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Special Article

NEUROSCIENCE AND NEUROANAESTHESIA

Improving perioperative brain health: an expert consensus review of key actions for the perioperative care team

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Summary

Delirium and postoperative neurocognitive disorder are the commonest perioperative complications in patients more than 65 yr of age. However, data suggest that we often fail to screen patients for preoperative cognitive impairment, to warn patients and families of risk, and to take preventive measures to reduce the incidence of perioperative neurocognitive disorders. As part of the American Society of Anesthesiologists (ASA) Perioperative Brain Health Initiative, an international group of experts was invited to review published best practice statements and guidelines. The expert group aimed to achieve consensus on a small number of practical recommendations that could be implemented by anaesthetists and their partners to reduce the incidence of perioperative neurocognitive disorders. Six statements were selected based not only on the strength of the evidence, but also on the potential for impact and the feasibility of widespread implementation. The actions focus on education, cognitive and delirium screening, non-pharmacologic interventions, pain control, and avoidance of antipsychotics. Strategies for effective implementation are discussed. Anaesthetists should be key members of multidisciplinary perioperative care teams to implement these recommendations.

Keywords: anaesthetists; delirium; education; neurocognitive disorder; perioperative brain health; preoperative screening

Editor's key points

- Delirium and perioperative neurocognitive disorders are common and often poorly proactively managed.
- This article provides expert, international, consensus-based recommendations.
- Anaesthetists should be key members and leaders of multidisciplinary clinical teams to improve management of perioperative neurocognitive disorders.

Delirium and postoperative neurocognitive disorder are the most common perioperative complications in patients more than 65 yr of age[1–3] with potential long-term consequences for brain health.[2–8] Patients who experience delirium have an increased length of stay, a higher incidence of morbidity and mortality, and increased costs.[9,10] The research literature on perioperative brain health is growing rapidly,[2] and evidence-based guidelines to reduce harm in older patients undergoing surgery have been issued.[11,12] Simple strategies can reduce the incidence of delirium by up to 40% and are effective for surgical patients.[13–15] Formal evaluations of the evidence base

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for delirium prevention and postoperative brain health have been published recently in the anaesthetic literature.[16,17] Despite the growing body of evidence and guidance, data suggest that anaesthetists fail to routinely screen patients for preoperative cognitive impairment, to warn patients of risk, or take preventive measures.[16,18] It is not just anaesthetists who need to address this issue, hospitals need to implement best practices for older adults, highlighted by initiatives such as the 'Age-Friendly Health System'.[19]

This problem has real urgency. Across the world populations are ageing rapidly,[20–22] and the number of older adults undergoing surgery is increasing.[23] The majority of older adults are worried about their brain health,[24] and are starting to ask questions about what actions will be taken to protect their cognitive function if they undergo surgery. The lay press is publishing stories of mental decline in older individuals after hospitalisation and asking what can be done.[25,26]

With the aim of closing the gap between research knowledge and clinical action, we assembled a group of international physicians and scientists with expertise in neurocognitive disorders and implementation science to perform a modified Delphi review of current literature and guidelines. We sought to produce a simple list of actions that if widely implemented could reduce the incidence of perioperative neurocognitive disorders (PNDs).[27] We undertook a consensus-based approach, recognising the urgent need for action, the rapid rate of new publications, and time required to develop systematic reviews and guidelines. We focused on screening, diagnosis, prevention, mitigation, and treatment. We did not include the ICU literature as we wished to focus on perioperative actions, but acknowledge there are many surgical patients who experience delirium in the ICU. We also focused on neurocognitive disorders, but understand that the term 'perioperative brain health' could be applied more broadly to include stroke. We considered not only the scientific evidence behind each recommendation, but on choosing actions feasible for implementation in all organisations, large and small, that manage surgical patients. The project developed over time from a number of key questions to a leaner approach to surface five or six high impact components with the aim of producing a 'bundle'[28] to drive action to reduce PNDs. Although these actions could be led by anaesthetists, they apply to the wider multi-professional perioperative team, and hospitals and system leadership. We were influenced by the success of the 'Choosing Wisely' campaign[29] with its focus on changing physician attitudes, practices, and public knowledge. By producing a final short list of recommendations based on feasibility of implementation and impact for all clinical settings, resource rich or poor, we sought to promote an environment for change where action is empowered to ensure all appropriate steps are taken to reduce the incidence of PNDs.

Methods

Selection of the Perioperative Brain Health Initiative expert panel members

The Perioperative Brain Health Initiative (PBHI) Steering Committee identified 30 potential international experts to serve on the Expert Panel (EP). The primary criteria for selection included publications and known perioperative-related brain health research. We also included experts who additionally had implementation science expertise. Of the 30 potential experts initially identified, 22 were invited and the remaining eight were designated as alternates. Of the 22 invited experts, 20 were anaesthetists, one a surgeon, and one a clinical neuroscientist. Our aim was to have a minimum of 15 experts on the final panel. We did not include formal patient or public involvement, but the questions posed and the need for a practical approach were driven by issues raised at a joint summit held with the American Association of Retired Persons (AARP) in summer 2018, which included a large number of patient representatives.[2] Eighteen physicians accepted the invitation to serve on the panel; all EP and PBHI executive committee members are listed in Appendix A. Each member of the EP completed conflict of interest, non-disclosure, and compliance forms.

Preliminary planning and selection of approach to consensus statement

In December 2018, the Steering Committee developed a list of 22 questions (Appendix B) related to perioperative delirium and longer-term postoperative neurocognitive disorders focused on screening, diagnosis, prevention, mitigation, and treatment. Through a series of three discussion exercises from January 2019 through March 2019, the EP reviewed the questions, developed a topical outline, established priorities, and provided additional questions. Areas of interest were identified, for which evidence could be reviewed and guideline development might be appropriate. Because of the broad scope of the discussions and potential time requirements to reach consensus, the Steering Committee refocused efforts to develop a short list of high priority best practices. The approach then taken was similar to that of the 'Choosing Wisely' campaign of the American Board of Internal Medicine (ABIM) Foundation[29] to help physicians become better stewards of finite health resources. The refocused efforts of the EP sought to identify a small number, five to seven, best practices that would be most effective in improving perioperative brain health and that could be implemented with reasonable resources in a relatively short timeframe by clinicians and hospitals. Our approach was to use existing published international guidelines and recommended best practices as a starting point. These efforts began in May 2019 and were completed in February 2020.

Literature search for existing guidelines

As the first task, we performed a literature search for guidelines and best practices related to perioperative delirium and postoperative cognitive deficit. We searched for articles or reports published between 2010 and April 2019, based in Australia, Europe, and North America, and written in English. We identified publications through PubMed and Google Scholar search engines. Title, abstract, or both search terms included: 'best practice'; 'clinical guideline'; 'clinical practice'; 'consensus'; 'delirium'; 'geriatric'; 'guideline'; 'management'; 'perioperative delirium'; 'postoperative delirium', and 'postoperative cognitive deficit'. Two researchers reviewed 475 titles and abstracts to assess relevance of recommended guidelines and related statements. We excluded publications focused on critical care/ICU, palliative or cancer care, and perioperative stroke. Seven publications met final criteria for inclusion; references from these articles revealed one additional publication, for a total of eight publications (Table 1) that included 88 best practice statements and recommendations.[11,12,16,30–35]

Table 1 Reference articles of guidelines and best practices reviewed by the Perioperative Brain Health Initiative Expert Panel (*listed in reverse chronological order, present to 2010*).

Abbrev.	Reference	Scope of reference article
SIGN 2019[30]	Scottish Intercollegiate Guidelines Network (SIGN). *Risk reduction and management of delirium: A national clinical guideline*. Edinburgh, Scotland. 2019	• Delirium • Adults • All settings: home, long-term care, hospital, and hospice • Recommendations presented from '2: Key recommendations' (2.1–2.3, p 5) and from '4: Non-pharmacological risk reduction, anaesthetic management (4.2.1, p 14)
Berger 2018[16]	Berger M, Schenning KJ, Brown CH, Deiner SG, Whittington RA, Eckenhoff RG. Best practices for postoperative brain health: recommendations from the Fifth International Perioperative Neurotoxicity Working Group. *Anesth Analg* 2018; **127**: 1406–13	• Brain health • Persons >65 yr of age • Postoperative
ESA 2017[31]	Aldecoa C, Bettelli G, Bilotta F *et al.* European Society of Anaesthesiology evidence-based and consensus-based guideline on postoperative delirium. *Eur J Anaesthesiol* 2017; **34**: 192–214	• Postoperative delirium • Certain recommendations for paediatrics and older individuals provided separately • Perioperative
Mohanty 2016[12]	Mohanty S, Rosenthal RA, Russell MM, Neuman MD, Ko CY, Esnaola NF. Optimal perioperative management of the geriatric patient: a best practices guideline from the American College of Surgeons NSQIP and the American Geriatrics Society. *J Am Coll Surg* 2016; **222**: 930–47	• Postoperative delirium as one of many clinical issues • Geriatric patients • Perioperative management
AUS 2016[32]	Australian Commission on Safety and Quality in Healthcare (ACSQHC): *Delirium clinical care standard*. Sydney, Australia. 2016	• Delirium • Adults; patients >65 are at 'high risk' • Hospital
AGS 2015,[33]	American Geriatrics Society Expert Panel on Postoperative Delirium in Older Adults: American Geriatrics Society abstracted clinical practice guideline for postoperative delirium in older adults. *J Am Geriatr Soc* 2015; **63**: 142–50	• Postoperative delirium • Older adults • Perioperative
Chow 2012[34]	Chow WB, Rosenthal RA, Merkow RP, Ko CY, Esnaola NF: Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. *J Am Coll Surg* 2012; **215**: 453–66	• Cognitive impairment, dementia, and postoperative delirium among many clinical issues • Geriatric patients • Preoperative assessment
NICE 2010[35]	National Clinical Guideline Centre. *Delirium: Diagnosis, prevention and management: Clinical Guideline 103*. London, England. 2010	• Delirium • Adults • Hospital and long-term residential care

Summary of PBHI Expert Panel exercises

The EP participated in five exercises between May 2019 and January 2020 (Table 2). Between Exercise 1 and Exercise 2, the Chair of ASA's Committee on Geriatric Anesthesia reviewed initial results and assisted with clinical interpretation. Subsequent to each further exercise (Exercises 2–5), one or more Steering Committee members reviewed the results of the most recent exercise and suggested language or minor edits.

Exercises were either internet-based and disseminated using SurveyMonkey, or distributed via email if the exercise consisted of only one to three questions. In Exercise 2, a six-point Likert scale was used to rate 'top' practices based on *Potential for Impact* and *Implementation Feasibility*. The original intent was to choose five top practices as in the 'Choosing Wisely' program. Of the 88 best practice statements or recommendations, we asked each EP member to select five to seven they felt had the greatest impact and implementation feasibility. Some panellists chose more than seven. Nine stood out as most frequently identified, after accounting for redundancy in some of the statements amongst the eight source documents. We did not score, rate, or rank the 88 statements and so could not apply statistical techniques to our ranking. We cannot include or rank the other 79 statements since most were not identified by expert panellists. Exercises 2 and 3 confirmed the top five statements with the EP and asked whether Statement F should be considered as it ranked six on impact, but number one on implementation feasibility. A top six were agreed. The statements were circulated again for further comments (Exercise 4). The Steering Committee then made minor edits for clarity, consistency in structure, and grammar; the original substance of the statements was never lost or compromised. The results of Exercise 2 are presented in Table 3 and Figure 1.

Results

From the 88 best practice statements in the eight publications that met the inclusion process, the consensus review resulted in six recommendations provided with descriptive headings below. No guidelines or best practice statements specifically on postoperative cognitive deficit were found. The recommendations were reordered to make sense with regard to time and place. The overarching system wide work needed to ensure that all staff who work with older surgical patients

Table 2 Summary of Perioperative Brain Health Initiative Expert Panel (EP) activities.

Activity	Dates	Description of activity	Number of EP* participants
Preliminary input	Jan 14–Mar 19, 2019		18
Exercise 1	Jun 23–Jul 10, 2019	• Identification of 'top' five to seven statements of best practice. An initial set of 88 statements from eight international published guidelines (Table1) were provided. EP members could select from those (with or without small edits) or add a new statement.	16
Exercise 2	Jul 29–Aug 9, 2019	• Based on the results of Exercise 1, the EP identified nine highest priority statements/recommendations. Exercise 2 asked the EP members to rate these nine statements on two criteria: (1) potential for impact to improve perioperative brain health for older adults and (2) implementation feasibility for anaesthesiology groups and associated practices to undertake in a relatively short time period. The results of Exercise 2 are presented in Figure 1.	15
Exercise 2 *follow-up*	Aug 20–Aug 26, 2019	• This follow-up to Exercise 2 asked the EP for input on whether to keep a statement that the EP had rated high on 'potential for impact' but rated relatively lower on 'implementation feasibility'.	18
Exercise 3	Sep 6–Sep 20, 2019	• Based on the identification of high priority best practice statements and comments provided by the EP in Exercise 2, the EP members were asked to comment on the specificity of one of the statements (and whether it should be edited) and to confirm that six statements should be identified rather than five, given the results of their relative ratings.	17
Exercise 4	Nov 16–Nov 19, 2019	• EP members reviewed six statements and were given the opportunity to agree or disagree and provide comments or suggested edits.	18
Exercise 5	Dec 22 2019–Jan 6, 2020	• Final exercise to obtain signoff (approval or not) on some or all of the revised six statements. Final comments were also solicited.	18

* Out of a total of 18 EP members.

Table 3 Results from Exercise 2: average ratings of highly ranked Best Practice Statements by the Perioperative Brain Health Initiative Expert Panel (PBHI EP) based on 'potential for impact' and 'implementation feasibility' ★, Five votes for top three.

Potential for impact	Voted as top three	Implementation feasibility	Voted as top three	'Top nine' best practices selected by the PBHI EP *(preliminary wording)*
5.20	★	3.87		A. Monitors older surgical patients by ensuring delirium screening once preoperatively and then postoperatively on a regular basis using a standard screening tool.
5.20	★	4.07	★	B. Works with clinicians and other healthcare professionals in the hospital to implement multicomponent non-pharmacologic intervention programs delivered by an interdisciplinary team for the entire hospitalisation for at-risk older adults undergoing surgery, to prevent delirium.
5.13	★	4.27	★	C. Conducts or directs the conduct of (1) a baseline cognitive assessment using a standard test and (2) an assessment of risk factors for postoperative neurocognitive disorders.
4.93	★	4.80		D. Works with educators and other clinicians in the hospital to educate healthcare professionals regarding delirium and postoperative neurocognitive disorders.
4.93		4.60	★	E. Works with surgeons and other clinicians to optimise postoperative pain control, preferably with non-opioid pain medications, to minimise pain in older adults to prevent delirium.
4.80		5.07	★	F. Avoids antipsychotic and benzodiazepine medications for older adults with postoperative hypoactive delirium and ensures this is effectively communicated to healthcare professionals throughout the patients' stay.
4.53		4.60	★	G. Helps to develop and ensures the conduct of a medication review by an experienced healthcare professional to identify medication-related risk factors.
4.27		4.73		H. Consistent with the hospital's informed consent process, informs older surgical patients of the risks of delirium and other postoperative neurocognitive disorders.
3.60		3.53		I. Actively participates in and ensures the development of individualised discharge plans for patients that experienced delirium or are at risk for postoperative neurocognitive disorders.

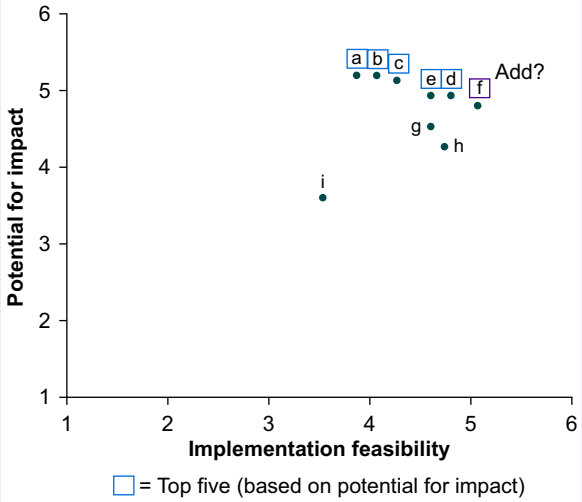

Fig 1. Results from Exercise 2. Average Perioperative Brain Health Initiative Expert Panel ratings of highly ranked best practice statements based on 'Potential for Impact' and 'Implementation Feasibility.' The letters (a)–(i) correspond to the statements in Table 3. The initial intent was to identify five statements; however, based on the results of this exercise, the Expert Panel was asked whether a sixth statement (f in blue box) should be added.

receive training in identification and management of older patients with delirium was placed first. In all cases when the recommendations are action-oriented, the action refers to anaesthetists in partnership with all relevant members of the multidisciplinary perioperative team.

Recommendations

Education and training

1. A multidisciplinary team including, but not limited to, anaesthetists, surgeons, nurses, pharmacists, and geriatricians should work together to develop education and training programs to:
   i. Support identification of risk factors for delirium and other PNDs.
   ii. Discuss risks for delirium, techniques to minimise delirium developing, and potential delayed return to baseline thinking and memory, with patients and their families.
   iii. Manage a patient with delirium.

The American Geriatric Society guidelines provide a summary of the evidence that educational programs reduce the incidence of hospital delirium.[33] To be effective, programs should cover all aspects of screening, risk factors, delirium identification, and non-pharmacologic and pharmacologic prevention and management. Effective education should include leadership, use champions and peer support, and be interactive.[36] Patients and families want to be informed about risks to their brain health and be given strategies to cope with an episode of PND.[2,37] Recommendations discussing the potential risk of delirium for patients and families, and actions to reduce risk have recently been published by the Global Council for Brain Health of the AARP (formerly known as the American Association for Retired Persons).[37] A handout for anaesthetists and surgeons to give to patients has been designed by the ASA PBHI in conjunction with the American Geriatric Society, and can be downloaded and adapted for local use.[38]

Cognitive screening

2. In at-risk patients, conducts or directs the conduct of (i) a baseline cognitive screen using validated tests and (ii) an assessment of additional risk factors for PNDs.

Identification of preoperative risk factors with a simple screening tool predicts postoperative complications in older surgical patients[34,39]; choice of a screening tool should consider ease of implementation in a busy preoperative setting.[39–42] A simple validated tool that has been used for preoperative screening is the MiniCog, which is strongly recommended as the tool of choice in the best practice guidelines from the American College of Surgeons and American Geriatric Society.[34] Documenting baseline status before surgery facilitates identification of postoperative neurocognitive disorder.[39] At present, few anaesthetists screen for, document, or discuss risks of PNDs with patients and families, despite neurocognitive complications being much more common than complications such as myocardial infarction.[16,18] Incorporation of routine simple baseline screening into preoperative assessment is feasible and can be done without additional resources.[41,42] Routine cognitive screening raises awareness amongst the perioperative team and can result in some simple changes in behaviour such as reduced use of benzodiazepines.[42]

Delirium screening

3. Monitors at-risk older surgical patients by ensuring a baseline delirium screen before surgery in patients undergoing emergency surgery, and for all patients before discharge from the recovery room, and then ideally twice daily until Day 5 or discharge, using a validated screening tool.

A useful overview and table of delirium screening tools with time required, level of training needed, sensitivity, specificity, and suitability for monitoring is given in the Scottish Intercollegiate Guidelines.[30] Commonly used tools include the 4 'A's Test (4AT) which scores Arousal, Attention, Abbreviated mental test, and any Acute change, and the Confusion Assessment Method (CAM). An advantage of 4AT over CAM is that it does not require any training and is very quick to use. However, the Scottish guidelines do not include 3D-CAM, a shortened 3 min CAM assessment recommended elsewhere.[32] Frequency of assessment should take into account patient risk and clinical setting. We included preoperative screening for emergency surgical patients only, as this is a high-risk group who may have physiological derangement and already have spent time in hospital.[1,31] Although ideally all patients should be screened preoperatively and postoperatively, evidence shows that anaesthetists currently screen less than 10% of patients *postoperatively*[18] and so we took a pragmatic approach on *preoperative* screening to encourage adoption in a high risk group.

Non-pharmacologic interventions

4. Partners with healthcare professionals and family in the hospital to implement multicomponent non-pharmacologic interventions to prevent delirium. Programs should be delivered by an interdisciplinary team for the entire hospitalisation, targeting at-risk surgical patients for the purpose of delirium prevention.

Examples of non-pharmacologic interventions used to prevent delirium include mobilisation, orientation, physiotherapy, communication, and comprehensive geriatric review.[13–15,30–35] Practical actions include returning cognitive aids immediately after surgery (glasses, dentures, hearing aids) and protecting sleep-wake cycles with quiet hours, dark rooms, and ear plugs. Encouraging presence of family and friends and using volunteer visits for social interaction is beneficial.[13–15,43] Relatives and caregivers can be educated to help with some care components such as reorientation. When strategies are used in multicomponent packages in hospitalised non-ICU patients they are effective.[43] Use of a checklist to promote non-pharmacological interventions is associated with risk reduction.[43,44] At a hospital level, reducing unnecessary transfers of care, and promoting noise reduction, sleep hygiene, and nutrition are beneficial.[30,32–35]

Pain control

5. Works with surgeons and other clinicians to optimise postoperative pain control, preferably with minimally sedating multimodal pain management.

Adequate postoperative analgesia is associated with delirium reduction.[33] Older adults are sensitive to opioids, and patients with a high preoperative risk for delirium who have significant pain and receive high opioid doses have a very high incidence of delirium.[45] Pethidine should be avoided.[16,34] Morphine, fentanyl, and oxycodone are not specifically associated with delirium. The most important factor with opioids is titration to minimal effective dose to manage pain and minimise side effects.[30] Multimodal pain management should be used when possible and should include routine use of paracetamol, NSAIDs if appropriate and not contraindicated, and local anaesthetic blocks and infiltration.[33,34] Patient-controlled analgesia (PCA) is an option if the patient is able to titrate the medication; delirium does not necessarily contraindicate PCA.[31] Before gabapentinoids are used in older adults, the benefits *vs* potential risk should be considered.[46] A recent meta-analysis and systematic review suggested no clinically significant impact on postoperative pain with gabapentinoids, but increased incidence of dizziness and visual disturbance.[47]

Antipsychotics and anxiolytics

6. Avoid antipsychotics and benzodiazepines for first-line treatment of delirium unless benefits (such as drug and alcohol withdrawal management) far outweigh known risks and there is an active risk of harm to the patient or staff. For first-line management of the patient with delirium, clinicians should seek to involve family, re-orient the patient and provide necessary hearing and visual aids, minimise pain, and seek and treat other sources of discomfort before pharmacologic options are used. This management approach should be communicated to all health professionals throughout the patient's stay.

Patients who undergo preoperative assessment should have a medication review, and consideration should be given to reducing potentially deliriogenic medications such as benzodiazepines in patients who are taking them.[12,34] Ideally this would be done as part of a comprehensive review with a "care of the older person" physician and pharmacist.[42]

The management and treatment of delirium is discussed in detail in the guidelines and best practice documents,[30–33,35] and should encompass immediate exclusion of life-threatening causes, such as hypoxia, hypotension, hypoglycaemia, and sepsis. Non-pharmacologic strategies are the most effective for preventing and decreasing the duration of delirium.[12,33,35] These begin with re-orientation and involving family and friends as soon as possible.[37] Familiar objects such as family photographs and music can be helpful.[33] A recent systematic review found no evidence for the routine use of haloperidol or second-generation antipsychotics to treat delirium in adult in-patients.[48]

Discussion

As the population ages and more older patients undergo surgery, a greater understanding of the impact and mechanisms underlying PNDs is developing. Although the perioperative biochemical and physiological changes in the brain are complex, we know that simple measures can reduce the incidence of delirium by up to 40%.[13] We also know that despite the launch of a public health campaign by the ASA in 2016 to draw greater awareness to the problem,[49] and publication of evidence-based guidance from international anaesthesia organisations,[16,17,31] evaluation of the brain and simple preventive measures are still not routinely undertaken.[16,18] The solution to reducing the incidence of PND is not in the hands of anaesthetists alone, but we are key members of the multidisciplinary perioperative team and well placed to help lead the organisational initiatives needed to address this problem.

This review of international best practice studies and guidelines up to April 2019 for the prevention and management of delirium and postoperative neurocognitive deficit produced a top six recommendations ranked for efficacy, impact, and practicality of implementation, in resource rich and poor settings, by the expert consensus review group. All reviews of this nature have limitations as this field of study is growing rapidly, and several important articles have appeared since our cut-off date. These include consensus statements from the American Society of Enhanced Recovery (ASER) on postoperative delirium prevention[17] and on the role of processed EEG monitoring in perioperative outcomes.[50] In addition, major studies such as 'NeuroVision' have highlighted the incidence of covert stroke in older surgical patients, the relationship to subsequent postoperative cognitive decline, and the significant incidence of cognitive decline in patients who did not have a stroke.[51] Evidence is also strengthening for the association of frailty with delirium and the need for preoperative cognitive screening to be linked with frailty screening.[52] These more recent articles complement our work. The ASER consensus statement on delirium prevention graded the strength of evidence on perioperative recommendations, and the recommendations with greatest strength align with our six. Neither the ASER consensus statement on delirium prevention nor the companion one on processed EEG[17,50] provide

any further recommendations on areas of particular interest to anaesthetists, such as use of a specific type of anaesthetic or sedative agent, advantage of regional or general anaesthesia, or use of processed EEG monitoring in high-risk surgical patients. These areas require further research. Specifically, the use of processed EEG is still controversial; randomised trials which achieved separation of anaesthetic dosing based on protocol-based algorithms have found a difference in the incidence of delirium.[50] Those that did not show separation found no effect.[53,54] There is minimal evidence on longer-term outcomes and intraoperative depth as measured by processed EEG, at least in part because of fewer studies of lower quality. The use of intraoperative monitoring, such as processed EEG or cerebral oximetry, not only has contentious efficacy at present, but the required equipment is expensive and penetrance into the community is incomplete.

Our study collated information from different specialties and countries, and from guidelines that anaesthetists may not have been previously aware of. None of the six recommendations require new equipment or new drugs. They are relatively simple evidence-based statements, which if widely implemented could reduce the incidence of PND in perioperative patients. However, implementation will require partnership with other disciplines across the patient's perioperative pathway. The recommendations are in line with important current initiatives internationally, to ensure that hospitals and health systems are 'age friendly'. In the USA, major work is occurring on the four pillars of an age-friendly health system described as the '4Ms', namely medications, mobility, mentation, and 'what matters to you' (i.e. understanding a patient's goals of care).[19] Our recommendations support each pillar of an age-friendly health system.

The gap between evidence and change in practice is well described in the medical literature.[55] To speed adoption of evidence-based recommendations we must consider the principles of implementation science and quality improvement.[56,57] Key principles that apply are measurement,[58] stakeholder engagement, creating the will and energy for change, understanding change management concepts, and building for sustainability.[59] Without a measurement system, for example, we cannot audit performance on screening of cognitive function, or know how effective we are at routine delirium surveillance.[58] Without an understanding of the current state, it is difficult to know where and how much improvement is needed.[60] To implement widespread improvement in education about PND and multimodal pain management for older patients, we need to understand who must be involved and effective ways to engage them. Without considering motivation and building the will for change[55] by demonstrating gaps in care with data and telling stories of patients who have been harmed, implementation across a hospital and system will be difficult. We must consider how to harness patients' and families' experiences and concerns, and work with them to create more brain-friendly perioperative care. All levels of the hospital and system must be involved to make large scale change successful.[61] Creating a simple business case about the significant costs of delirium and impact on patient experience should engage senior leadership support.

The 'Choosing Wisely' campaign focuses on how systems, and clinicians working within those systems, can improve care to deliver on the promise of affordable and high-quality care for all, with particular consideration of vulnerable populations such as older individuals.[29] The UK approach to 'Choosing Wisely' emphasises shared decision-making.[62] The recent work by the Global Council for Brain Health of the AARP demonstrates that perioperative brain health is a significant concern for older patients considering surgery and should be discussed with them.[37] We believe the recommendations developed here, influenced by 'Choosing Wisely', offer a practical opportunity to reduce both harm and costs associated with PNDs.

This study started with a list of 22 questions felt to be important by the expert committee to improve brain health of older patients undergoing surgery. These ranged from topics such as 'are current enhanced recovery protocols appropriate for older adults' and 'does EEG management reduce PND' to 'are certain blood or CSF biomarkers helpful to predict PND risk and course'? The scope of the project became unfeasible, as ease of implementation was considered essential to produce usable results within a short timeframe; hence our move to a smaller number of components. This may mean that our study is flawed as our concept re-focused half-way through; however, the original aim to produce practical recommendations from an expert group was met.

This study surfaced many potential questions and areas where more knowledge is required. There is an urgent need for more resources to study concepts such as 'does an enhanced recovery approach reduce the incidence of delirium'. There is opportunity to improve patient follow-up to better understand the incidence of cognitive dysfunction after discharge. We did not include formal patient and family representation, and that should be addressed in further work. However, this project developed from a summit with significant patient representation, and the need for action and practical solutions was made clear. Going forward, we need to spend more time understanding the barriers to implementation of evidence-based practice and studying those 'positive deviants'[63] who have managed to implement some of the recommended practices sustainably, what resources did they have, and how did they do it?

In conclusion, we describe six evidence-based practice recommendations that if implemented across hospitals and health systems could reduce the incidence of perioperative neurocognitive disorders and associated harm. Anaesthetists should be key members and leaders of multidisciplinary clinical teams to implement change.

Authors' contributions

Wrote the manuscript: CP
Performed the literature review and analysis, collection of the rounds of review responses and drafted the methods section of the manuscript: TM
Participated in the consensus review: CP, SD, RE, LF
Participated in the conceptual design of the project and critical review and approval of the manuscript: all authors

Declarations of interest

CP: consultancy fees from Merck and the Institute for Healthcare Improvement.
SD: consultancy fees from Merck, expert legal witness.
TM, RE, and LF authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

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