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Cognitive Impairment Assessment in Older Adults: A Narrative Review of Available Tools

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Abstract

Purposes: First to define and to differentiate the concepts of delirium, dementia, confusion and disorientation. Second to review and compare current relevant published cognitive impairment assessment. This review will assess how well these tools as can be integrated in a clinician's routine to estimate the reliability of the information given by a patient. Third, to discuss the potential positioning of the STOT (Spatial-Temporal Orientation Test) among currently available tools.

Methods: The literature search was conducted using PubMed. Cognitive impairment assessment tools dedicated to older adults over 65, published from January 1st, 1950, to April 15, 2018 were compared.

The authors reviewed existing cognitive impairment assessment tools and compared the evaluated neurocognitive domains, the duration of these tests, the sensitivity, the specificity and the predictive values.

***Results*:** We identified 132 tests through PubMed search, and we included 30 of them in our analysis. Twenty-five tools tested for orientation and 23 for memory. Seventeen tools evaluated dementia, while 10 of them tested for mild cognitive impairment. Eleven of them evaluated delirium. Thirteen tests in our list take up to 5 minutes to complete, and three of these tests take 3 minutes or less to administer.

Conclusions: Some tests have the potential to be integrated in clinical pharmacists' routine, since they take less than 3 minutes to administer. The STOT would probably be one of the easiest tools to use systematically considering the simplicity of the questions, but data is needed to validate its use.

Keywords: Delirium; Dementia; Mild Cognitive Impairment; Neurocognitive disorders; Neuropsychological Tests; Older people

Key Summary Points

Aim: This review allows clinical pharmacists and other clinicians to compare cognitive tools that evaluate cognitive functions and to choose among them the more adapted to their services.

Findings: The need for quick cognitive assessment tools to evaluate the reliability of information given by patients is not well addressed in the literature. While there are a few reviews of cognitive tools that have been published, we have found none that evaluates them in this particular context. However, in our daily work as clinical pharmacists, we have found this type of evaluation to be necessary, especially in the context of polymedicated patients in the geriatric ward. Thus, our review analyses the current cognitive tools with a novel approach, evaluating their possible use to test for the reliability of patient-given information.

Message: Multiple existing tools have the potential to measure quickly and accurately a patient's cognitive function, from which we can now study the reliability of patient-given information.

Introduction

As geriatric clinical pharmacists, we perform acts which allow us to identify pharmacologic problems, prevent idiopathic events and optimize pharmacotherapy. High prevalence of cognitive impairments in geriatric populations is an obstacle to gathering precise information directly from the patient. Indeed, when clinicians question patients on their health and lifestyle, there is a possibility that the answer is erroneous. This inaccuracy could be harmful to the patient. Using a brief and effective test to evaluate the patient's cognitive function every time information was needed from them would give clinicians a better idea of the reliability of those answers and the necessity to look for other information sources, (eg, family members and nursing homes). The Spatial-Temporal Orientation Test (STOT) was devised to address this problem and has been used for many years at the Bertinot Juël Hospital in Chaumont-en-Vexin, France [1].

It consists of 4 questions regarding the actual year, the current geographical location of the patient, the patient's address and the

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time of the day. For now, we consider the patient disorientated if doesn't score 4 correct answers out of 4. However, this test has yet to be validated, and numerous other tools currently exist to evaluate cognitive function.

Furthermore, in the context of possible neurocognitive disorders, it is important to distinguish between the different concepts such as dementia, delirium, confusion and disorientation.

- Thus, there are three main objectives to this review: first to define and to differentiate the concepts of delirium, dementia, confusion and disorientation;
- second to review and compare current relevant published tools;
- third to discuss the potential positioning of the STOT among currently available tools.

Definitions and Concepts

Causes of cognitive impairment sometimes overlap, sometimes are very distinct. It is necessary to differentiate symptoms from illnesses. Regarding medical definitions, the World Health Organization's (WHO) International Classification of Diseases (ICD) is recognized as an international standard, but the Diagnostic and Statistical Manual of Mental Disorders (DSM) prevails as the main reference in the psychiatric department. The classification of dementia by the DSM has recently been updated. In the fourth edition of the DSM, published in the nineties, dementia was classified in a category of its own, while the fifth edition published in 2013 included it in the new "Major neurocognitive disorders" (MCD) category along with other possible causes of impairment such as HIV or brain trauma [2-4]. Major neurocognitive disorders diagnosis is defined as a significant cognitive decline of one or more cognitive domains over time. According to *DSM-V*, there are six neurocognitive domains: learning and memory, language, executive function, complex attention, perceptual-motor function and social cognition [2]. Supplementary Figure S1 presents DSM-V classifications of the six neurocognitive domains and their components [5]. Mild neurocognitive disorders or impairment (MCI) are also mentioned for the first time in this latest edition and require basically the same criteria as MCD with distinction being assessed upon severity [5]. Delirium is an acute alteration of cognitive domains and it is excluded from MCI and MCD according to *ICD-10* and *DSM-V* definitions.

A major obstacle to evaluating validity of a patient's affirmations is underdiagnosis of cognitive impairment, especially delirium [6]. Delirium was shown to be a predictor of increased mortality, complications rate, length of hospital stay, relocation at discharge, cost for society, permanent cognitive and functional decline and delirium history was even associated to a higher risk of developing dementia [7-9]. It is essential to recognize it to prevent and treat it whenever possible. The DSM-V criteria as well as the ICD-10 definitions offer a reference in spotting delirium cases but the difficulty to recognize the mentioned symptoms among healthcare providers and its low diagnosis rate are already well documented [4,10]. Even through published literature, reported delirium prevalence is subject to large variations. These variations seem to be influenced by clinical context, but methods also seem to have an important impact, as there are variations between publications for similar contexts [10]. These

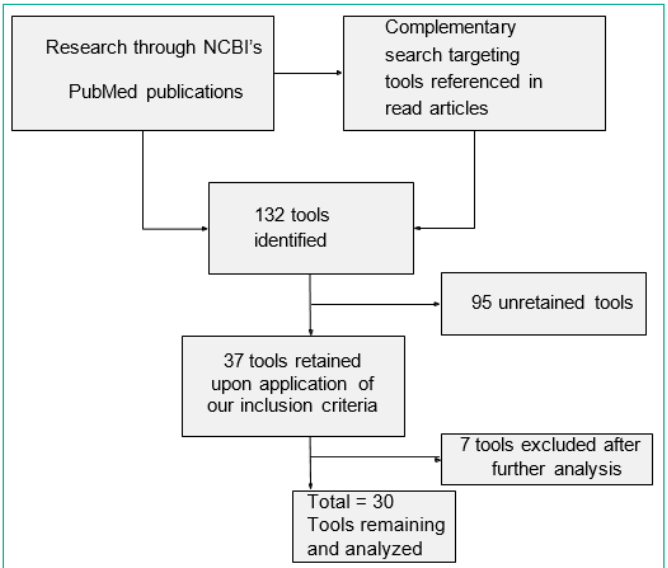

Figure 1: Flow diagram of the literature search.

elements strengthen the need to implement tools to systematically screen for cognitive impairment in healthcare settings, especially in clinical contexts with high prevalence of geriatric patients.

Dementia prevalence across the world was estimated to 24 million cases in 2010 and it was predicted this number would double every 20 years [11]. This disease is usually presented as a chronic, irreversible and associated to organic damages in which symptoms can only worsen gradually over time at a variable rhythm. The conversion rate from MCI to dementia is estimated to be around 10% yearly [12,13]. The principal causes of dementia are Alzheimer's disease, vascular (post-cerebrovascular event permanent damages) and Lewy body dementia. Other causes or aggravating factors include substance abuse, vitamin B deficiencies, hypothyroidism, etc [4]. Even if MCI and dementia usually present stable symptoms, the subtlety of symptoms and slow progression can delay diagnosis until a more advanced stage.

Therefore, an absence of documented MCI, MCD or even delirium does not guarantee normal cognitive function, and thus does not warrant reliable information.

Differentiation between delirium and other neurocognitive disorders is also complicated, even for caregivers working on their bedside daily [6]. Summarily, delirium can develop suddenly, it is usually not associated to any organic damages, and it is, most notably, reversible. Other notable differences between dementia and delirium are mentioned in Table 1.

Many predisposing factors as well as triggering factors for delirium have been mentioned in literature (Supplementary Table S2). Dementia is a predisposing factor for delirium; both often coexist and can be hard to differentiate. The presence of short- and long-term related questions for both time and space components of orientation evaluated by the STOT aims to assess whether short- or long-term memory is the most affected. The results could help rapidly distinguish between dementia and delirium. Terms "confusion" and "disorientation" are closely related and WHO presents them as synonyms. Indeed, *ICD-10* definition for "disorientation" simply states "Confusion *not otherwise specified*". Confusion generally describes an

Table 1: Clinical presentation mapping for delirium and dementia [2,14,19–24].

		Delirium	MCI and MCD
Apparition		Fast and sudden	Progressive
Evolution		Fluctuations	Steady
Resolution		Reversible in days to weeks	Irreversible
Cognitive domains	Executive	Possible rapid decrease in executive functions	Progressive degradation of executive functions
	Attention	Hardly sustained, short concentration	Harder to concentrate but attention sustainable
	Memory	Short term memory importantly impaired; important recognition memory loss	Short, then long term memory loss;
			semantic memory loss more probable as disease progresses
	Language	Wrong word choice, incoherent sentences, etc.; naming and comprehension possibly decreased; probable impact of visual	Mainly name and words forgetting as disease progresses (impacted by semantic memory loss and other developed
		misperceptions	extralinguistic deficiencies)
	Perceptual-motor	Frequent hallucinations, misinterpretation, significant loss of awareness (altered gnosis)	Hallucinations are uncommon; agnosia possible with progression of the disease
	Social cognition	Probable loss of emotions recognition	Usually not affected until advanced stages
Emotions and behavior		Possible fear, aggressiveness	Possible anxiety, fear, irritability, apathy
Sleep		Altered sleeping-waking cycle	Usually, normal

alteration of one or more cognitive domains. Neurocognitive disorders are only one possible cause of confusion amongst many. Other possible causes include various medical situations, iatrogenic effects, exposition to harmful substances, etc. However; "disorientation" seems frequently employed in the meaning of "spatiotemporal disorientation" which is a symptom of confusion mainly related to the cognitive domain of memory (more specifically to dysfunction of the recognition memory) and perceptual-motor domain [14,15]. These domains are frequently impaired in both neurocognitive disorders and delirium. Also, spatiotemporal disorientation is one of the most easily detectable symptoms of confusion, which is why the STOT concentrates on this aspect to evaluate cognitive function.

Methods

The first step was to identify the existing tests concerning cognitive function impairment: the search was done on PubMed and using the keywords "neuropsychological tests", "cognitive dysfunction", "evaluation", "screening", and "diagnosis" to find relevant publications. Since we aren't looking to diagnose delirium or dementia, or to differentiate one from the other, we included tests to evaluate both conditions. We excluded articles that weren't in published English and those concerning mental impairment in a specific population other that patients over 65 (eg, stroke patients). We looked at reviews of tools, from which we extracted additional tests that weren't directly found through this search. After gathering a list of all the tests that are mentioned through this search, the second step was to look for the original articles where these tests were first mentioned and validated. We only included tests that have been published in a journal and those that have been validated. We excluded tests that were done via telephone and those that could not be completed in one meeting. We also excluded tests that needed a support other than pen and paper, such as a screen.

We extracted the main objective of the test, sensitivity, specificity, positive and negative predictive values from the original validation study as available, and then compared with subsequent studies when a lot of data was available, favoring reviews and meta-analysis. We also looked for the duration of each test and if they included an evaluation of the spatial temporal orientation. For some tools, we had to dig for more information if we didn't find all the data we needed within the articles we had already gathered. For instance, we sometimes had to research for specific data like sensibility, specificity or predictive values individually. Considerable reputation, clinical experience and more recent publications were also weighted in our selection. Some tools required a modified approach, such as MMSE, for which the original publication didn't present sensitivity, specificity or accuracy data. We thought this could be explained by the evolution in standards over several decades. In this case, we chose to include meta-analyses, which constituted a reasonable approach considering the important literature. These meta-analyses were chosen to optimize sample size and diversity while minimizing duplicates.

Results

As illustrated in Figure 1, we identified 132 tools with our PubMed search, including articles that were referenced in other publications. We retained 30 tools which matched our inclusion and exclusion criteria and we separated them into three categories: those evaluating and screening for chronic neurocognitive disorders from MCI to dementia, those targeting delirium, and those developed with time-saving in mind and that don't differentiate between dementia and delirium (STOT-like tools). Tables 2 to 4 present the basic characteristics of the different tools and specifies each domain that they test for. Supplementary tables S3 to S5 present the performance of the different tools and include sensitivities, specificities and predictive values of the different tests. We also included other practical information concerning each publication such as the main author's name, size of the studied population, purpose or object of the study, comparators (if applicable) and reference cognitive assessment method.

Orientation and memory are the elements evaluated in the most tests: 25 of them tested for orientation and 23 for memory. Seventeen tools evaluated dementia, while ten of them tested for mild cognitive impairment. Eleven of them evaluated delirium. Study sizes are very variable between tests: some studies have less than 50 subjects, others have more than 500 subjects, and in meta-analyses such as those of the MMSE, pooled data can come from more than ten thousand subjects. Sensitivity varies between 20 and 100%, and 21 tests have at least one study suggesting a sensitivity of more than 90%. Specificity varies between 25 and 100%. Thirteen tests in our list take up to 5 minutes to complete, and three of these tests take 3 minutes or less to administer. Most tools, especially the shorter ones, test for a specific condition

Table 2: Basic characteristics and domains of MCI and dementia tools.

e	Abbreviation	Year of publication	Evaluated condition		Cognitive domains													Emotional disturbances	Test duration (minutes)	Number of items or subtests
					Perceptual-motor function					Learning/ memory					Executive function					
			Mild cognitive impairment (MCI)	Dementia	Gnosis (awareness)	Psychomotor disturbance	Visual perception	Visuoconstructional	Spatiotemporal orientation	Learning	Memory	Complex attention	Language	Social cognition	Working memory	Thought process	Other executive functions			
Mini Mental State Examination and Standardized MMSE [27.28]	MMSE/ SMMSE	1975 and 1997	Adjusted cutpoint	X					X		X	X	X						10-15	11
Mini-Cog [29]		2000		X				X			X								3	2
Demenz Detektion (*German*) [30]	DemTect	2004	X	X							X				X		X		8-10	5
Memory and Executive Screening [31]	MES	2012	X								X	X	X						7	7
Memory orientation screening test [32]	MOST	2010		X				X	X		X								< 5	4
Montreal Cognitive Assessment [33]	MoCA	2005	X	+/-				X	X		X	X	X		X				10	30
Short-MoCA [34]	s-MoCA	2005	X	+/-				X	X		X	X	X		X				< 10	8
AB Cognitive Screen [35]	ABCS	2003	X	+/-				X	X		X		X						3-5	5
Quick Mild Cognitive Impairment [16,36]	Qmci	2012	X	+/-				X	X		X		X						5	6
Hasegawa's Dementia Scale-Revised [37,38]	HDS-R	1994		X					X		X		X		X				10	9
7 Minutes Neurocognitive Screening [39]	7MS	1998		X				X	X		X		X						7	4
Ascertain Dementia 8 [40]	AD8	2005		X					X		X						X	X	<3	8
Addenbrooke's Cognitive Examination III [41]	ACE- III	2017		X				X	X		X	X	X						15	5
Memory Alteration Test [42]	M@T	2007	X	X					X		X								5-7	40 to 50
Memory Impairment Scale [43]	MIS	1999		X							X		X		X				4	4

Table 3: Basic characteristics and domains of delirium tools.

Name	Abbreviation	Year of publication	Cognitive domains														Delirium elements					
			Perceptual-motor function					Learning/ memory					Executive function									
			Gnosis (awareness)	Psychomotor disturbance	Visual perception	Visuoconstructional	Spatiotemporal orientation	Learning	Memory	Complex attention	Language	Social cognition	Working memory	Thought process	Other executive functions	Emotional disturbances	Acute onset	Fluctuations	Sleep-wake cycle	Duration (minutes)	Number of items or subtests
Cognitive Assessment Method [44]	CAM	1990	X				X		X	X				X			X	X	X	5-10	9
CAM adapted for intensive care units [45]	CAM-ICU	2001	X				X			X				X			X	X		< 5	4
Intensive Care Delirium Screening Checklist [46]	ICDSC	2001	X	X	X		X			X		X		X			X	X	X	7-10	8
Recognizing Acute Delirium As part of your Routine [47]	RADAR	2015	X	X											X				X	2-3	3
Delirium Observation Screening Scale (25 items) [48]	DOS	2003	X	X	X		X			X					X	X			X	< 5	25
Delirium Observation Screening Scale (13 items) [49]	DOS	2003	X	X	X		X			X				X		X			X	< 5	13
Neecham Confusion Scale [50,51]	NEECHAM	1996		X			X		X	X	X	X			X					10	9
Memorial Delirium Assessment Scale [52]	MDAS	1997	X	X	X		X		X	X			X	X					X	10	10
Delirium-O-Meter [53]	DOM	2005	X	X	X		X			X				X		X			X	3-5	12
Delirium Symptom Interview [54,55]	DSI	1992	X	X	X		X							X					X	10-15	109
Delirium Rating Scale Revised-98 [56,57]	DRS-R-98	2001		X	X	X	X		X	X	X			X		X	X	X	X	15-20	16

rather than cognitive function as a whole. None of the tests screens specifically for spatial temporal disorientation, but this element is often included in the evaluation process regardless of whether the system tests for dementia or delirium.

Discussion

While the sensitivity, specificity and predictive values of numerous tools included in our review are similar, the size of published data give us a good idea of what tests are frequently used and allows a more global interpretation of the validity of each tool. Unsurprisingly, the MMSE is amongst the most commonly used in clinical practice, but is also a common reference in dementia diagnosis and follow-ups. However, it has limitations such as suboptimal sensibility and specificity, especially in patients with MCI where the Montreal Confusion Assessment (MoCA) appears superior. For delirium screening, the Confusion Assessment Method (CAM) has an important amount of relatively strong data supporting its effectiveness. The optimal duration of a tool depends on the context in which it will be used. Since we want to evaluate reliability of data extracted from patients, it should logically be quicker than the ones generally used for diagnostic. Most tools that we examined are not very time-consuming, requiring less than 10 minutes to complete. However, even this amount of time can become a burden should it be used repeatedly as part of a routine. For example, if a clinician sees 20 patients per day, doing these tests

Table 4: Basic characteristics and domains of STOT-like tools.

Name	Abbreviation	Year of publication	Evaluated condition				Cognitive domains															
							Perceptual-motor function					Learning/ memory					Executive function					
			Cognitive dysfunction	MCI	Dementia	Delirium	Gnosis (awareness)	Psychomotor disturbance	Visual perception	Visuoconstructional	Spatiotemporal orientation	Learning	Memory	Complex attention	Language	Social cognition	Working memory	Thought process	Other executive functions	Emotional disturbances	Duration (minutes)	Number of items or subtests
Short Portable Mental Status Questionnaire [58]	SPMSQ	1975	X	X							X		X				X				5-10	10
Abbreviated Mental Test [59]	AMT	1972	X		X						X		X				X				5-7	10
4-items AMT [60]	AMT-4	1997	X		X						X		X								3-5	4
6-items Cognitive Impairment Test [61]	6CIT	1983	X	X	X						X		X				X				2-3	6

before seeing each patient would take them at least an hour and a half per day. Therefore, the required time is an important factor if we want to validate information acquired from patients every time we interact with them. In this context, time required to go through a formulary like the MMSE, the MoCA or even the CAM, which all take around 10 minutes to complete, explains the interest for shorter, quicker tools derived from them. For example, the short-MoCA (s-MoCA) has less evaluation elements than the MoCA while assessing the exact same domains, and it presents similar results compared to the original MoCA. In contrast, Mini-Cog, a derivative of the MMSE, hasn't been able to come up with consistent results and seems to magnify some of MMSE's weakness such as questionable specificity.

Focusing on time-saving alternatives, the Short Portable Mental Status Questionnaire (SPMSQ), Abbreviated Mental Test (AMT) and 6-items Cognitive Impairment Test (6CIT) all have a similar structure to the STOT with a few questions that can be answered relatively fast. Despite these similarities, the use of SPMSQ and 6CIT is backed by stronger evidence. The 6CIT, while having only six predefined questions, might still be longer to administer than the STOT, since answering some of its questions can be complicated and take more time (eg, counting backward).

However, the number of items does not often reflect the duration of the test. For example, the Memory Alteration Test (M@T) contains between 40 and 50 items, but takes less time to complete than Hasegawa's Dementia Scale-Revised (HDS-R) composed of only nine items. The longest test in our list is the Delirium Rating Scale Revised-98 (DRS-R-98).

Delegating cognitive function assessment to different caregivers could be a plausible approach to bypass the time constraint. However, it has been thoroughly demonstrated that results obtained may vary between caregiver categories, at least with some tools like MMSE. There is a possibility that this discrepancy is the result of varying moments of administration, especially when considering the possibility of the daily fluctuations of delirium. Specialized caregivers seem to obtain better results in these situations, but these results could be influenced by their basic knowledge. Interestingly, some tools were designed specifically for nurses, such as the RADAR test and the Delirium-O-Meter, and are adapted and evaluated for nurse-patient interactions. The same working process could be used in developing and evaluating tools for other caregivers, such as clinical pharmacists.

Clinical settings can also motivate the modification of existing tools. For instance, a couple of variations of the CAM currently exists, and some are supported by good evidence and used relatively often in clinical settings. One of such variation is the ICU adapted version (CAM-ICU), meant to be used on intubated patients.

Other tools with less supporting evidence also present interesting characteristics. The Quick MCI (Qmci) test presents interesting results in differentiation of MCI from normal cognition and was compared to MoCA on that matter. Qmci was created by modifications to AB Cognitive Screen's (ABCS) subsections and takes only 3 to 5 minutes

to complete, but results are presented in the form of a score from 0 to 100 that seems to bring cutoff issues. In fact, the authors originally suggested a cutoff of less than 62 for differentiating MCI from normal cognition, but a more recent study [16] seem to demonstrate that a lower cutoff would be more accurate. The same problems occur with MoCA as different authors suggest different cutoffs - at least four different values have been proposed. It seems to us that this is a serious obstacle in evaluating, comparing and optimizing results of these tools in everyday caregiving and it could be an interesting matter to address in a further literature review.

Overall, the *DSM-V* criteria to delirium diagnosis when applied by a clinician remains the cornerstone of neurocognitive disorders and delirium recognition and it seems to us that these criteria should be the gold standard when validating a new tool to obtain reliable accuracy data. However, MMSE is also used in many cases as the comparative in validation studies. Other tests have also been used as references, such as the CAM and the DSR-R-98. Clinical context and destined users should to be considered for choosing the right comparator. An optimal cutoff should also always be determined.

While classifying the different domains that each test assesses, we noticed that for certain types of questions, there isn't a consensus on the targeted domain. For example, questions requiring naming days of the week or months of the year backwards, is classified under the section 'disturbance of consciousness' in the Delirium Symptom Index (DSI) while the 6-CIT considers it a calculation test. Establishing the neurocognitive domains, we want to evaluate prior to building a new evaluation tool based upon its objective (eg, screening delirium, evaluating dementia).

Bernabeu-Wittel et al. [17] analyzed each of the SPMSQ's questions separately. As previously mentioned, some of these questions are very similar to those of the STOT and evaluate the same cognitive domains. Therefore, the relatively conclusive results of this analysis are interesting and are part of what encourages us to pursue the STOT's validation process.

Limitations

Since there is an important number of tests that currently exists, there was more than two thirds of them that could not be included in our review. Some existing reviews of cognitive tests are more thorough, such as the systematic review for the U.S. Preventive Services Task Force [18], although we have not found one that included every test that we have come across in our search.

Furthermore, for some of the tests, we extracted the validity data from one publication, which was often the original validation study. This can be a source of bias, particularly publication bias, since the author is the creator of the tool. Additionally, having data from multiple studies would have given a better estimate of the sensitivity and specificity of the different tools through our review. Effectively, there has been some variations in data with almost every tool. Since delirium is known to be difficult condition to diagnose. In fact, even between experts, there isn't always a consensus, and clinical context also seems to be a significant source of variation. These discrepancies between publications on a same tool make it harder to draw conclusions and hinders comparison of different tools, especially those with similar statistics. Thus, these variations and their possible causes must be kept in mind when comparing tests to one another to minimize the impact on our analysis as much as possible.

Some other variable would have been interesting to compare between tools, such as details of the populations in which the tools were tested and inter-rater variability, as we have sometimes seen these two elements having an impact on a tool's performance.

Conclusion

The notions of delirium, dementia, confusion and disorientation are closely intertwined. While dementia and delirium are two separate conditions that affect one another, confusion is a manifestation of these disorders and disorientation is one face of confusion. Cognitive dysfunction can affect the reliability of patients' answers to clinicians' questions, but the numerous currently available tests have limited applicability as a systematic pre-interview screen. While some tests are quite short (less than 3 minutes to administer) the STOT would probably be even shorter considering the simplicity of the questions, which makes it easier to be used for this function. Validation studies including sensitivity, specificity and ROC calculations would be needed to support its systematic use the healthcare system. Furthermore, it would be relevant to consider the relationship between disorientation and the reliability of the patient's answers: does a disoriented patient's answers are necessarily erroneous? Further studies are needed on this subject to help guide clinicians' approach to potentially confused patients.

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Author Contributions

Every contributing author has been named and all named author have contributed significantly to this article.

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