

Introducing a new pain monitoring
system (PainMonitor™) to
Neurocritical care

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Objectives...

1. Evaluate the feasibility of using a skin conductance monitor (PainMonitor™) in neurocritical care.
2. Investigate the relationship between the PainMonitor™ peaks per second and patient CPOT scores.

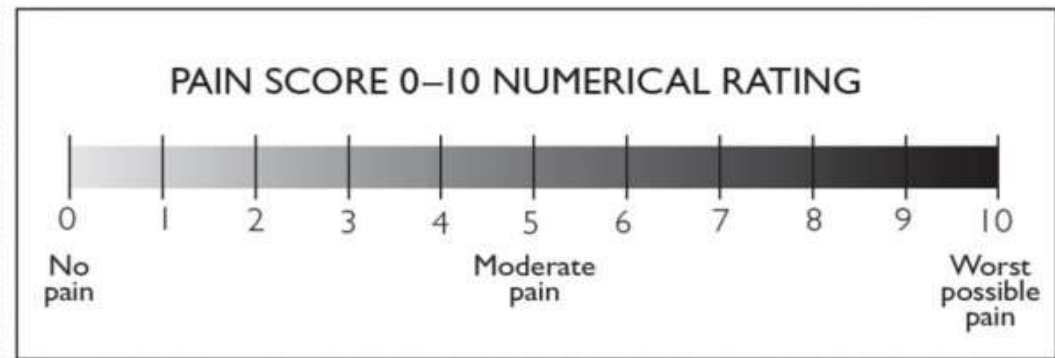


Background

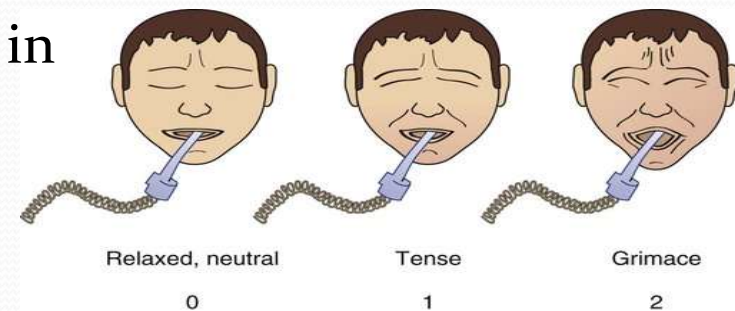
- Assessing pain in critical care is challenging but important
- In neurocritical care it is even more challenging due to brain and spinal cord injury
- Vital signs should serve as a cue to initiate further assessment of pain using methods such as CPOT but such scales have limited validity and use in brain injured patients (Azevedo-Santos, 2018)

Pain assessment tools

- Numerical Pain rating score



- Critical Pain observation tool (CPOT)
score > 2 has 86% sensitivity and 78% specificity in intubated patients for pain
(but not tested in neurocritical care)

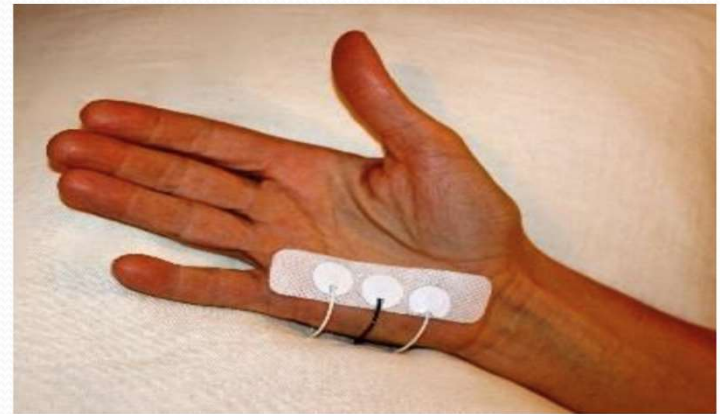




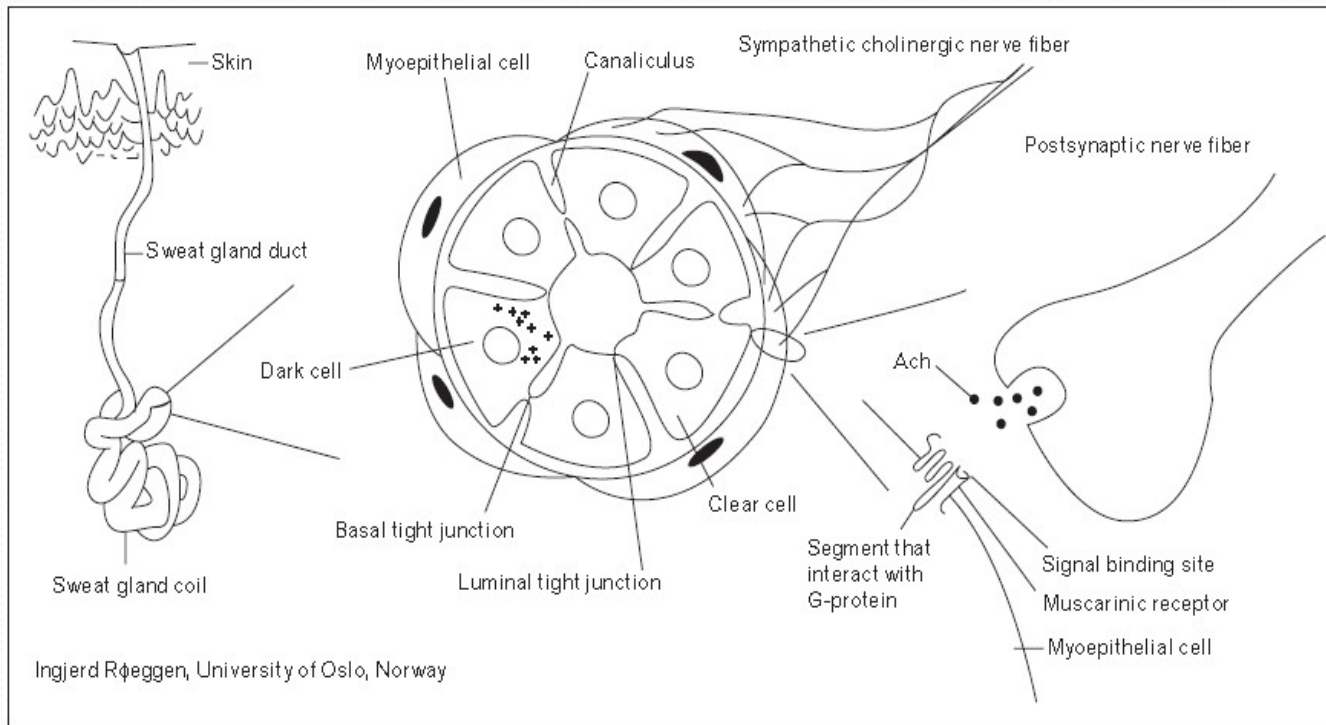
Why???

- The recent PADIS guidelines recommend research focus on development of objective measures of pain assessment (Devlin, 2018).
- Palmar skin conductance has been previously investigated as an objective indicator for pain in the intensive care setting with recent research suggesting it is more sensitive than other physiological markers (Aslandis, 2018), but this technique has not been validated in neurocritical care.

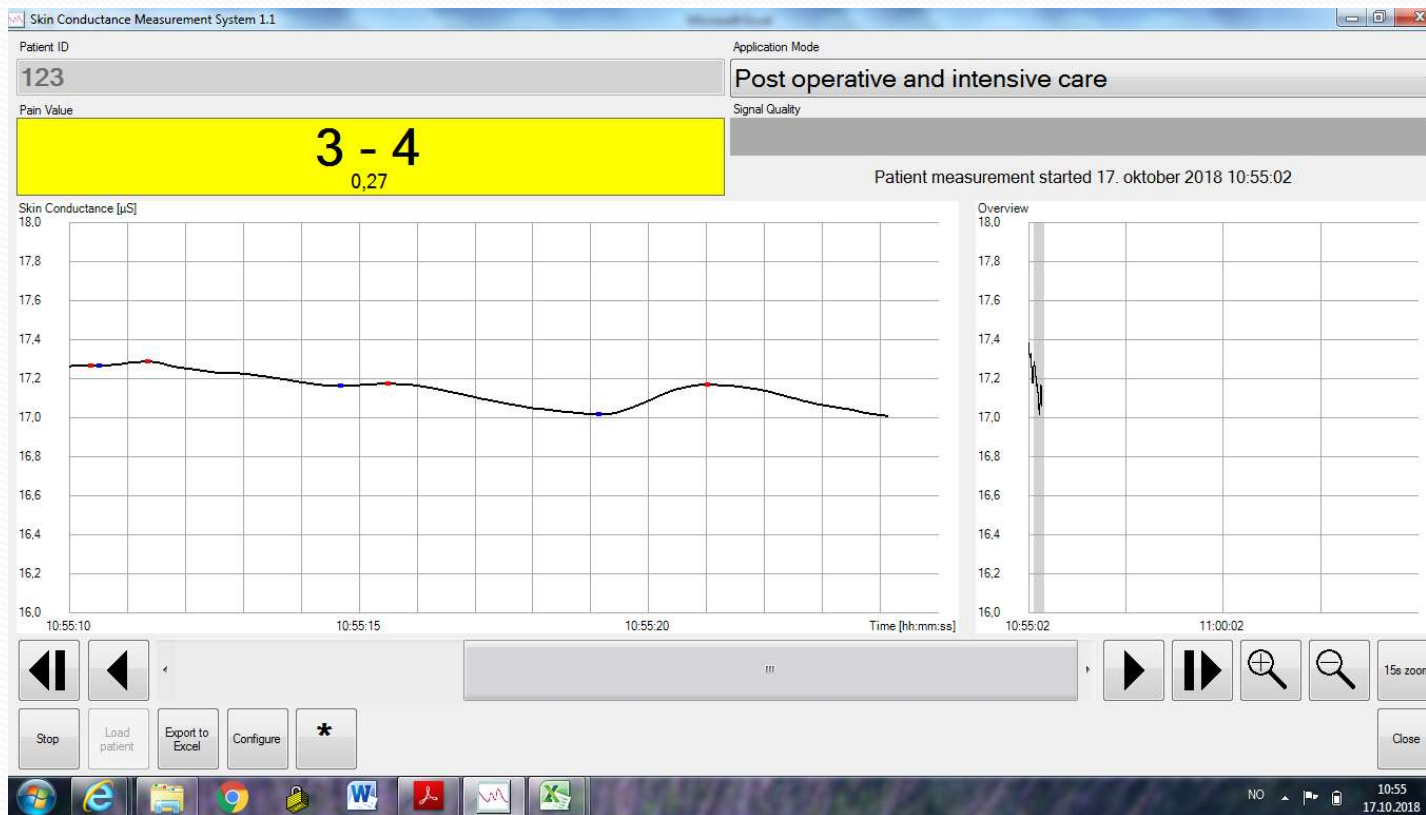
Measuring unit



Physiology



Pain index: intensive care



Index for patients intensive care

White: 0 0.00-0.07 peaks/sec	No pain
Light yellow: 1-3 0.13 peaks/sec	No pain or VAS* less than 40
Yellow: 3-4 0.27 peaks/sec	Patient is active, can be pain VAS* 40-50
Orange: 5-7 0.33 peaks/sec	Patient is possibly in pain, VAS* 60- 80 – go evaluate the situation
Red: 8-10 0.40 or more peaks/sec	Patient is probably in pain, VAS* 80- 100 – go find out how to help the patient

*VAS – Visual Analogue pain Score

Methods and results

Objective 1: Evaluate the feasibility of using a skin conductance monitor (PainMonitor™) in neurocritical care

- Questionnaire of experience using PainMonitor™ at end of shift
- 30 recording sessions (each over 3-5 hours approx.)
- 30 questionnaires completed

Nurse name: _____ Date: _____
Patient MRN: _____ Bed space number: _____

Skin algometer questionnaire

Q1. How easy was the device to apply? Easy Difficult Very difficult
Q2. How easy was the device to maintain? Easy Difficult Very difficult
Q3. If any parts required replacing during use, please state what and how many times?

Skin electrodes 1 2 3 4 5 6 7 8 9 10
Pain monitor 1 2 3 4 5 6 7 8 9 10

Q4. Did the device interfere with any other monitoring or routine clinical care? If yes, please name what.
No Yes _____

Q5. How many times did you respond to the number generated and how did you respond? E.g. Bolus dose of which drug? Seek medical advice?

0	1	2	3	4	5

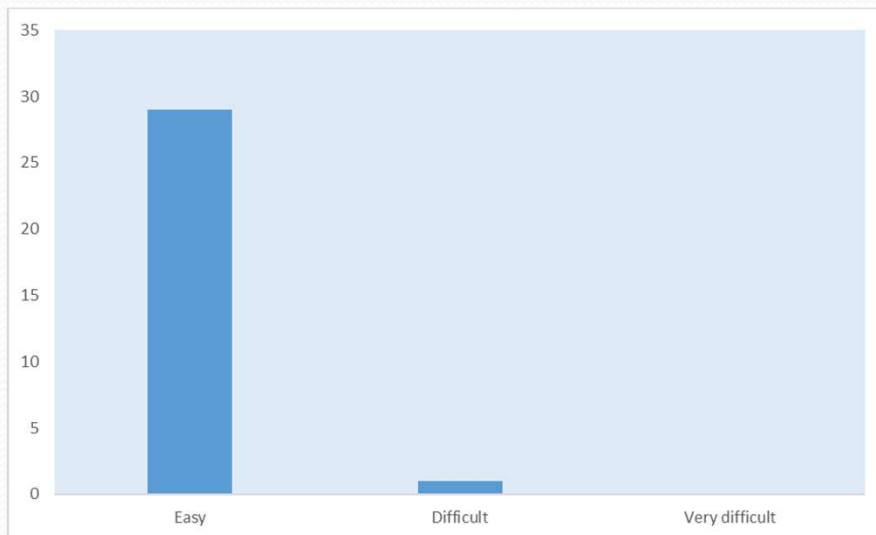
Q6. How many times did you respond to the CPOD score? E.g. Bolus dose of which drug? Seek medical advice?

0	1	2	3	4	5

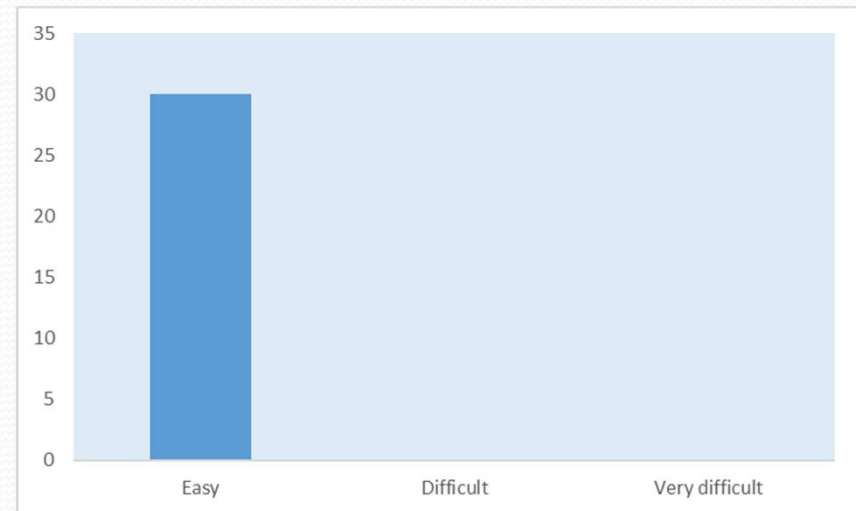
Q6. How easy was the device to remove? Easy Difficult Very difficult

How easy was the device

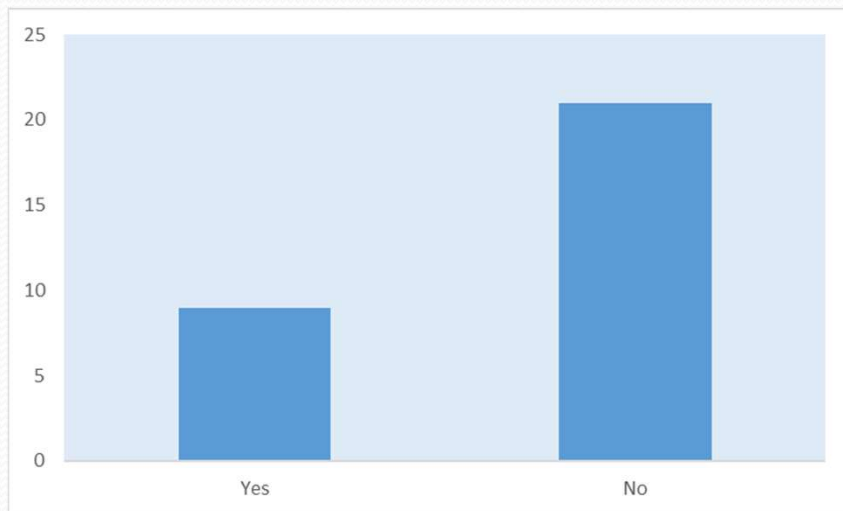
To apply



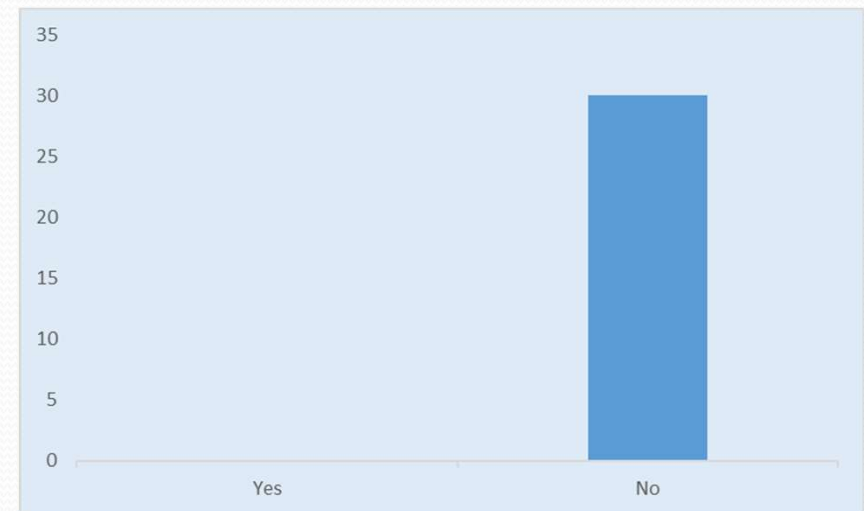
To maintain



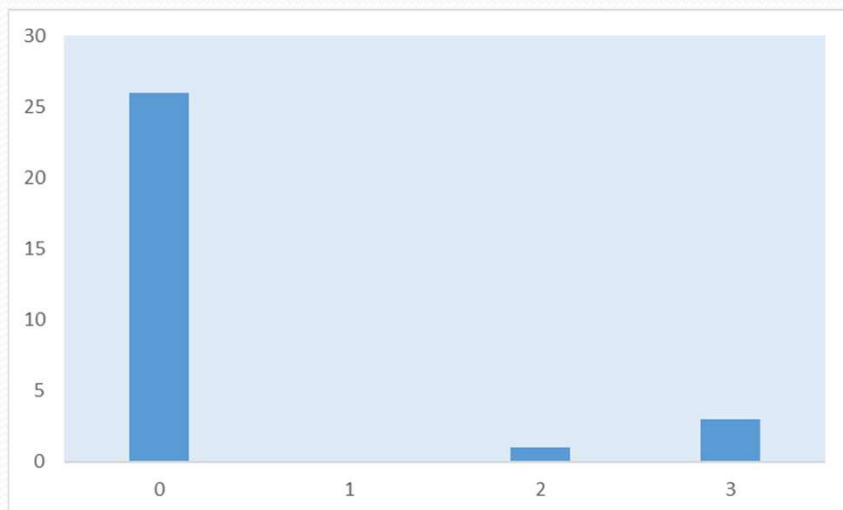
Did the skin electrodes need replacing?



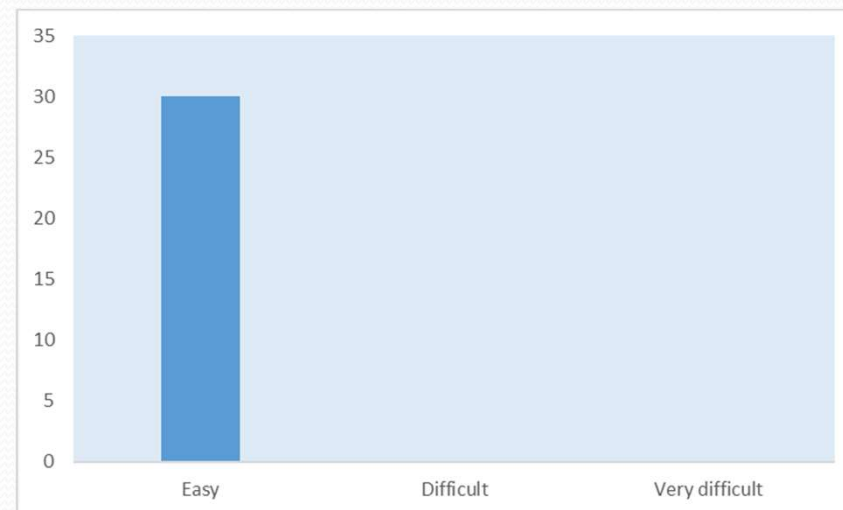
Interfere with any other clinical equipment?



How often did you respond to the peaks per second?



How easy was the device to remove?



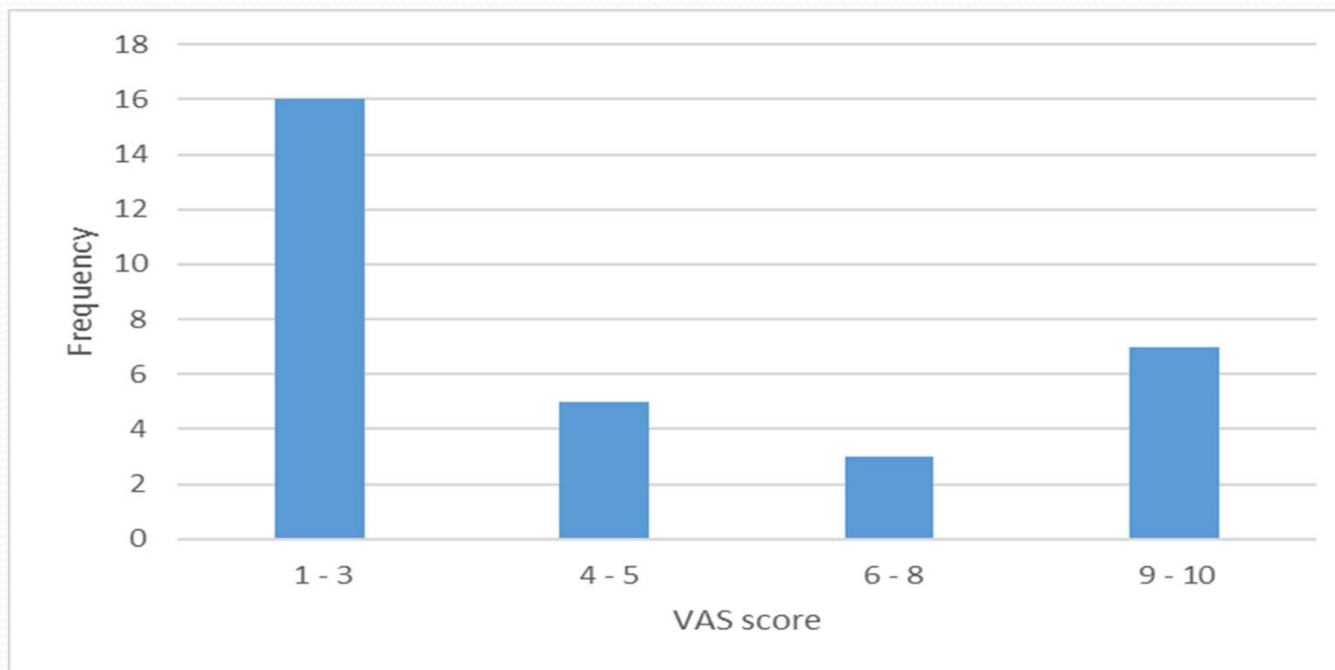


General comments...

- “Difficulty with starting PainMonitor™ software”
- “Even though the monitor read 0 for the entire shift I liked being able to tell relatives that the monitoring did not suggest their loved one was in pain”
- “Electrodes needed replacing due to sweat on patients palms”
- “I preferred having something objective to assess for pain”

Closer inspection...

- 31/ 87 PainMonitor™ suggested patient was in pain but CPOT score did not...

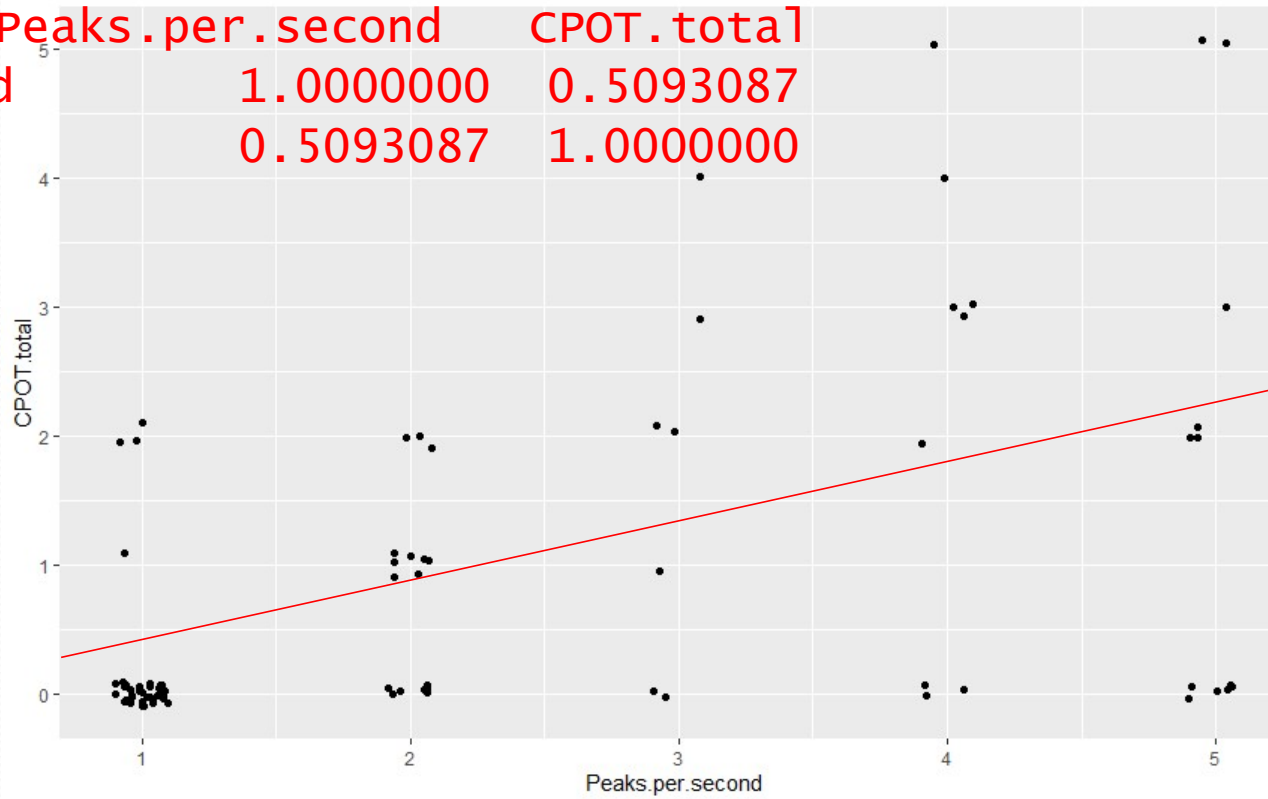


Methods and results

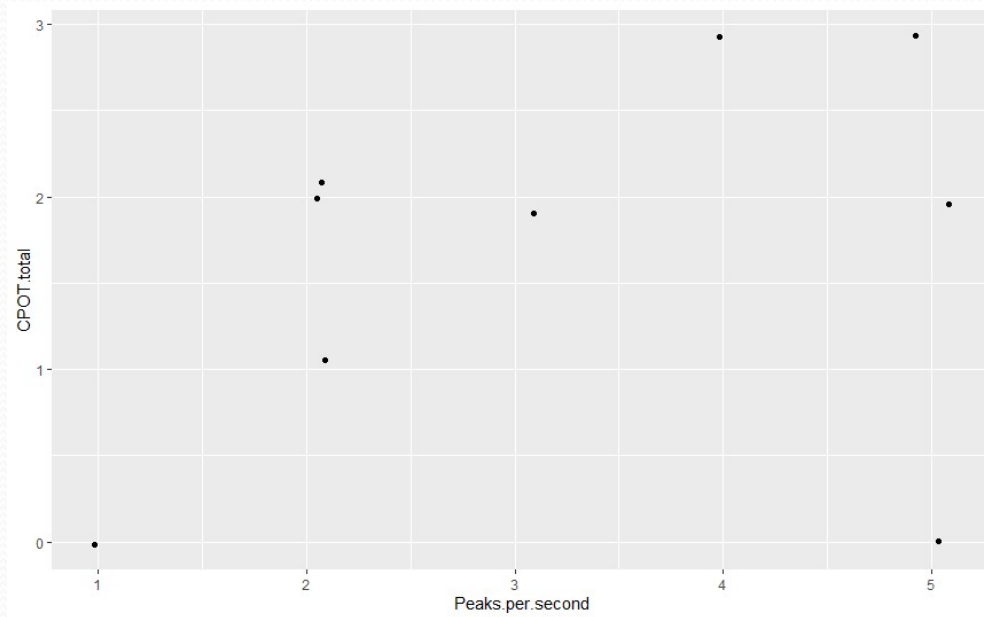
- Objective 2: relationship between the PainMonitor™ peaks per second and patient CPOT scores
 - Retrospectively collected data from clinical notes
 - CPOT; peaks per second; RASS
 - Data analysis with R studio (version 1.1.463)
- 30 recording sessions (each over 3-5 hours approx.)
 - 25 patients
- 116 'peaks per seconds' values recorded
 - 87 with a simultaneous CPOT score
 - 79 with a corresponding RASS score

All data

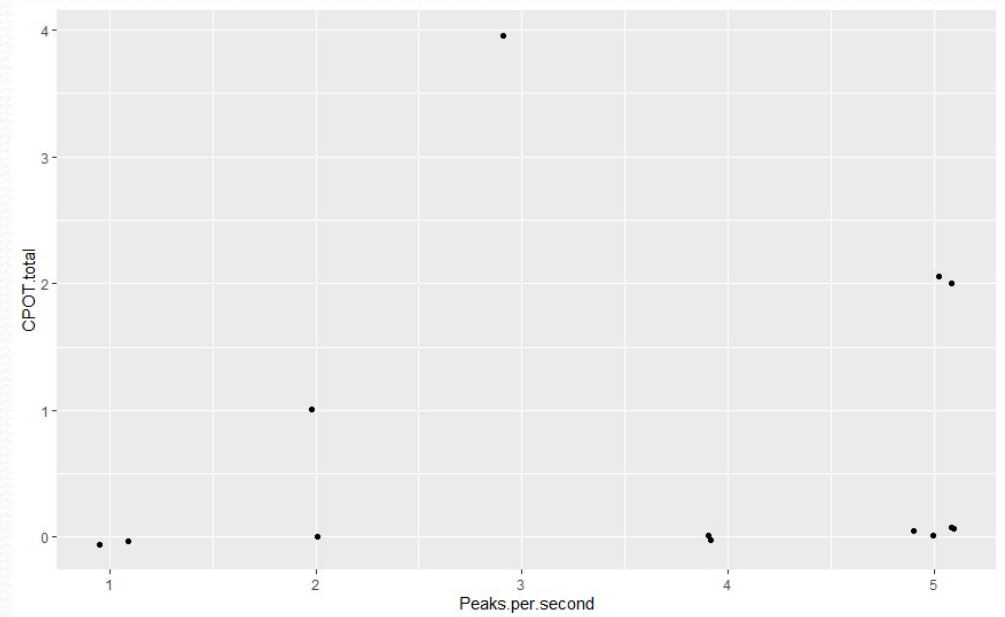
Peaks.per.second CPOT.total
Peaks.per.second 1.000000 0.5093087
CPOT.total 0.5093087 1.0000000



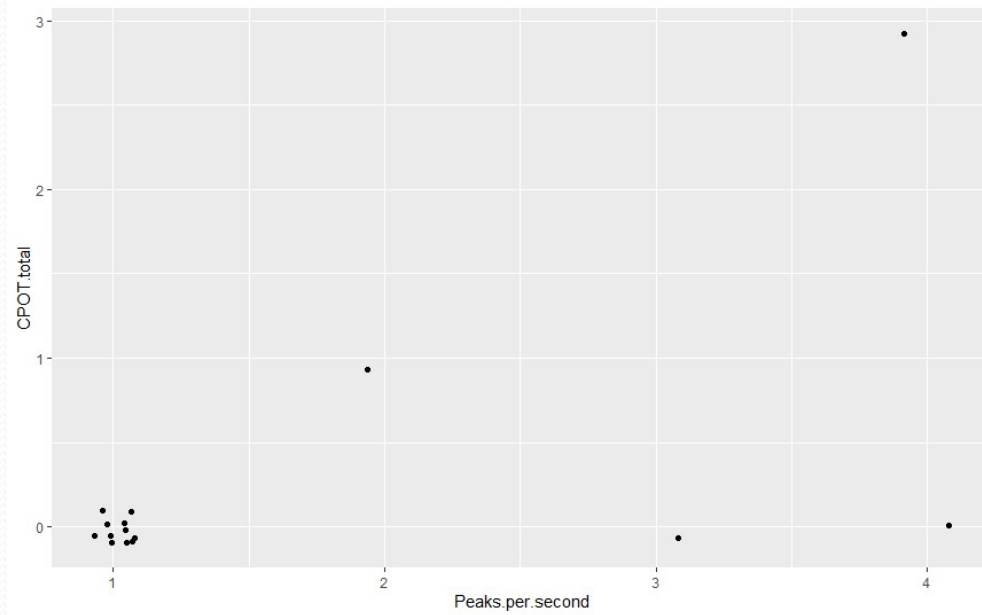
Rass -1 = 0.3337119



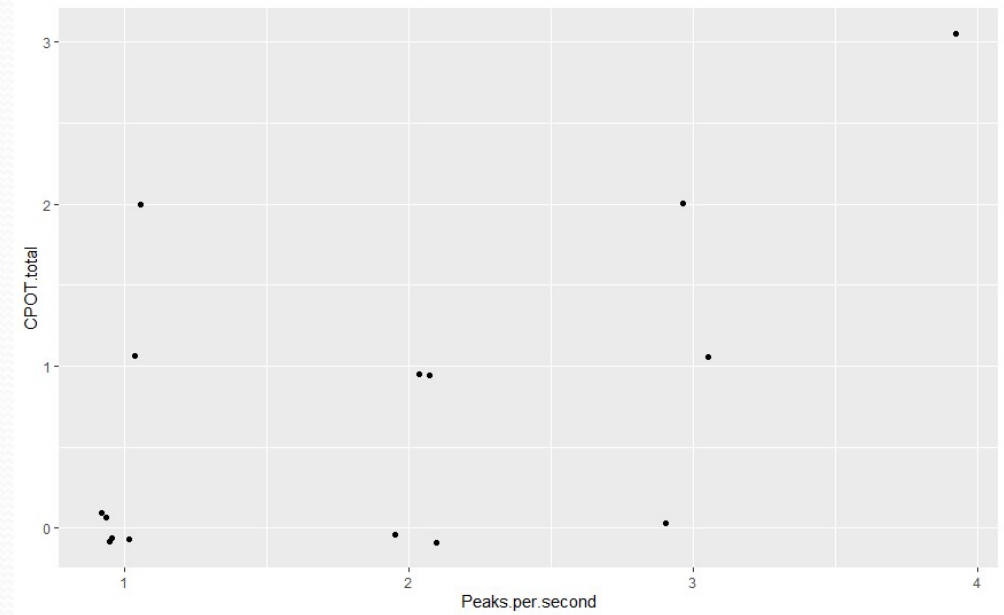
Rass -2 = 0.06051569



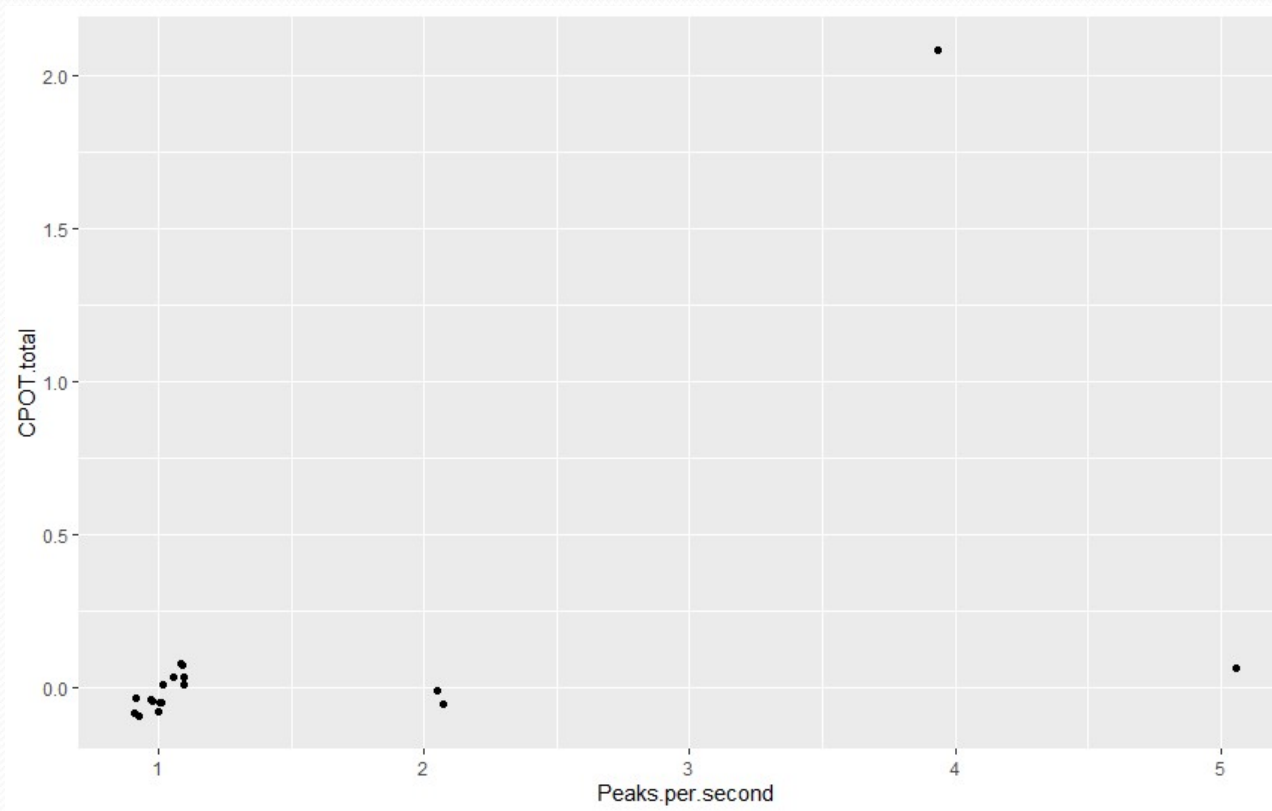
Rass -3 = 0.6061087

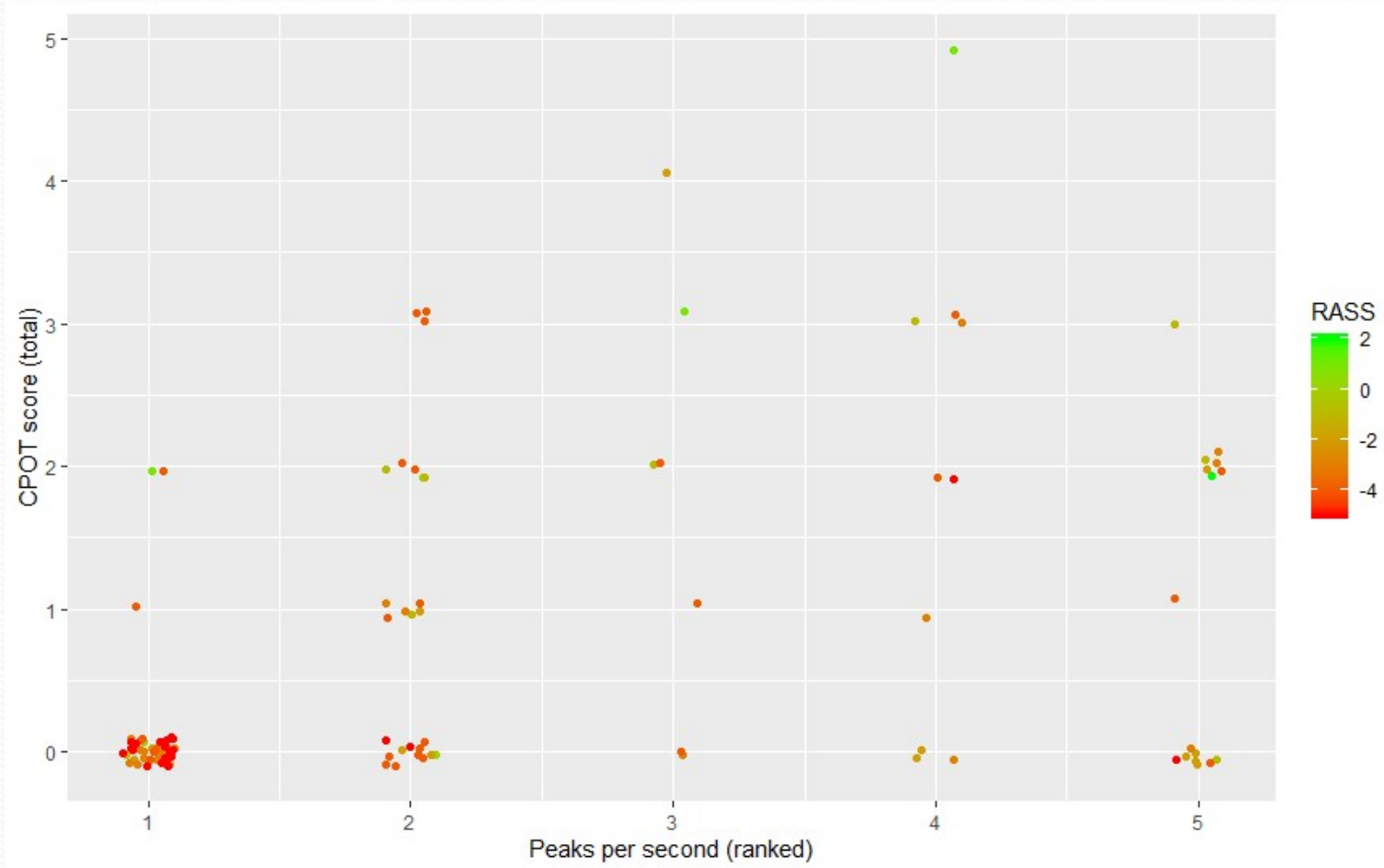


Rass -4 = 0.5602522



Rass -5 = 0.5423261





Peak Rank	CPO Score	RASS
1	0.0	-3.5
1	0.0	-3.0
1	0.0	-2.5
1	0.0	-2.0
1	0.0	-1.5
1	0.0	-1.0
1	0.0	-0.5
1	0.0	0.0
1	0.0	0.5
1	0.0	1.0
1	0.0	1.5
1	0.0	2.0
1	0.1	-3.0
1	0.2	-2.5
1	0.3	-2.0
1	0.4	-1.5
1	0.5	-1.0
1	0.6	-0.5
1	0.7	0.0
1	0.8	0.5
1	0.9	1.0
1	1.0	1.5
1	1.1	2.0
1	1.2	2.5
1	1.3	3.0
1	1.4	3.5
1	1.5	4.0
1	1.6	4.5
1	1.7	5.0
2	0.0	-3.5
2	0.0	-3.0
2	0.0	-2.5
2	0.0	-2.0
2	0.0	-1.5
2	0.0	-1.0
2	0.0	-0.5
2	0.0	0.0
2	0.0	0.5
2	0.0	1.0
2	0.0	1.5
2	0.0	2.0
2	0.1	-3.0
2	0.2	-2.5
2	0.3	-2.0
2	0.4	-1.5
2	0.5	-1.0
2	0.6	-0.5
2	0.7	0.0
2	0.8	0.5
2	0.9	1.0
2	1.0	1.5
2	1.1	2.0
2	1.2	2.5
2	1.3	3.0
2	1.4	3.5
2	1.5	4.0
2	1.6	4.5
2	1.7	5.0
3	0.0	-3.5
3	0.0	-3.0
3	0.0	-2.5
3	0.0	-2.0
3	0.0	-1.5
3	0.0	-1.0
3	0.0	-0.5
3	0.0	0.0
3	0.0	0.5
3	0.0	1.0
3	0.0	1.5
3	0.0	2.0
3	0.1	-3.0
3	0.2	-2.5
3	0.3	-2.0
3	0.4	-1.5
3	0.5	-1.0
3	0.6	-0.5
3	0.7	0.0
3	0.8	0.5
3	0.9	1.0
3	1.0	1.5
3	1.1	2.0
3	1.2	2.5
3	1.3	3.0
3	1.4	3.5
3	1.5	4.0
3	1.6	4.5
3	1.7	5.0
4	0.0	-3.5
4	0.0	-3.0
4	0.0	-2.5
4	0.0	-2.0
4	0.0	-1.5
4	0.0	-1.0
4	0.0	-0.5
4	0.0	0.0
4	0.0	0.5
4	0.0	1.0
4	0.0	1.5
4	0.0	2.0
4	0.1	-3.0
4	0.2	-2.5
4	0.3	-2.0
4	0.4	-1.5
4	0.5	-1.0
4	0.6	-0.5
4	0.7	0.0
4	0.8	0.5
4	0.9	1.0
4	1.0	1.5
4	1.1	2.0
4	1.2	2.5
4	1.3	3.0
4	1.4	3.5
4	1.5	4.0
4	1.6	4.5
4	1.7	5.0
5	0.0	-3.5
5	0.0	-3.0
5	0.0	-2.5
5	0.0	-2.0
5	0.0	-1.5
5	0.0	-1.0
5	0.0	-0.5
5	0.0	0.0
5	0.0	0.5
5	0.0	1.0
5	0.0	1.5
5	0.0	2.0
5	0.1	-3.0
5	0.2	-2.5
5	0.3	-2.0
5	0.4	-1.5
5	0.5	-1.0
5	0.6	-0.5
5	0.7	0.0
5	0.8	0.5
5	0.9	1.0
5	1.0	1.5
5	1.1	2.0
5	1.2	2.5
5	1.3	3.0
5	1.4	3.5
5	1.5	4.0
5	1.6	4.5
5	1.7	5.0

Conclusions and future work...

- PainMonitor™ is a feasible pain monitoring device in neurocritical care
- PainMonitor™ peaks per second has a moderately strong association with CPOT scores
 - the strength of the association increases with increasing depth of sedation
 - further data is required to investigate this relationship and at different levels of sedation
 - PainMonitor™ peaks per second could be used as part of a multimodal approach to improve assessment of pain in non-communicative neurocritical care patients
- The sensitivity and specificity of the PainMonitor™ in critical care requires further evaluation

References

- Aslanidis, T., Grosomanidis V., Karakoulas, K., Chatzisotiriou, A., 2018. Electrodermal Activity Monitoring During Painful Stimulation in Sedated Adult Intensive Care Unit Patients: a Pilot Study. *Acta Medica*. [e-journal], pp.47-52. <https://doi.org/10.14712/18059694.2018>.
- Azevedo-Santos, I., DeSantana, J., 2018. Pain measurement techniques: spotlight on mechanically ventilated patients. *Journal of Pain research*, [e-journal], 11, pp.2969-2980. <https://doi.org/10.2147/JPR.S151169>.
- Devlin, J.W., Skrobik, Y., Gelinas, C., et al. 2018. Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU. *Critical Care Medicine*, [e-journal] 46(9) pp. 825-873. DOI: 10.1097/CCM.0000000000003299.

Any questions?

