

MULTIMODALITY MONITORING

Set-up Guide

Brandon Foreman, M.D.
Capt Kelsey Cacic, MD
Molly O'Brien, ACNP

Updated Apr 2022



Contact Info:

Brandon Foreman, MD
foremabo@ucmail.uc.edu
214-683-9863

Table of Contents

Topic	Pages
List of equipment	3
Preparation	4-5
Connections	
Hardware	6-8
Moberg	6
Raumedic	6
Hemedex	6
EEG	7-8
Software connections	9-10
Troubleshooting	11-13

List of Equipment

Machines

Moberg

Raumedic (*usually on IV pole with Hemedex*)

Hemedex (*usually on IV pole with Raumedic*)

Philips sleds x2

EEG Moberg amplifier box

EEG Natus box (*from EEG techs*)

Cables

RS232 → RS232 (*Moberg to Hemedex*)

RS232 → LAN (*Moberg to Philips*)

LAN → LAN (*Moberg to network*)

EEG amplifier cable

EEG jumper cables (*30, 32 if strip electrode present*)

EEG platinum needle reference electrode + IV dressing kit

Preparation

1. Neurosurgery bolt placement
 - a. Will place the quad lumen bolt (Figure 1a)
 - i. Raumedic PTO
 - ii. Hemedex
 - iii. Depth EEG
 - iv. CMD catheter
 - b. Will wrap bolt (and all cables) in Kerlix™ to keep cables safe (Figure 1b)
 - c. Obtain initial ICP prior to confirmatory CT
 - i. Connect the orange connection and the blue connection (Figure 2) to obtain the ICP then disconnect for travel
 - ii. Travel ICP device is available
 - d. Order sedation and/or HTS as needed prior to travel for CT



Fig 1a. Quadlumen bolt prior to wrapping in Kerlix™

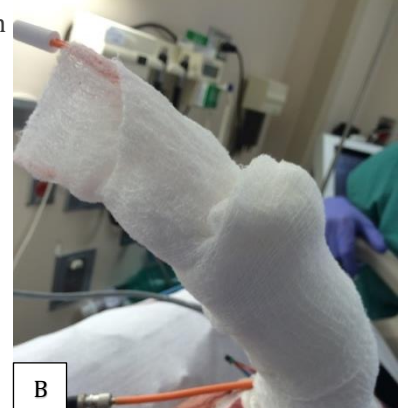


Fig 1b. Bolt wrapped in Kerlix™

2. Gather equipment
 - a. Machines
 - i. Raumedic (Figure 3a)
collects ICP, PbtO2, and temperature
 - ii. Hemedex (Figure 3a)
collects rCBF/perfusion
 - iii. Moberg
 - iv. Philips sleds (2) (Figure 3b)
 - v. EEG amplifier box with amplifier cable (Figure 3c)

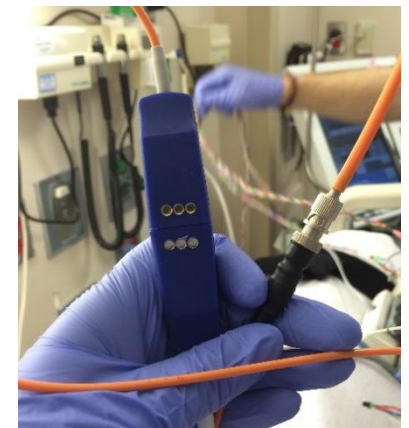


Fig 2. Raumedic connection

Fig 3a. IV pole with Raumedic (top) and Hemedex (bottom)

Fig 3b. Two Philips sleds

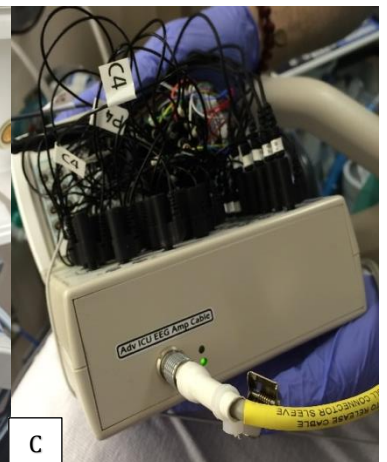
Fig 3c. EEG amplifier with cable



A



B



C

- b. Cables
 - i. RS232→LAN cable (Figure 4a)
connects Moberg to Philips
 - ii. RS232→RS232 cable (Figure 4b)
connects Moberg to Hemedex
 - iii. LAN cable (Figure 4c)
connects Moberg to network
 - iv. EEG jumpers (Figure 4d)
connects EEG to EEG amplifier box (Moberg)

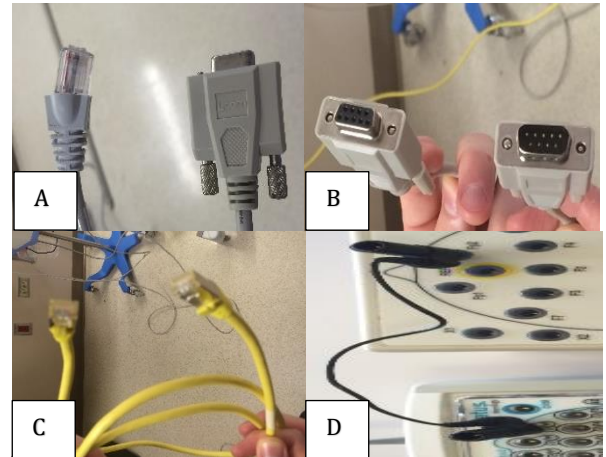


Fig 4. Cables A) RS232->LAN B) RS232->RS232 C) LAN D) EEG jumper

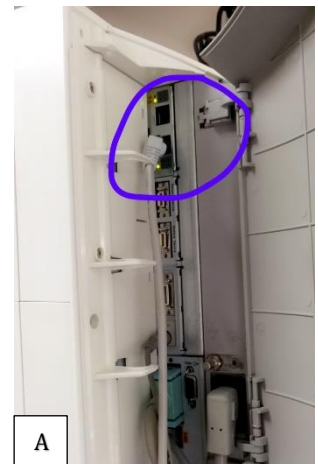
- 3. Arrange equipment
 - a. Room arrangement
 - i. Place Moberg near the RN computer in the rom
 - ii. Place Raumedic and Hemedex (on same IV pole) behind the IV pole with pumps; this will not need to be viewed on a regular basis (Figure 5)
 - b. Install two Philips sleds (Figure 3b)
 - c. LAN cable
 - i. Plug in the LAN cable to the LAN port above the mounted computer in the room
 - ii. This may be most easily done when the patient is out of the room for scan
 - d. EEG
 - i. Should go on opposite side of room from Moberg
 - ii. Ensure cEEG ordered in EPIC with comment "Patient has Depth Electrode with Moberg EEG amplifier"



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

Hardware Connections

1. Moberg connections
 - a. Plug the Moberg power cable into one of the **RED** wall outlets
 - b. RS232→LAN cable from the back of one of the four ports in the back of the Moberg to the back of the Philips monitor (Figure 6 a,b)
 - c. RS232→RS232 cable from the back of one of the three remaining ports in the back of the Moberg to the back of the Hemedex monitor (Figure 7)
 - d. LAN cable (from the LAN port above the mounted computer) to the back of the Moberg (**LAN1**, **not LAN2**) (Figure 8)
 - e. Plug the EEG amplified cable into the back of one of the USB ports in the back of the Moberg
 - f. Wind any slack from any cables around the Moberg's wire basket
2. Raumedic connections
 - a. Plug the Raumedic into one of the **RED** wall outlets
 - b. Connect Raumedic orange and blue cables
 - i. The orange cable slides in place over a notch in the plug
 1. If resistance is met, do not push
 2. The orange cable is fiberoptic and may break
 - ii. The blue cable has three brass dots on each connects; they match up so they are on the same side (Figure 2)
 - c. Connect the cable labeled "ICP" from the Raumedic to one of the two Philips sleds (Figure 3b)
 - d. Connect the cabled labeled "PbtO2" from Raumedic to the second of the two Philips sleds (Figure 3b)
3. Hemedex connections
 - a. Plug the Hemedex into one of the **RED** wall outlets
 - b. Turn on the Hemedex (power switch from of the box)
 - c. Press "Start" to start the Hemedex calibration cycle



A



B

Fig 6. A) Back of the Philips (LAN end), **B)** Back of the Moberg (RS232)



Fig 7. Back of the Hemedex (RS232 → RS232)

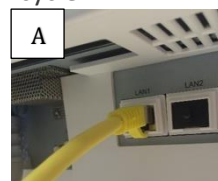
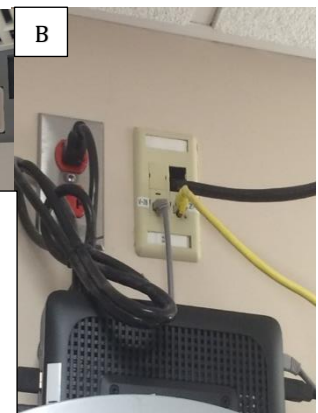


Fig 8. A) Moberg LAN1
B) room LAN above computer



4. EEG connections

- EEG techs will connect the patient (standard 10-20 montage)
- Place platinum reference electrode behind ear; cover with IV dressing
- EEG jumpers will be used to plug in a channel from the Moberg EEG amplifier to the Natus EEG amplifier (Figure 9)
- Plug in the electrodes as follows:



Fig 9. Natus (left) jumped to Moberg (right)

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 or T8
T6	→	T6 or P8

		Depth
Moberg		Natus
AUX1	→	LOC
AUX2	→	ROC
AUX3	→	CHIN1
AUX4	→	CHIN2
AUX5	→	LAT1
AUX6	→	LAT2
AUX7	→	RAT1
AUX8	→	RAT2

- Plug in the ground and reference electrodes as follows: (Figure 10)
 - Moberg REF → Natus REF, which receives REF from 10-20 (head) montage
 - Moberg REF → Moberg AUXREF, receives platinum needle (if used)
 - Moberg GND (either one) → Natus COM, which receives ground electrode (chest)

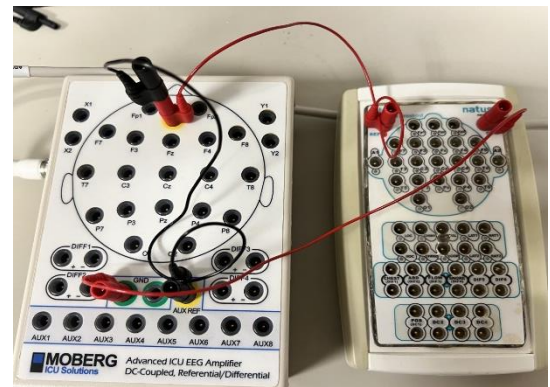


Fig 10. Ground and reference electrode connections

f. Depth electrodes

- i. Flip open the clear part of the depth electrode connector (Figure 11) and insert depth wire into the small hole until all electrodes are inside the connector, then snap the clear hinge back into place



Fig 11. Depth electrode connector

1. Be sure the contacts on the tail of the depth wire are lined up with the contact pins
2. Do not force the hinge into place, it should click easily

- ii. AUX electrodes (on Moberg amplifier) have depth electrode pins plugged in, deepest (1) to shallowest (8) (Figure 12)

g. Strip electrodes (if present)

- i. Strip electrodes will replace depth electrodes in AUX1-6
- ii. Depth electrodes will go into channels X1, X2, Y1, Y2 on Moberg amplifier (top left, top right)
 1. Plug in 1-4
 2. If poor or attenuated signal, plug in 5-8 instead

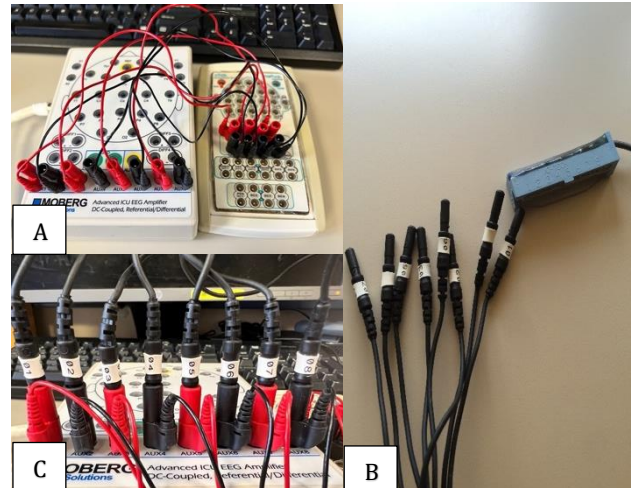


Fig 12. A) depth electrode Moberg to Natus connection, B) depth electrode pins, C) depth electrode pins to Moberg

Software set-up

1. Philips

- a. On the monitor, select 8 waveforms (if not already done)
- b. ICP and PbtO2
 - i. Make sure two Philips sleds are labelled “ICP” and “UVP” (which will be PbtO2)
 - ii. Go to Raumedic and select “OUT”, then confirm both ICP and PbtO2 are plugged into sleds; press OK
 - iii. On the Philips, zero both the ICP and UVP; press OK once “0” appears for both
 - iv. The next step will inject 20mmHg into each of the ICP and UVP ports. WAIT until both read 19-20 (may take up to two minutes), then selected OK on Raumedic
 - v. Verify Philips monitor now displays ICP and UVP (= *PbtO2*)
- c. CPP
 - i. Ensure A-line is present
 - ii. Verify that the arterial blood pressure waveform is labeled “**ABP**”, not “ART” on Phillips monitor

2. Moberg – General

- a. Press the power button and Moberg will boot up
- b. Selected “New Patient” on main screen
- c. Verify the protocol matches the EEG electrodes used for the patient
 - i. Protocol options include:
 1. SD2 scalp only
 2. SD2 depth and scalp
 3. SD2 strip depth and scalp
 - ii. Hit “edit / select protocol” to change to the correct protocol
- d. Select the big green “Begin Monitoring” button, then “OK”, “Start EEG recording”, and “Done” until you get prompts for Name and MRN
- e. Enter the MRN number and name; select OK
- f. Ensure the “Main Display” shows up with Philips waveforms in the upper part of the screen and numerical values on the bottom
- g. Verify network connectivity (Figure 13):
 - i. Touch “Main Menu”
 - ii. Go to “System Information” → verify an IP address is present

3. Moberg - CMD set-up
 - a. On the top of the Moberg screen, there is usually a colored banner to click and select “ISCUS”; otherwise, on the left side there is a “Setup” tab you can click and then select the “ISCUS” / “CMD”
 - b. Then click “find patients” and give it a few minutes to search
 - c. Click the patient name when it appears

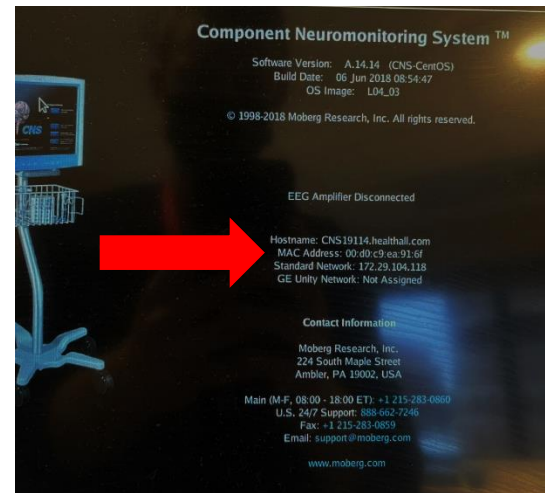
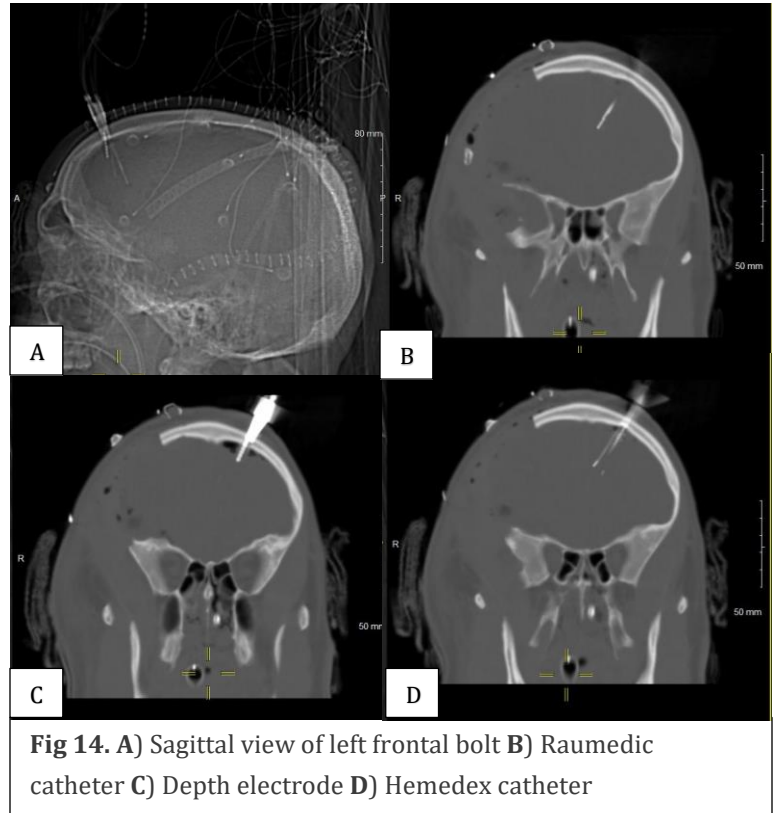


Fig 13. Verify network connectivity by ensuring an IP address is present

Troubleshooting

1. Bolt
 - a. Verify placement of catheter/bolt on the CT head
 - b. Four distinct catheters should be visible (Figure 14)
2. Moberg
 - a. Flashing banner on the top right will alert you to issues with connections
 - b. If there is not enough storage, go to “Manage Patients”
 - i. Scroll to the bottom and select a file
 - ii. Each file will denote if it was archived; if it says “Archived: once”, you can delete it
 - iii. If the file does not denote it was archived, select “Archive” and wait for it to process; do not delete
 - c. If a former patient session had been improperly shut down
 - i. You will see an option to “Restore”
 - ii. Select this and then proceed with “Discharge”
3. Hemedex: requires a thermal gradient to calculate CBF
 - a. “Probe advanced” or “Research settings not at default” error messages can be ignored; press “clear message”
 - b. “No storage space” errors require data to be cleared from the machine
 - i. Press button on right that says “stop”
 - ii. Then “data” menu → “select all” and “delete”
 - c. PPA (probe placement assistant) measure pulsatility near the catheter
 - i. Value >5 suggests inaccurate blood flow measurements due to nearby pulsatile heat source
 - ii. Consider asking NSGY to pull back the catheter 0.2-0.3cm
 - d. Temp too low



- i. Tperf should be $>36^{\circ}\text{C}$ and within 0.7°C of the Raumedic temperature
 - ii. Tperf $< 36^{\circ}\text{C}$ suggest an ambient temperature and a shallow Hemedex catheter placement or removal of the Hemedex from the parenchyma
 - e. Hemedex may fluctuate or recalibrate frequently
 - i. Particularly if there are systemic or local temperature fluctuations (ice packs, Artic Sun) or rapid changes in blood flow (stimulation or neuro exam)
4. Raumedic
- a. Requires no calibration or zeroing procedure
 - b. If ICP waveform does not appear, select “Optimum scale” on the Phillips monitor; if this does not help, repeat the steps in the “Hardware connections: Raumedic” section and the “Software connections: Phillips” section
 - c. If the UVP/PbtO₂ is reading < 5
 - i. Verify no hematoma at insertion site or along catheter on head CT
 - ii. Check that light is visible from the end of the fiberoptic cable (the end of the plug that connects from the Raumedic to the patient)
 - 1. If so, check the quality of the light signal: on the Raumedic box, select “SET” and scroll down to “PbtO₂ Settings” and verify the waveform amplitude is $> 400\text{ nM}$
 - 2. 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
 - iii. Challenge the Raumedic by increasing the FiO₂ for up to 20 minutes
 - 1. An expected response of 10-20 mmHg is adequate
 - 2. This should be repeated every 8-12 hours

5. EEG

- a. Depth EEG will not record properly without ground and reference electrodes; ensure they are connected properly (see “Hardware connections: EEG connections”)
- b. If depth EEG is not displaying properly on the Natus or Moberg, contact EMU, Foreman for troubleshooting (Figure 13)
- c. If no EEG tracing (go to ECOG side menu)
 - i. Go to EEG config (bottom menu)
 - ii. Verify EEG data collection is on

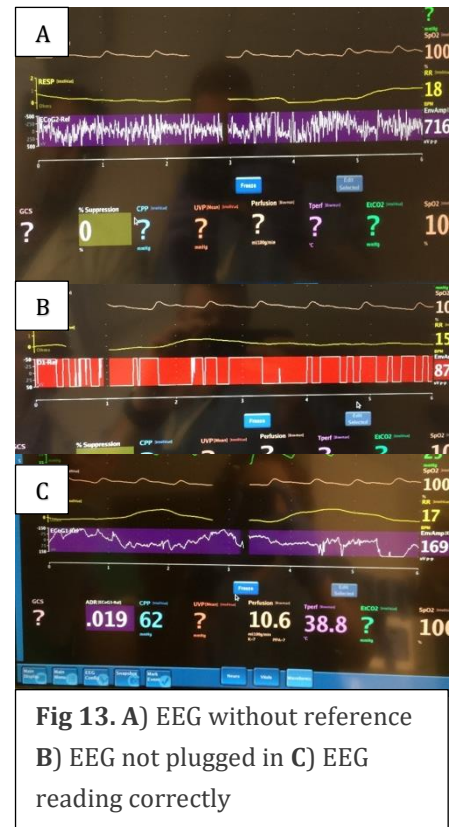


Fig 13. A) EEG without reference
B) EEG not plugged in C) EEG
reading correctly