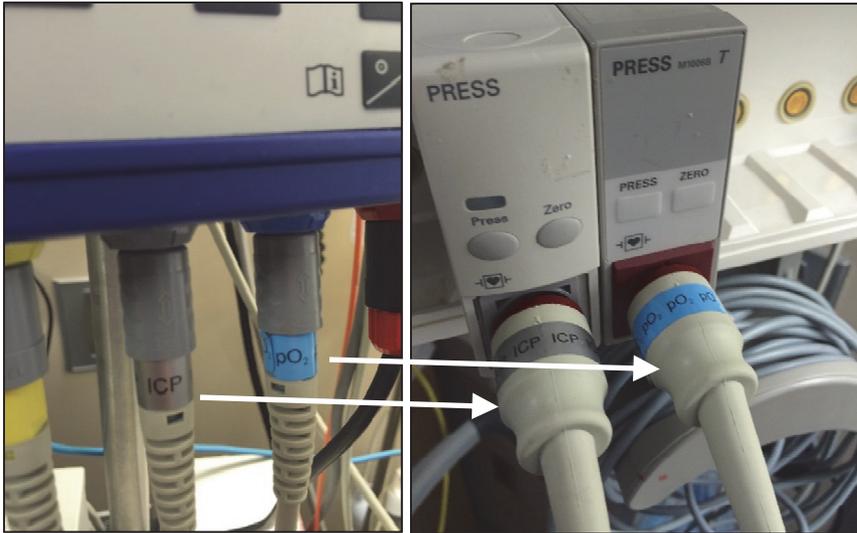
**Figure 10.** The RED power outlet



**Figure 11.** Moberg with wrapped cables (white arrows)

## CONNECTING THE RAUMEDIC

1. Plug the Raumedic back into one of the RED outlets on the wall (**Figure 10**).
2. Connect cable labelled "ICP" from Raumedic (should already be connected) to one of the two Philips sleds. Connect cable labelled "PbtO2" from Raumedic (should already be connected) to the second of the two Philips sleds (**Figure 12**).



**Figure 12.** Raumedic to Philips sleds.

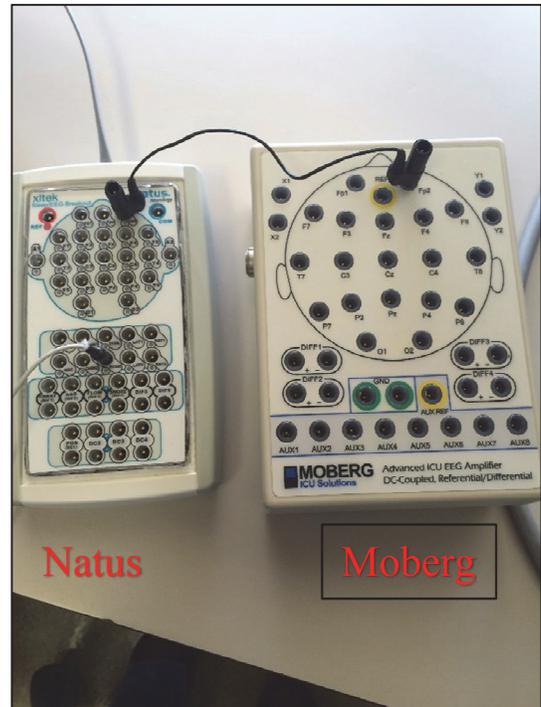
## CONNECTING THE HEMEDEX

1. Plug the Hemedex back into one of the RED outlets on the wall (Figure 10).
2. Turn on the Hemedex (front of the box).

## CONNECTING EEG

1. Obtain a Natus headbox from the EMU
2. In the Moberg wire basket, find the EEG cable 'jumpers'. Each jumper will be used to plug in a channel from the Moberg EEG Amplifier to the Natus EEG amplifier (**Figure 13**).
3. Plug in jumpers into the following from Moberg -> Natus:
  - Fp1 -> Fp1
  - F3 -> F3
  - C3 -> C3
  - P3 -> P3
  - O1 -> O1
  - F7 -> F7
  - T3 -> T3 (or T7)
  - T5 -> T5 (or P7)
  - Cz -> Cz
  - Pz -> Pz
  - Fp2 -> Fp2
  - F4 -> F4
  - C4 -> C4
  - P4 -> P4
  - O2 -> O2
  - F8 -> F8
  - T4 -> T4 (T8)
  - T6 -> T6 (P8)
  - AUX1 -> LOC
  - AUX2 -> ROC
  - AUX3 -> CHIN1
  - AUX4 -> CHIN2
  - AUX5 -> LAT1
  - AUX6 -> LAT2
  - AUX7 -> RAT1
  - AUX8 -> RAT2

4. Order cEEG in EPIC with comment "Patient has Depth Electrode with Moberg EEG Amplifier"
5. Find the Depth EEG connector in the Moberg wire basket. Plug each pin (labeled 1 through 8) into the Moberg Amplifier channels AUX1 to AUX8 in numerical order (**Figure 14**).



**Figure 13.** Natus headbox and Moberg headbox. A 'Jumper' is connecting Fp2 on the Natus headbox



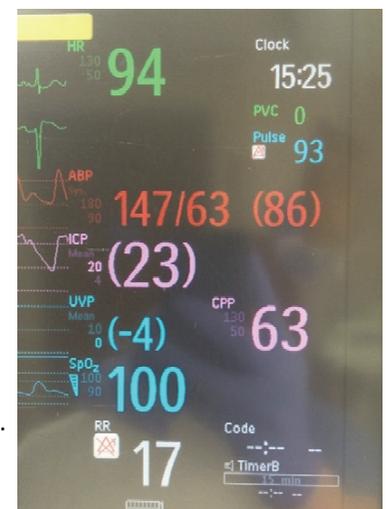
**Figure 14.** Depth electrode connector. 'Pins' are labeled 1 through 8.

## CONNECTING THE PATIENT

1. Connect Raumedic orange and blue cables to the Raumedic.
  - The Orange cable slides in place over a notch in the plug. *If resistance is met, do not push* – the orange cable is a Fiberoptic cable and may break.
  - The Blue cable has three brass dots on each connector. Match up so they are on the same side (**Figure 15**).
2. Connect the Hemedex catheter with the Hemedex box.
  - Ensure the Hemedex box does not have any errors on the top line:
    - “Probe advanced or research Settings not at defaults” can be ignored. Press “Clear Message”
    - “No storage space” errors require data to be cleared from the machine; contact Foreman.
    - Select “Start” to start the Hemedex calibration cycle.
3. Connect the Depth electrode to its connector. *Flip* open the clear part of the connector and slide the depth wire into the small hole until all electrodes are inside the connector. Be sure the contacts on the tail of the depth wire are lined up with the contact pins on the connector, and then snap the clear hinge back into place. Do not force the hinge into place. It should *click* easily.
4. Connect Raumedic to the Philips
  - On the Philips monitor, select 8 waveforms.
  - Make sure the two Philips sleds are labelled “ICP” and “UVP”
  - Once there are two waveforms labelled “ICP” and “UVP” showing up on the screen, go to the Raumedic and select “OUT” and follow the prompts:
    - Confirm both ICP and PbtO2 are plugged into sleds, and select OK
    - On the Philips, zero both the ICP and UVP -> OK once “0” appears for both
    - The next step will inject 20 mmHg into each of the ICP and UVP ports -> WAIT until both read 19-20 (may take up to 2 minutes) and then on the Raumedic select OK.
    - Verify that the Philips monitor now displays ICP and UVP
5. Set up CCP
  - If the patient has an arterial line, verify that the arterial pressure waveform is labeled “ABP” and NOT “ART” (**Figure 16**).
  - If the patient does not have an arterial line, please have NCC place an arterial line.



**Figure 15.** Raumedic connector with brass dots lined up correctly.



**Figure 16.** Arterial Line labelled as ‘ABP’ correctly. The CPP shows up as confirmation.

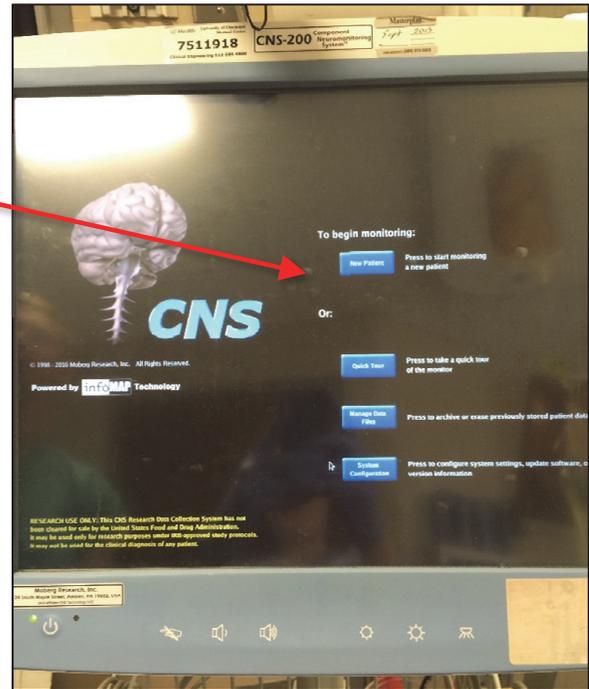
## TURNING ON THE MOBERG

- Press the power button and the Moberg will boot up.
- Select “New Patient” (**Figure 17**)
  - If a former patient monitoring session had been improperly shut down, you will see an option to “Restore”. Select this, and then proceed with “Discharge” instructions below to safely stop the prior monitoring session.

- Select the big green button (**Figure 18**)
- Select “OK”, “Start EEG Recording” and “Done” for the next prompts until you get to a screen that ask for Name and MRN.
- Enter the patients MRN number. Do not use any other identifiers. Select OK.
- Ensure that the “Main Display” shows up with Philips waveforms in the upper part of the screen and numerical values on the bottom, including the PbtO2, Perfusion (may not show up until calibration is completed), and CPP



**Figure 18.** “Begin Monitoring”



**Figure 17.** Moberg Start Screen

## TROUBLESHOOTING

1. Verify placement on NCHCT of the catheters. Three distinct catheters should be visible in the brain parenchyma (**Figure 19**).
2. Raumedic ICP – requires NO calibration or zeroing procedure (unlike Codman). If ICP waveform does not appear, select “Optimum Scale” on the Philips monitor. If ICP values do not appear, go back to the **Connecting the Patient** section and try steps 1) and 4) again.
3. Raumedic PbtO<sub>2</sub> - requires NO time for the PbtO<sub>2</sub> to read accurately (unlike Licox) as long as there are no technical issues; if UVP is reading < 5,
  - Verify on NCHCT that there is no hematoma at the insertion site or along the catheter.
  - There may be microscopic blood or other tissue over the Fiberoptic “window”, the reading may be inaccurate. Have Neurosurgery “spin” the Raumedic 90-180 degrees inside the bolt and allow time for the window to clear.
  - There may be a problem with the Fiberoptic cable. Light should be visible from the end of the plug that connects from the Raumedic to the patient. If so, check the quality of the light signal. On the Raumedic box, select “SET” and scroll down to “PbtO<sub>2</sub> Settings” and verify the waveform amplitude is > 400 nM. If the amplitude is low, unplug the orange cable and using an alcohol swab, gently wipe the Fiberoptic cable on both ends to verify there is no dust.
  - Challenge the Raumedic by increasing the Fio<sub>2</sub> (an expected response of 10-20 mmHg is adequate) for up to 20 minutes. If this does not work, increase the CPP by 10 mmHg if it is safe to do so, targeting a CPP of 80 mmHg. If neither work, consider replacing the catheter.
4. Hemedex
  - The Hemedex requires thermal gradient to calculate CBF. The **PPA** is the Probe Placement Assistant, which measures pulsatility near the catheter which suggests a nearby blood vessel. A value of >5 suggests inaccurate blood flow measurements due to this nearby pulsatile heat source. Ask Neurosurgery to pull back the catheter 0.2-0.3 cm.
  - The Hemedex may not be in parenchyma. Verify the temperature (T<sub>perf</sub>) of the brain is > 36C and within 0.8 C of the Raumedic temperature (found on the Raumedic box). In addition, temperatures < 36 C suggest an ambient temperature and a shallow Hemedex catheter placement or removal of the Hemedex from the parenchyma altogether.
  - The Hemedex may fluctuate or recalibrate frequently if there are systemic or local temperature fluctuations or rapid changes in blood flow (e.g. sudden changes in sedation, temperature with head ice packs).



**Figure 19.** NCHCT Scout Image with 3 clearly visible catheters. Axial images can be used to verify depth and location.

## 5. Depth EEG

- Depth EEG will not record properly without ground and reference electrodes. These will be placed by EEG technologists along with cEEG.
- If Depth EEG is not displaying properly on Natus or Moberg, please contact EMU or Foreman for troubleshooting (Fig 20).
- Depth EEG data is reviewed for clinical purposes via the EMU.



**Figure 19.** NCHCT Scout Image with 3 clearly visible catheters. Axial images can be used to verify depth and location.