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REVIEW ARTICLE/BRIEF REVIEW

A brief review of practical preoperative cognitive screening tools

Un article de synthèse court sur les outils de dépistage préopératoire de troubles cognitifs

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Abstract

Purpose *Preoperative cognitive impairment is associated with the development of postoperative delirium, a common and consequential complication of major surgery in older patients. Screening for cognitive impairment should become a routine part of the preoperative evaluation of older patients; however, its implementation is hampered by limited clinical time and resources. The objective of this review was to identify cognitive screening tools that could be easily incorporated into the evaluation of older patients before major surgery.*

Search strategy *Using strict inclusion and exclusion criteria, we searched PubMed over a 15-year period for short and simple cognitive screening tools. In addition, we reviewed studies that examined these cognitive screening tools in a perioperative environment.*

Search results *We identified six cognitive screening tools that could each be administered in 2.5 min or less. Among the tools, sensitivity for cognitive impairment ranged from 79-99%, while specificity ranged from 70-98%. Only one (Mini-Cog) of the six tools we identified had been tested in a perioperative environment.*

Conclusions *Incorporating a cognitive screening assessment into the preoperative evaluation of older patients is feasible. More research is needed to validate cognitive screening tools in the perioperative setting.*

Résumé

Objectif *Un trouble cognitif préopératoire est associé à l'apparition d'un delirium postopératoire, une complication fréquente et secondaire aux interventions chirurgicales majeures chez les patients âgés. Le dépistage des troubles cognitifs doit entrer dans l'évaluation préopératoire standard des patients âgés; toutefois, sa mise en œuvre est gênée par les limites de temps clinique et de ressources disponibles. L'objectif de cet article de synthèse était d'identifier des outils de dépistage de troubles cognitifs qui pourraient être facilement inclus dans l'évaluation des patients âgés avant une chirurgie majeure.*

Stratégie de recherche *Ayant défini des critères d'inclusion et d'exclusion stricts, nous avons recherché des outils courts et simples de dépistage de troubles cognitifs dans la base PubMed sur une période de 15 ans. Nous avons aussi analysé les études qui portaient sur ces outils de dépistage dans un cadre périopératoire.*

Résultats de la recherche *Nous avons identifié six outils de dépistage de troubles cognitifs qui pouvaient chacun être administrés en 2,5 min ou moins. Parmi ces outils, la sensibilité pour un trouble cognitif était comprise entre 79 % et 99 %, avec une spécificité allant de 70 % à 98 %. Un seul (le Mini-Cog) parmi les six outils identifiés a été testé dans un environnement périopératoire.*

Conclusions *L'inclusion d'une évaluation de dépistage de troubles cognitifs dans l'évaluation préopératoire des patients âgés est faisable. Il est nécessaire de poursuivre les recherches afin de valider ces outils de dépistage dans un environnement périopératoire.*

Author contributions *L. Stephen Long* and *Jaqueline M. Leung* designed the review, analyzed the data, and managed the review. *L. Stephen Long*, *Jaqueline M. Leung*, and *William A. Shapiro* contributed to manuscript preparation.

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Postoperative delirium is an acute and fluctuating confusional state.[1,2] Its incidence is high, affecting 40-50% of older patients after major surgery.[3-6] The development of delirium impacts both short- and long-term outcomes, including a higher rate of complications after surgery, longer hospital stays, increased likelihood of discharge to long-term care facilities, and increased mortality.[7-9]

Multiple preoperative risk factors for postoperative delirium have been identified. These include cognitive impairment, sensory impairment, older age, American Society of Anesthesiologists (ASA) classification, low education level, psychotropic drug use, poor functional status, dehydration, medical comorbidities (especially cerebrovascular or other brain disease), electrolyte abnormalities, low albumin, and depression.[3,4,10-25] Pre-existing cognitive impairment (e.g., dementia or mild cognitive impairment [MCI]) is the risk factor often cited as the strongest predictor of postoperative delirium[26] (see Table 1 for descriptions of different types of cognitive impairment).

It is important to recognize that "cognitive impairment" is a nonspecific term that can be used for a variety of cognitive problems. In our view, screening for cognitive impairment before surgery should be considered as screening for pre-existing dementia or MCI. Dementia and MCI are specific well-described conditions used to classify chronic cognitive impairment, as detailed in Table 1. Accordingly, most outpatient cognitive screening tools are designed to detect one or both of these conditions.

Currently, routine preoperative evaluation does not include the evaluation of baseline cognitive functioning. Clinicians have considered "alert and oriented times three" (i.e, patient is aware of WHO they are, WHERE they are, and WHAT time it is) to be "normal" cognitive status. In fact, this assumption has not been proven, and patients who do not have documented dementia may in fact have MCI. Accordingly, knowing the cognitive status of patients before surgery is critical for risk stratification to allow for subsequent prophylaxis, surveillance, and treatment. Indeed, a number of promising interventions and therapies have been proposed for postoperative delirium, including perioperative neuroleptic prophylaxis,[27-32] reduction in sedative dosing,[33] improved postoperative pain control,[6,10] and proactive postoperative nonpharmacologic management.[5]

Previous investigators have examined the use of a variety of cognitive assessment tools to measure preoperative cognitive impairment. The most popular tool used for clinical research is the Mini-Mental State Examination (MMSE) developed by Folstein *et al.*[34] Despite its strengths and wide use, the MMSE may not be practical for preoperative cognitive screening due to its length of seven to ten minutes. Indeed, even a five-minute test can add a substantial amount of work when implemented in a high-volume preoperative clinic. In addition, the MMSE has been criticized for copyright restrictions and age- and education-related biases.[35]

Thus, an ideal preoperative cognitive screening tool should: 1) require a very short amount of time for administration and scoring; 2) detect cognitive impairment with moderately high sensitivity and specificity; 3) be validated in a preoperative geriatric sample.

The goal of this paper is to identify cognitive screening tools suitable for the preoperative setting.

Search strategy

A literature search of PubMed was conducted. The database was searched over a 15-year period from January 1, 1996 to January 1, 2011. A 15-year period was chosen to

Table 1 Different types of cognitive impairment

Types of Cognitive Impairment	Definitions
Delirium	*Delirium* is an acute and fluctuating confusional state characterized by impaired attention, perception, and cognition.[1] It is usually triggered by an acute illness (e.g., urinary tract infection) or intervention (e.g., surgery, drug administration) and is reversible.
Dementia	*Dementia* is a combination of cognitive deficits that are chronic and nonfluctuating in nature. It always involves memory impairment.[1] The most common causes are Alzheimer's disease and cerebrovascular disease. Dementia is viewed as a non-reversible disease.
Mild Cognitive Impairment (MCI)	*MCI* is the presence of memory impairment not explained by normal aging and not severe enough to meet criteria for dementia. MCI predicts progression to dementia, with an annual conversion rate reported as high as 25%.[36]
Normal Aging	*Normal aging* results in cognitive changes not considered pathologic. Importantly, these individuals are able to retain learned information nearly as well as their younger counterparts and experience no functional deficits.[37,38]
Postoperative Cognitive Decline (POCD)	*POCD* is the precipitous worsening of cognitive function after surgery. The duration of POCD is on the order of months to years. At present, POCD is not coded as a disease despite garnering significant interest from researchers and clinicians.[39,40]

limit the search to contemporary tools only. The following search terms were used: *screen* or *screener* or *test* or *tool* or *measure* or *instrument* or *assessment* or *battery* combined with *dementia* or *cognitive* combined with *quick* or *brief* or *short* combined with *Mini-Mental State Examination* or *MMSE*. Abstracts were limited to English language only. Inclusion criteria specified that the tool: 1) assesses at least two distinct domains of cognitive function (i.e., multidomain tools only); 2) has a mean administration time of 2.5 min or less in non-demented subjects; 3) has been developed in a preoperative, primary care, or community sample; 4) has been tested against or developed with the MMSE; and 5) has been developed on subjects aged 60 yr or older. Studies were excluded for inadequate data (e.g., studies that did not report sensitivity or specificity). Tools requiring informant interviews or self-administration were also excluded.

After identifying cognitive screening tools using the aforementioned criteria, a second PubMed search was performed for each tool. All published English language abstracts were reviewed for each screening tool from January 1, 1996 to January 1, 2011. Studies examining the tools in perioperative settings were included.

Search results

The preliminary search identified 513 abstracts, most of which did not directly examine cognitive screening tools. Thirty-one abstracts were primary studies of multidomain cognitive screening tools. Twenty-five abstracts were excluded (19 due to length of administration, three for self-administration, two for inappropriate study samples, and one for informant interview). The six remaining abstracts described primary studies of cognitive screening tools (see Table 2 for a summary).

Six-item screener (6-IS)[41]

The 6-IS consists of a three-item recall (e.g., apple, table, penny) and a three-item temporal orientation (day of the week, month, year). Each correct response earns 1 point for a total of 6 points. Administration time is one minute, not including the delay for the recall component.

The 6-IS was published in 2002 to be used for quick screening for cognitive impairment with "an acceptable sensitivity and specificity" for dementia and mild cognitive impairment. The tool was developed in a community sample of 344 geriatric subjects and then validated in a cohort of 651 referrals to an Alzheimer's centre. A geriatric psychiatrist or neurologist evaluated subjects first for MCI and dementia, and then subjects were screened with both the 6-IS and MMSE. In the community sample, using a 6-IS cut-off score of 3 points or less, the sensitivity and specificity for dementia was 88.7% and 88.0%, respectively, while the MMSE cut-off score of 23 produced values of 95.2% and 86.7%, respectively. At a cut-off score of 4 points or less, the 6-IS showed a sensitivity and specificity for MCI of 74.2% and 80.2%, respectively, and at 5 points or less, the results were 97.7% and 49.2%, respectively.

Eight-item screener (8-IS)[42]

The 8-IS employs a three-item recall (e.g., bicycle, red, happiness) and an attention/calculation exercise whereby subjects subtract 7 from 100 serially for 5 iterations (serial 7s). One point is awarded for each correct answer, totalling 8 points. It can be completed in two minutes or less.

The 8-IS was published in 2011 to be used for rapid screening for dementia in primary care clinics using eight of the items included within the MMSE. The tool was developed in a cohort of 188 seniors from a geriatric clinic. Subjects were first screened with the complete MMSE (30 points). Those with scores less than 24 or 20, depending on education level, were referred to a neurologist for formal evaluation for dementia. The authors then calculated the sensitivity and specificity for dementia using only 8 points from the MMSE (recall plus attention/calculation). Scores of 6 or less produced a sensitivity and specificity for dementia of 94.9% and 59.1%, respectively, and these values changed to 85.9% and 78.2%, respectively, for scores of 5 or less. The authors advocate different 8-IS cut-off values for people with lower levels of education.

Six-item cognitive impairment test (6-CIT)[43]

The 6-CIT involves a three-item temporal orientation (year, month, time within one hour), a five-item address recall (John, Brown, 42, West Street, Bedford), and two attention exercises (count backwards 20 to 1, say months in reverse order). Each incorrect response is given 1 point, and a formula is used to generate a weighted score. It can be completed in one to two minutes.

The 6-CIT was developed in 1999 for "usage as a screening tool" in primary care. The tool was tested against the MMSE in a sample of 287 geriatric subjects from England. The 135 non-demented controls and the 152 subjects who carried a previous diagnosis of dementia were selected from both the community and outpatient settings. All subjects received the 6-CIT and MMSE. The 6-CIT was found to correlate strongly with the MMSE (r^2= −0.911). In addition, at a cut-off score of 6 points or higher, the 6-CIT produced a sensitivity and specificity for dementia of 92.1% and 95.6%, respectively, while the

Table 2 Comparison of cognitive impairment screening tools

Tool	Setting	n	Average age (yr)	Items	Admin. Time (min)	Scoring	Sn for dementia	Sp for dementia	Tested in a perioperative setting?
6-IS	Community and demented samples, USA	Cohort 1: 344 Cohort 2: 651	Cohort 1: 74.4 Cohort 2: 69.6	3 recall 3 orientation	1	Simple adding	88.7%	88.0%	No
8-IS	Geriatric clinic sample, Taiwan	188	77.0	3 recall 5 serial 7s	<2	Simple adding	94.9% or 85.9%, depending on cut-off	59.1% or 78.2%, depending on cut-off	No
6-CIT	Community and 2 demented samples, UK	Cohort 1: 135 Cohort 2: 70 Cohort 3: 82	Cohort 1: 68.1 Cohort 2: 73.8 Cohort 3: 81.7	5 recall 3 orientation	1-2	Rubric required	92.1%	95.6%	No
S-16	Post-acute hospitalization and national registry samples, USA	Cohort 1: 774 Cohort 2: 709	Cohort 1: 83.1 Cohort 2: 78.8	3 recall 8 orientation 3 registers 2 digit spans	2	Simple adding	99%	70%	No
5-IRF	Community and demented samples, USA	Cohort 1: 194 Cohort 2: 318	Cohort 1: Demented: 84.2 Non-demented: 83.8 Cohort 2: Demented: 78.5 Non-demented: 78.0	5 recall Verbal fluency	<2	Simple adding	79%	98%	No
Mini-Cog	Community sample, USA	249	Demented: 77.9 Non-demented: 69.0	3 recall Clock drawing	2.5	Simple algorithm	99%	93%	Yes

6-IS = six-item screener; 8-IS = eight-item screener; 6-CIT = six-item cognitive impairment test; S-16 = the sweet 16; 5-IRF = five-item recall and fluency; Sn = sensitivity; Sp = specificity

MMSE produced values of 78.6% and 100.0%, respectively, at a cut-off of 23 points or less.

Sweet 16 (S-16)[44]

The S-16 includes eight temporal/spatial orientation questions (i.e., orientation to time and place), three registration questions (i.e., immediate repetition of three items), two sustained attention questions (i.e., digit spans backward), and a three-item recall, for a total of 16 points. The instrument and instruction manual are available at http://hospitalelderlifeprogram.org. In the pilot group study, the mean administration time was two minutes.

The S-16 was published in 2011 as an alternative to current cognitive screeners that are "underused, lack sensitivity, or may be restricted by copyright laws". The tool was developed in 774 geriatric subjects who were recently hospitalized, and it was then validated in 709 subjects who were randomly selected from a large national sample. An expert panel of clinicians assigned the diagnosis of dementia using DSM criteria. The performance of the S-16 was compared directly with that of the MMSE. The two instruments correlated well with r^2=0.94. At a cut-off score of 13 points or less, the S-16 showed a sensitivity of 99% and specificity of 70% for dementia. The sensitivity and specificity for the MMSE at 23 points or less were 87% and 89%, respectively.

Five-item recall and fluency (5-IRF)[45]

The 5-IRF consists of a five-item address recall (John, Brown, 42, Market Street, Chicago) and a one-minute verbal fluency for animals (i.e., name as many different animals as possible in one minute). The tool is scored by counting the number of recall errors and the number of animals named; three or more recall errors or eight or fewer animals named correlates with dementia. It has an administration time of less than two minutes.

The tool was developed in 2005 to screen for dementia in patients with memory complaints. The authors retrospectively analyzed two geriatric cohorts. The first cohort consisted of 97 demented subjects (diagnosed using DSM criteria) matched with non-demented controls 1:1. The second cohort was comprised of 159 demented subjects (diagnosed using clinical criteria for dementia due to Alzheimer's disease) matched 1:1 with non-demented controls. Subjects were screened for cognitive impairment. The cohorts were combined to allow for greater statistical power. The 5-IRF achieved a sensitivity of 79% and a specificity of 98% for dementia using cut-off scores of 3 or more errors on the five-item recall test and eight animals or less on the verbal fluency test. At the same specificity (98%), the MMSE generated a sensitivity of 53% for dementia.

Mini-Cog[46]

The Mini-Cog is composed of a three-item recall and a clock drawing task. One point is awarded for each correctly recalled word. The clock drawing is scored as normal if the clock has the correct time and is grossly normal. Recall scores of 0, irrespective of the clock drawing score, and recall scores of 1-2, with an abnormal clock drawing score, correlate with dementia. In the pilot study, non-demented subjects required an average of 2.5 min for completion, whereas demented subjects took 3.7 min.

The Mini-Cog was published in 2000 for "discriminating demented from non-demented persons" in a diverse geriatric community sample. The tool was developed on a multicultural multilingual sample of 249 older adults who were first classified as demented or non-demented using formal diagnostic criteria. The subjects were then given the Mini-Cog and MMSE. The Mini-Cog's sensitivity (99%) and specificity (93%) for dementia were found to be higher than those of the MMSE (91% and 92%, respectively).

We identified two studies examining the Mini-Cog in a perioperative setting. The first study sought to determine preoperative risk factors for the development of postoperative delirium in older patients scheduled for a major surgery. One hundred forty-four subjects were studied, and 64 (44%) developed postoperative delirium. Subjects had received baseline cognitive and functional assessments preoperatively. The Mini-Cog was used to screen for preexisting cognitive impairment, and the authors found that this factor was the most robust predictor of postoperative delirium.[4]

The purpose of the second study was to identify preoperative variables associated with six-month mortality after major surgery in older adults. One hundred ten subjects were studied, and the six-month mortality was 15% (16 subjects). The Mini-Cog was used for preoperative cognitive assessment, and abnormal scores were shown to be significantly associated with six-month postoperative mortality.[47]

Discussion

The aim of this review was to identify practical screening tools that could be used to detect preoperative cognitive impairment in a clinical setting. During this review, we identified six screening tools that can be administered in 2.5 min or less. We believe any one of these tools could be used in a time-constrained preoperative environment.

Despite similar lengths of administration, the tools differed in their ability to screen for cognitive impairment. The best screening tools were the S-16 and Mini-Cog, each with a sensitivty of 99% for dementia in their respective study populations. The Mini-Cog, which was also the only tool found to be tested in a perioperative environment, generated a higher specificity (93%) for dementia compared with the S-16 (70%). However, we must stress that direct comparison of sensitivities and specificities between tools is restricted by the diversity of methodology among the studies reviewed.

We also emphasize that cognitive impairment detected by these tools is not diagnostic for dementia or MCI, rather, it is a screen only (these tools are also not designed to diagnose postoperative delirium). Accordingly, it would be prudent to discuss a positive screening with the patient and family to ensure referral to a primary care physician, neurologist, or psychiatrist for further evaluation before or after surgery. In addition, the possible significance of a positive screening should be discussed with the patient prior to the start of screening for cognitive impairment. Furthermore, if the screening is positive, proactive consultation with perioperative providers, including surgeons, anesthesiologists, nurses, and pharmacists, may be warranted to provide a strategy for delirium surveillance and possible care modification.

There are limitations to this review. First, none of the tools was designed specifically for surgical patients in a preoperative setting. Moreover, despite ample evidence linking preoperative cognitive impairment (usually detected by the MMSE) to postoperative delirium, only one of the tools (Mini-Cog) has been studied for preoperative risk stratification of postoperative delirium, and no tool has been studied extensively for this purpose. It is important to point out that surgical patients may have unique characteristics affecting their cognition, including pain and anxiety, and they may be taking medications to treat either or both. These factors may not be prevalent in non-surgical community residents.

Another potential limitation of the review is the strict inclusion and exclusion criteria. Our goal was to find cognitive screening tools that would be easy to incorporate into a time-constrained preoperative evaluation. Thus, we sought the simplest and briefest tools available. We acknowledge that screening tools with a longer administration time were excluded and that some of these tools may be more comprehensive and therefore preferred by some clinicians.

A final limitation of this review is the inclusion of the MMSE criterion. This criterion was selected because of the MMSE's historical importance and widespread presence in published literature. However, the MMSE criterion likely reduced the number of tools identified in our search. We must also emphasize that a tool need not be compared with the MMSE for it to be suitable for preoperative cognitive screening.

In summary, this review offers a starting point for preoperative cognitive screening, which, as pointed out by a recent editorial, should become a routine part of the evaluation of older patients before major surgery.[48] Only after assessing cognitive function at baseline can we further understand how cognitive changes occur after anesthesia and surgery and potentially intervene to mitigate these changes. Future studies are critically needed for prospective validation of cognitive screening tools as a means to identify patients at risk for postoperative delirium.

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Conflicts of interest None declared.

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