Table 1 Postoperative pain regimen for adult patients receiving peripheral nerve block for ambulatory upper extremity surgery.[*]

Medication	Frequency	Dosage
Paracetamol	Every 6 h	1000 mg
Ibuprofen	Every 6 h	600—800 mg
Gabapentin	Three times per day	100—300 mg[‡]
Oxycodone	Every 6 h	5—10 mg[‡]

[*] Medications are started immediately postoperatively, administered on schedule for the first 24 h, and tapered thereafter.
[†] Gabapentin is used for peripheral nerve procedures.
[‡] Most patients are prescribed oxycodone since peripheral nerve block is reserved only for major extremity procedures. A stool softener, laxative, or both is co-prescribed with oxycodone use.

We appreciate Barry and colleagues[1] determining factors that we can use to identify and treat patients at greatest risk for experiencing rebound pain from regional anaesthesia. Regional anaesthesia offers excellent pain control in the acute perioperative period, but as currently administered for outpatient surgery in many centres, actually results in more intense pain after discharge.[2,3] Through collaboration between anaesthetists and surgeons, we can decrease the prevalence of severe rebound pain, optimise outcomes, and prevent unnecessary resource utilisation.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Perioperative sleep in geriatric cardiac surgical patients: a feasibility study using a wireless wearable device

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Editor—Sleep plays an essential role in homeostasis of multiple organ systems and cognitive function.[1,2] It is commonly disrupted in the perioperative period.[3] The lack of large-scale pragmatic trials investigating the relationship between perioperative sleep and clinical outcomes can be attributed to logistics of labour-intensive clinical polysomnography. As an alternative to polysomnography, lightweight wireless wearable devices may provide high-quality sleep data for in-home studies.[4,5] However, it is unclear whether these technological advances can potentially translate into larger clinical investigations on the putative relationships between sleep and perioperative outcomes.

Here, we evaluate the feasibility of using a wireless EEG headband for characterising perioperative sleep structure (Fig. 1a). The Dreem headband (Dreem, New York, NY, USA), previously validated against polysomnography for a broad age demographic,[5] has EEG dry electrodes, including frontal (F7, F8, and Fpz) and occipital (O1 and O2) sensors. An infrared light source—detector pair allows pulse plethysmography whilst accelerometers track respiratory effort. We hypothesised that (i) wireless wearable headbands would allow acquisition of perioperative EEG sleep markers suitable for sleep staging and quantitative analyses, (ii) one night of preoperative sleep is sufficient for establishing baseline sleep
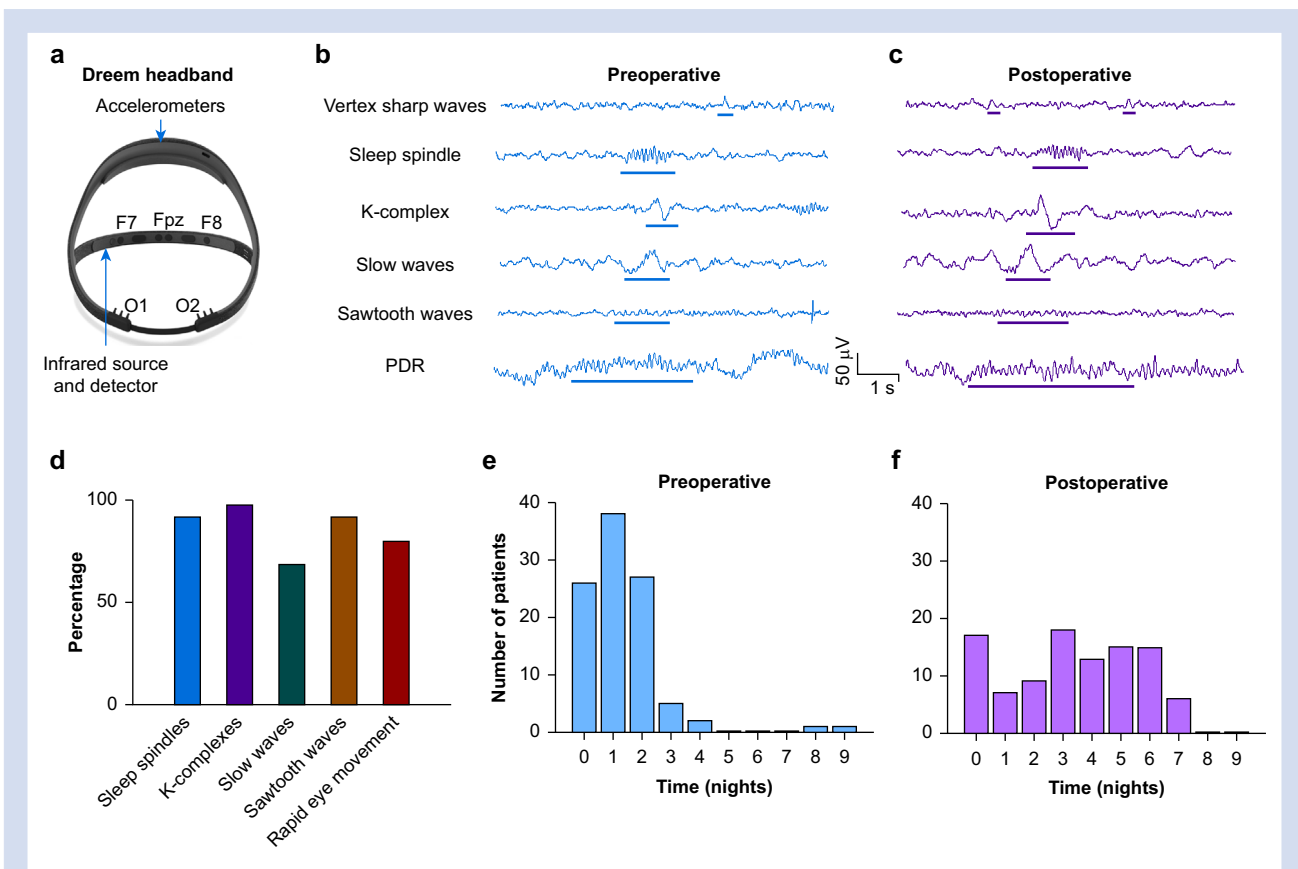

Fig 1. Electroencephalogram (EEG) waveforms recorded by the Dreem device allowed sleep staging in the pre- and postoperative settings. (a) The Dreem device is a portable, wireless headband used to continuously monitor EEG data, pulse plethysmography, and accelerometry data during sleep. The Dreem device contains five dry EEG electrodes for recording at three frontal locations (F7, F8, and Fpz) and two occipital locations (O1 and O2) in addition to sensors for obtaining plethysmography and accelerometry data. Example EEG waveforms from one patient are shown (b) before and (c) after surgery (postoperative Day 3). These EEG signals were recorded from channel Fpz—F7. The EEG microstructural elements that allow sleep staging include vertex sharp waves, sleep spindles, K-complexes, slow waves, and sawtooth waves. The posterior dominant rhythm (PDR) assists in the detection of wakefulness (recorded in channel Fpz—O1). (d) Percentage of detectable EEG microstructural elements in preoperative records. Frequency of the device utilisation for all patients in (e) pre- and (f) postoperative settings. The Dreem device was utilised with a median (inter-quartile range) of 1 (1) and 3 (2) nights in the pre- and postoperative periods, respectively.

structure, and (iii) sleep would be disrupted in the post-operative period.

We recruited 100 geriatric cardiac surgical patients at Barnes-Jewish Hospital for this pilot study as part of the prospective observational investigation, Prognosticating Delirium Recovery Outcomes Using Wakefulness and Sleep Electroencephalography (ClinicalTrials.gov NCT03291626).[6] These cardiac surgical patients are at risk for poor clinical outcomes related to disruption of perioperative sleep.[7] Human studies approval was obtained from the institutional review board. The following inclusion criteria were used: English speaking, 60 yr of age or greater, and scheduled for elective cardiac surgery requiring cardiopulmonary bypass. Participants were excluded for deep hypothermic circulatory arrest, preoperative delirium at enrolment, and deafness or blindness. Patients were offered remuneration for up to two preoperative and seven postoperative recordings.

The Dreem was used to record nocturnal sleep data preoperatively and from postoperative night 0 to 7. Each record underwent scoring in 30 s epochs by registered polysomnographic technologists. The modified American Academy of Sleep Medicine criteria for scoring single-channel frontal EEG[4] were further amended to include occipital EEG, closely spaced frontal EEG electrodes, and respiratory effort.[6] Epochs were non-scorable if they did not fulfil staging criteria for wakefulness (W), non-rapid eye movement (N1−N3), and rapid eye movement (REM) sleep. Records were excluded as non-scorable if <60 min of sleep was present.

Dreem provided adequate EEG microstructural elements required for staging sleep macrostructure.[8] Figure 1b and c illustrates EEG motifs used in sleep staging, using exemplary recordings obtained on a preoperative (Fig. 1b) and a postoperative (Fig. 1c) night for the same patient (EEG channel Fpz−F7). Amongst the 74 patients who provided preoperative data, 80% (106/132) of records were scorable. Of these scorable data sets, 92% had sleep spindles, 98% had K-complexes, 69% had slow waves, 92% had sawtooth waves, and 80% had REM (Fig. 1d). Total sleep time (TST; median of 209.8 min) was distributed as 8.3% N1, 70.6% N2, 2.1% N3, and 19% REM (Supplementary Fig. 1a), consistent with expected sleep structure in geriatric populations.[9] Overall, Dreem afforded sufficient EEG quality in providing scorable preoperative sleep data.

Tolerability of Dreem was acceptable for recording nocturnal preoperative sleep. Of the 90 patients approached for preoperative recordings, 74 (82%) recorded at least one preoperative night. The yield of overnight preoperative sleep records was reasonable given a multistate referral base and patient engagement days before surgery, with a median (interquartile range [IQR]) of 1 (1) night (Fig. 1e).

We observed minimal intra-subject variance in preoperative sleep structure. Amongst 26 patients with two preoperative nocturnal recordings, paired Wilcoxon signed-rank tests revealed no significant intra-subject differences in the fraction of TST for REM (median difference: 5.6%; $P=0.12$), N1 (median difference: 0.17%; $P=0.58$), N2 (median difference: 6.06%; $P=0.18$), or N3 (median difference: 0.03%; $P=0.99$).

We had 83 patients (94%) complete at least one postoperative night of recording. An example set of hypnograms is included (Supplementary Fig. 1c). We excluded 69 records because of mechanical ventilation and concurrent sedation (propofol, dexmedetomidine, fentanyl, or midazolam). Of the remaining 270 postoperative nocturnal recordings, 189 (70%) were scorable. The recording time median (IQR) was 796 (275) min with corresponding TST of 178 (140) min (Supplementary Fig. 1b). N1 and N2 sleep accounted for 93.5% of TST, with median (IQR) durations of 24 (23) min for N1 and 137 (123) min for N2. Median (IQR) durations of N3 and REM were 0 (0) and 0 (13) min, respectively. Non-scorable epochs were attributed to movement or inadequacy for satisfying staging criteria because of atypical morphology.[10] Contamination of these epochs could arise from effects of analgesics, sedatives, or noise arising from temporary external pacemakers. Non-scorable epochs accounted for 16.4% of total epochs between the first stage of sleep onset and the last epoch with a median (IQR) of 17 (112) min in postoperative recordings. Overall, patients wore Dreem with a median (IQR) of 3 (2) postoperative nights (Fig. 1f). Mann−Whitney U-tests with Benjamini−Hochberg adjustment showed significant differences in TST proportions for all sleep stages across pre- and postoperative sleep records. Overall, N1 and N2 were augmented in the postoperative period at the expense of REM and N3 (Supplementary Table 1).

In summary, we evaluated the perioperative use of a headband equipped with EEG dry electrodes, built-in amplifiers, and a design for consumer comfort. We reported disruption of sleep structure in postoperative setting consistent with previous investigations.[7] A single night, rather than multiple nights, may suffice in establishing preoperative sleep macrostructure during Dreem wear. We avoided the time and labour required for repeated placement of gel/paste-based electrodes normally utilised for polysomnography. Thus, despite the caveats for gauging duration of TST and sleep stages, Dreem is a feasible alternative to polysomnography for serial evaluation of sleep in the perioperative period, particularly for EEG microstructural elements. This approach will be useful for large-scale investigations on the epidemiology, clinical impact, and treatment of perioperative sleep disturbances.

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Declarations of interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2021.02.018.

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Central venous catheter misplacement into an aberrant pulmonary vein: implications of a congenital variation

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Editor—Confirmation of the correct position of central venous catheters (CVC) is a major factor in patient safety. Recognising catheter misplacement and, most importantly, inadvertent arterial cannulation, is a crucial step in this process. However, rare congenital venous variations could pose significant difficulties in the interpretation of CVC position criteria, such as pressure waveform, blood gas analysis, and chest radiography.[1] We report an example of an aberrant pulmonary vein as an unexpected cause of CVC misplacement.

A 64-yr-old patient with no significant medical history required CVC replacement after abdominal surgery (patient provided written consent for publication). He was mechanically ventilated via tracheostomy, with an FiO_2 of 0.5. Although in atrial flutter, he was haemodynamically stable. Left internal jugular vein cannulation was performed under ultrasound guidance. Dark red blood was aspirated under low pressure and the guidewire was passed easily. The operator used ultrasonography to confirm guidewire entry into the internal jugular vein and its course up to the junction with the left subclavian vein before dilation and catheter insertion. We did not perform further ultrasonographic examination of the major thoracic veins or the heart, as there was no suspicion of

guidewire misplacement at that time. Catheter tip position was not confirmed by intracardiac electrocardiography, as this technique is not established in our unit.

The transduced pressure waveform had a pulsatile triangular shape with a steep upslope, wide base, and no dicrotic notch. This resembled the 'cannon' waves observed when the right atrium contracts against a closed tricuspid valve. The mean pressure transduced from the distal lumen of the CVC was 12 mm Hg, implying that the CVC tip was positioned in a blood vessel with venous pressure characteristics.

The chest radiograph taken after the procedure revealed that the new CVC followed an unusual, straight course in the left mediastinum (Fig. 1). The image suggests catheter misplacement in the internal thoracic, pericardiophrenic, or accessory hemiazygos vein, or in a persistent left superior vena cava. Surprisingly, blood gas analysis of a sample from the CVC showed oxygenated blood with a Po_2 of 29 kPa. This ruled out catheter tip position in a vein and raised a suspicion of inadvertent arterial cannulation. However, the ultrasonographic findings of the guidewire reaching the junction of the left internal jugular vein with the left subclavian vein during insertion, and a mean pressure of 12 mm Hg transduced from