Review Article

The impact of cognitive impairment in urologic implants: a narrative review

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Background and Objective: With the general population aging and thus more patients developing bothersome erectile dysfunction, stress urinary incontinence and overactive bladder, there will likely be a higher demand for three common interactive implants in urology, the penile prosthesis, artificial urinary sphincter (AUS) and sacral neuromodulation (SNM). Further, the prevalence of mild and major neurocognitive disorders (also known as mild cognitive impairment and dementia, respectively) is expected to increase. While the aforementioned urologic implants have excellent short and long term outcomes, there are also known device issues such as malfunction or misuse that may require surgical removal and/or revision. The objective of this narrative review is to describe the association of cognitive impairment and urologic implants.

Methods: We performed a search on PubMed between the years 1975–2023 for English language articles that reported on any type or severity of cognitive impairment and its association with penile prosthesis, AUS and/or SNM. While peer-reviewed published manuscripts were prioritized, abstracts that fit our search criteria were also included.

Key Content and Findings: Data assessing outcomes of patients with cognitive impairment who undergo placement of a urologic implant are limited. There is an association between AUS failure or misuse with cognitive impairment. SNM is efficacious in this population in the short term. In patients who develop dementia, an inflatable penile prosthesis can be deflated via in-office needle puncture and an AUS can be deactivated. The Memory Alteration Test, Quick Screen for Mild Cognitive Impairment and the Saint Louis University Mental Status Examination are relatively quick screening tests with good sensitivity and specificity for mild cognitive impairment.

Conclusions: While data on the association between urologic implants and cognitive impairment are sparse, there are tools that urologists can use to screen patients for cognitive impairment. With screening, urologists can provide appropriate preoperative counseling (including recommending against implantation) and can provide closer postoperative monitoring. Further study is required to assess which patients should be excluded from device implantation and how to properly assess for cognitive impairment in a manner that is both beneficial for the patient and convenient and efficient for a urologist.

Keywords: Inflatable penile prosthesis; artificial urinary sphincter (AUS); sacral neuromodulation (SNM); neurocognitive disorder; cognitive impairment

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Introduction

Within the field of genitourinary surgery, three main implantable (and interactive) devices have been popularized with excellent short- and long-term outcomes: the penile prosthesis for erectile dysfunction (ED), the artificial urinary sphincter (AUS) for stress urinary incontinence (SUI, primarily in males) and implanted devices for sacral neuromodulation (SNM) for refractory overactive bladder (OAB), urinary urgency incontinence and non-obstructive urinary retention (1-11). While these implants have important, quality-of-life improving applications, they also have potential adverse events including device malfunction, infection, injury to adjacent anatomic structures that may necessitate removal of the device with or without re-implantation of a new device and repair of the injury (3,5,8,10-12). Thus, after a urologic device is implanted, it is important that patients are counseled on the long-term risks of the implant, have an understanding of how to use the device appropriately, and are instructed to continually monitor their devices for issues that could warrant re-intervention.

As ED and urinary incontinence are increasingly present in those with advanced age (13-20), the typical urologic patient receiving one of the aforementioned implants is older. With the older adult population projected to reach 21% of the total American population by 2030 (21) more people will be at risk for multiple issues associated with aging including cognitive impairment and dementia, both at time of implant and over the commonly lengthy device lifespan. The Diagnostics and Statistical Manual of Mental Disorders Fifth Edition uses the term 'Neurocognitive Disorders' to describe acquired deficits in cognitive function, which can be described as major type or mild type (22,23). Mild neurocognitive disorder, also known as mild cognitive impairment (MCI), is associated with modest decline in one or more cognitive domain (complex attention, executive function, learning and memory, language, perceptual-motor, or social cognition) without interference of a person's independence in daily activities, whereas major neurocognitive disorder is synonymous with dementia and is characterized by the cognitive decline that impairs independence in everyday activities (22,23). While the prevalence of MCI is difficult to estimate, it has been reported between 3–42% in adults over 65 years old, with up to 15% advancing to dementia each year (24-29). Indeed, population estimates of people with MCI in the United States reaches over 16 million by 2030 and over 21.5 million by 2060.

Several studies have reported the association of frailty—a measure of physiologic vulnerability that manifests as increased susceptibility to adverse events such as falls, disability, loss of independence, and death (30,31)—with outcomes in urologic surgery. While frailty has been associated with increased risk of complication in urologic surgery (30,31), there have been reports specifically related to penile prostheses and SNM that showed no association of poor outcomes in frail older adults who undergo these surgeries (32-34). However, data assessing urologic implants in the setting of neurocognitive disorders are lacking. In this narrative review, we aim to report what is known about cognitive impairment (MCI and dementia) in association with penile prostheses, AUS and SNM; we will report data that has been published in this area and describe what urologists can do in counseling patients preoperatively and monitoring them postoperatively. We present this article in accordance with the Narrative Review reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-23-226/rc).

Methods

This is a narrative review. PubMed was used to search for sources. Searches were performed between December 1, 2022 and June 16, 2023. Search terms used were: neurocognitive disorder, cognitive impairment, mild cognitive impairment, dementia, cognitive status, elderly, elderly male, older male, screening, Penile prosthesis, Inflatable penile prosthesis, artificial urinary sphincter, sacral neuromodulation and outcomes. Timeframe for included studies were between the years 1975 and 2023. Only English language studies were included. While peer-reviewed published manuscripts were prioritized, abstracts and textbook chapters that fit our search criteria (found on google.com) were included. Each author was independently involved in literature search. The primary author (DJB) reviewed all included articles. The search strategy summary can be found in *Table 1*.

Discussion

Penile prostheses

For the last 50 years, penile prosthesis has been a recommended treatment for those suffering from ED, especially if refractory to pharmacotherapy (35,36). Innovations in technology and surgical approach over this time have led to a variety of prosthetic options for surgeons

Table 1 Search strategy summary

Items	Specification
Date of search	Searches performed between December 1, 2022 and June 16, 2023
Databases and other sources searched	PubMed
Search terms used	Neurocognitive disorder, cognitive impairment, mild cognitive impairment, dementia, cognitive status, elderly, elderly male, older male, screening, Penile prosthesis, Inflatable penile prosthesis, artificial urinary sphincter, sacral neuromodulation, outcomes
Timeframe	Between the years 1975 to 2023
Inclusion and exclusion criteria	Only English language studies were included. While peer-reviewed published manuscripts were prioritized, abstracts and textbook chapters that fit our search criteria (found on google.com) were also included
Selection process	Each author was independently involved in literature search. The primary author (DJB) reviewed all included articles
Any additional considerations, if applicable	None

and patients. These devices have been shown to provide high rates of patient satisfaction and device longevity for ED, and concomitant issues like Peyronie's disease and ischemic priapism (1-3,37,38).

Several forms of penile prostheses exist on the market today, including a 2-piece inflatable penile prosthesis (IPP), 3-piece IPP and a malleable (non-inflatable) device. Most IPPs work through a simple hydraulic mechanism in which a fluid reservoir (implanted in the pelvis or abdomen) is connected to inflatable cylinders (implanted in the corpora cavernosum) by a tubing system. The inflation and deflation of the cylinders is controlled manually through a pump that is typically implanted in the scrotum. Factors that lend modern IPPs the high rates of patient satisfaction are discreteness of the hydraulic pump mechanisms, ease and rapidness of activation, and their increased resistance to mechanical wear and erosion.

Much work has been done to elucidate characteristics that could predict patient satisfaction with penile prosthetic devices. Not surprisingly, there is scant information available to aid related clinical decision making in patients with ED who also have MCI. The AUA guideline on ED does not mention this as a potential concern (36). ED and aging are positively associated (14). However, age has not been shown to be a predictor of poor penile prosthetic outcomes. Chung *et al.* compared IPP outcomes between men under and over 75 years old and found similar IPP mechanical survival and patient satisfaction (39). Further, Villarreal *et al.* reported low infection rate and high satisfaction in a cohort of men over 71 years old (40). Still, in a study that assessed the relationship between sexual and cognitive function, Hsu *et al.* evaluated almost 1,000 men and found that decline in erectile function is associated with decline in cognitive function (13); interestingly, decline in sexual desire was not associated with decline in cognitive function (13). There is some data in regard to frailty—an estimation of patient physiologic vulnerability—and its association with penile prosthesis outcomes. Madbouly *et al.* found no association of frailty and IPP complications, whereas in a review of frailty assessment and penile prosthetics, Brennan *et al.* reported that frail patients had issues postoperatively with device manipulation (31,34).

Habot *et al.* recognized the importance of being aware that an older patient has a penile prosthesis in order to prevent prosthetic complications (41); the main concern they note is catheterization of these patients, especially if the caregiver has no knowledge of the presence of a penile prosthesis or how the implant works. Luna *et al.* reported a technique for permanent IPP deflation via puncture in 10 patients, 9 of which were requested due to the patient being diagnosed with dementia (42). They report a "typical case" of a man who was implanted over a decade prior who developed Alzheimer's dementia and was unable to deflate the device; on assessment, he could not be retaught proper IPP use (42). A persistently inflated IPP can cause distress to the patient, relative or caretaker and even urethral erosion (42). Another consideration would be to exchange the IPP for a 1-piece malleable penile prosthesis. The benefit being that a patient with MCI who desires sexual activity could still enjoy the quality of life benefits from a penile prosthesis without the complexities of a 3-piece IPP. However, this would require an additional surgery

(and its inherent complications) and may not alleviate the aforementioned catheterization issue. Further, there is no data reporting the role of malleable penile prosthesis placement in the setting of cognitive impairment.

An additional issue associated with cognitive impairment is inappropriate sexual behaviors or hypersexual behaviors (43-46). This sexual behavior is highlighted by disinhibited and indiscriminate behavior of a sexual nature that is out of the person's control (46). The combination of inappropriate sexual behavior and presence of a penile prosthesis could potentially lead to inappropriate use of the device. To date, there have been no reports of this type of sexual behavior issue in association with penile implants. Still, permanent deactivation can alleviate these concerns and prevent complications associated with an IPP.

Mohan *et al.* reported survey results of how experienced prosthetic surgeons would approach several challenging clinical scenarios, including two patients with possible cognitive impairment—the first is a patient with Down Syndrome and the second is a non-verbal patient following a stroke (47). The authors report that providers are half as likely to offer an IPP to patients in these clinical scenarios as they would be to the baseline 50 years old male with medication-refractory ED (47). However, having a better understanding of the patient's autonomy, including cognitive capacity to understand their surgery, resulted in higher odds of the provider offering IPP (47). The authors stress the importance of balancing the biomedical ethical principles (autonomy, nonmaleficence, beneficence and justice) during surgical planning (48); in the scenario of a patient with MCI, autonomy may be the key principle.

While there is no data specifically evaluating penile prosthesis outcomes in association with cognitive impairment, it is clear that prosthetic urologists need to consider this issue before and after implanting a penile prosthesis. Non-use of an IPP may have few risks, however, if an issue with the device were to arise, a urologist can consider removal of IPP (if patient is an acceptable surgical candidate) with or without malleable penile prosthesis placement (depending on the patient's desire for sexual activity), or IPP deactivation via cylinder puncture, which can be safely performed in the clinic setting.

Artificial urinary sphincter

AUS is the primary treatment option for men with bothersome SUI (especially moderate to severe) after prostate surgery (18,49). In fact, the AUA/SUFU guideline on Incontinence after Prostate Treatment claims that AUS is the most predictable and reliable treatment of SUI after prostate treatment (49). Use of AUS in the treatment of male SUI has excellent long term outcomes (4-6,11); still, AUS have limited lifespans and will likely lose efficacy over time, possibly requiring re-operation (11,18,49).

An AUS device functions with 3 parts: an inflatable cuff that wraps around the urethra, a control pump located in the scrotum (or labia majora in women), and a pressure-regulating balloon in the lower abdomen or pelvis that provides constant occlusive pressure. The AUS is a hydraulic sphincter where the mechanical action of the device depends on the pump to inflate or deflate the cuff (50). When the device is active, the cuff is filled with fluid at baseline, compressing the urethra and preventing the passage of urine. To empty the urinary bladder, one squeezes the pump, moving fluid to the pressure-regulating balloon and allowing urine to pass out the urethra; the fluid soon passes from the pressure-regulating balloon back to the cuff to resume urethral compression and restore urinary continence. Thus, requirements to operate an AUS are manual dexterity to locate and then squeeze the pump and sufficient cognition to remember to compress the pump when preparing to urinate (51). If a patient does not have appropriate cognition to remember to cycle the device, a chronically active device can lead to urinary retention and complications thereof as well as urethral atrophy or injury.

Prior data has shown that incontinence after prostatectomy increases with age (16). Even though risk of MCI also increases with age, Chung *et al.* compared AUS outcomes between men under and over 70 years old and found similar clinical efficacy (52). Further, they found that frailty was not associated with higher AUS revision rate (52). Conversely, Ziegelmann *et al.* reported that men over 80 years old who have an AUS implanted have a higher risk of device infection or erosion compared to men under 60 years old with an AUS and that age over 80 years was independently associated with increased risk for device infection/erosion (53); still, 5-year overall device survival was not significantly different between any age groups. Further, Medendorp *et al.* reported that frailty is a significant predictor of 30-day postoperative major complications after an AUS implantation and that frailty and age over 85 years was associated with increased odds of undergoing an AUS removal procedure (compared to an AUS implantation) (54).

Unlike the AUA guideline on ED, the AUA/SUFU guideline on Incontinence after Prostate Treatment states

that clinicians should ensure that patients demonstrate cognitive ability for proper use of the device (49). While data are limited, there are several reports of the association of MCI and AUS use and outcomes. Notably, a grave complication of inability to use AUS pump or confusion with device may be postrenal acute kidney failure and even end-stage renal disease as a result of chronically activated cuff (55). Wolski *et al.* described performing preoperative psychological assessments of 16 men who desired AUS and disqualified two patients due to cognitive disorders; they propose that psychological assessment should be included when working up a patient for AUS (56).

Two groups have retrospectively assessed the role of cognitive function on AUS outcomes. Raup *et al.*, in a retrospective analysis of 213 men who underwent AUS implantation, were the first to report a higher rate of AUS failure and worse incontinence in patients with preoperative cognitive dysfunction (57). Still, they found no association between advanced age and AUS failure. It is notable that only 5 of the patients included in this study had cognitive dysfunction. The authors conclude that providers should make an effort to identify cognitive dysfunction before and after AUS implantation and should exercise caution if a patient with declining cognitive function desires AUS implantation. Keles *et al.* reported results of 163 patients who underwent AUS implantation with the primary objective of evaluating the role of baseline education level and cognitive status (Mini-Mental Status Exam (MMSE) score) on AUS success and revision rates (58). In their cohort, 20.2% had MCI and 42.3% had moderate cognitive impairment. They found that those with intact cognition and MCI had greater success (measured by continence rates) than those with moderate cognitive impairment. Neither education level nor age had an association with higher rate of failure or revision. These studies further highlight the importance of proper patient selection and counseling.

Limited study is available to inform prevalence of cognitive impairment and its impact on efficacy and outcomes longitudinally following implantation of an AUS. Ballantyne *et al.* took a different route in their study and assessed cognition using a telephone survey in 74 men who had previously undergone AUS implantation (59). Eighteen (24%) patients met criteria for cognitive impairment. Patients with impaired cognition had more difficulty using their device but no differences were seen in AUS revision, erosion or failure rates or incontinence rates between patients with normal and impaired cognition (59). The authors conclude that urologists should continually monitor AUS patients who may be affected by cognitive dysfunction. Indeed, O'Connor *et al.* and Léon *et al.*, in their studies of the long-term outcomes of AUS implantation, reported device deactivation due to patient dementia (11,60), thus highlighting the importance of long term follow up and even cognitive assessment in men who have previously undergone AUS implantation.

Based on the limited data available, cognitive impairment is associated with poorer AUS outcomes. While the AUA/SUFU guideline on Incontinence after Prostate Treatment recommends clinicians ensure patients have adequate physical and cognitive abilities to operate an AUS (49), there is no standardized protocol for testing these abilities preoperatively or following these patients for the lifespan of the device. Identifying patients who may be at highest risk of developing cognitive decline or dementia is important for preoperative counseling (51). Further, if concerns about cognitive impairment or a patient's ability to properly use the AUS arise post-AUS implantation, urologists should consider device deactivation. While this would render the patient incontinent again, deactivating the device will alleviate most concerns regarding device misuse, including urinary retention, urethral atrophy and device erosion, and likely decrease risks of severe complications.

Sacral neuromodulation

SNM therapy is Food and Drug Administration (FDA) approved for urinary urgency incontinence and non-obstructive urinary retention and also indicated for refractory OAB (17,61). Therapy involves delivery of continuous low-level stimulation to the S3 nerve root, which contains afferent sensory nerves from the pelvic floor and parasympathetic fibers to the bladder. Therapy is thought to modulate afferent signaling and thereby modulate both voiding and continence reflexes (62,63).

Currently available SNM devices include Medtronic Interstim® and Axonics®, both of which are implanted systems that include a permanent quadripolar tined lead and an implantable pulse generator (battery). Prior to implantation, patients must undergo a test-phase, in which either temporary wires (peripheral nerve evaluation) or the tined lead (Stage 1) are placed and connected to a temporary external battery for one-to-two-week timeframe. The test-phase is typically considered successful if the patient objectively demonstrates a 50% or greater improvement in symptoms compared to baseline, after which the permanent battery is placed. After placement, patients can control the

device with a communicator, including turning therapy on/off, adjusting amplitude, and (for Medtronic® devices) choosing amongst different programs.

Sacral neuromodulation therapy thus requires engagement with therapy during both the test-phase and following treatment. The AUA/SUFU guideline on overactive bladder indicates that a certain cognitive ability is needed to participate in and maintain any OAB therapy, although the guideline does not provide guidance regarding appropriate cognitive thresholds (17). As a technologic device, SNM theoretically may require higher cognitive thresholds compared to other OAB therapies such as pharmacotherapy or chemodenervation (32). Indeed patient interaction is often necessary to optimize device function and ensure patients are satisfied with the device program settings that they are using. Normal cognitive function along with an understanding of the device function are thus key aspects to a good outcome.

Understanding the effect of cognitive impairment on SNM treatment outcomes is particularly important in the OAB population because patients with cognitive impairment are more likely to suffer from OAB symptoms and have worse urinary incontinence compared to the general population (19,20,64). However, data are sparse on the subject. Furthermore, there are likewise no studies to our knowledge of the impact of cognitive impairment on other neuromodulation therapies for other disease states such as chronic pain, gastroparesis, or headache from which to extrapolate insight.

Zillioux *et al.*, in a retrospective analysis of patients who underwent SNM for OAB found 10.2% (52/510) had cognitive impairment diagnosis in their chart at time of test-phase implant, with an additional 6% (30/510) receiving a diagnosis following test-phase SNM (65). Based on the retrospective methods which relied on electronic medical record diagnosis codes, the authors noted that these estimates were likely an underestimate. Multivariable analysis found that cognitive impairment diagnosis did not significantly impact rates of permanent implantation. Interestingly, on subanalysis, age was an independent negative predictor of permanent implantation. Device explantation and revision rates also did not differ based on presence of a cognitive impairment diagnosis. The authors conclude that a diagnosis of cognitive impairment should not necessarily exclude patients with refractory OAB from SNM therapy.

Conversely, interim analysis of an ongoing prospective study by Shenhar *et al.* of cognitive impairment in older patients (age over 60 years) undergoing test-phase SNM for OAB at the same institution found 67% (39/58) of patients met criteria for MCI at baseline (66). The authors report that in a short-term follow-up (mean 4.1 months), patients with cognitive impairment were less involved in changing programs or amplitudes but patient-reported outcomes did not differ (66). Study accrual is still ongoing and when complete should inform whether cognitive impairment impairs short-term SNM outcomes.

Taken together, very limited available data suggest SNM is efficacious in the short-term in patients with MCI. Further study is certainly needed to understand the efficacy, long-term durability and risks associated with SNM in this vulnerable population. It should be noted that SNM non-use is unlikely to cause severe complications. Still, for patients with or at risk for cognitive impairment, urologists should counsel on potential worse outcomes as optimizing device parameters may be more difficult without appropriate patient feedback.

Screening for cognitive impairment

This narrative review has thus far described the potential role of neurocognitive disorders in the outcomes of interactive urologic implants. It is notable that while MCI may advance to major neurocognitive disorder (dementia) over time, not all people with MCI progress to dementia. Studies have shown that 10–40% of people with MCI may return to normal cognition over 4 to 5 years (27,67,68). Indeed, it would benefit a urologist to have familiarity with longitudinally assessing patients for cognitive impairment, especially when a complex device has been implanted. Further, counseling these patients (and their partners and caregivers) on the risks of device misuse or malfunction related to development or progression of neurocognitive disorder is extremely important.

The United States Preventive Services Task Force (USPSTF) in 2020 concluded that evidence is lacking, and the balance of benefits and harms of screening for cognitive impairment cannot be determined (26). The screening tools that have been validated show a range of sensitivity and specificity for the detection of cognitive impairment. Screening tools are more sensitive and specific for dementia than MCI, and the effect often depends upon the prevalence of cognitive impairment within the community; for example, when the prevalence of dementia is high in people over 85 years, the positive predictive value of screening can be greater than 50%, however in a population of people 65–74 years old, where the prevalence is lower, the positive predictive value drops closer to 20% (26). It is important

Table 2 Descriptive characteristics of screening tests for MCI

Test name	Approximate administration time (minutes)[†]	Test description	Total score	Score that indicates MCI
Mini-Mental Status Examination	10	11 questions measuring orientation, registration, attention and calculation, recall and language	30	<24
Montreal Cognitive Assessment	10–12	Measures short term memory, visuospatial abilities, executive function, attention, concentration and working memory, language and orientation	30	<26
Memory Alteration Test	5	40–50 questions measuring encoding, temporal orientation, semantic memory, free recall and cued-recall	50	<37
Quick Screen for Mild Cognitive Impairment	5	Measures orientation, registration, clock drawing, delayed recall, verbal fluency and logical memory	100	<62
Addenbrooke's Cognitive Examination Revised	12–20	Measures orientation, registration, attention and concentration, recall, anterograde and retrograde memory, language, and visuospatial and perceptual abilities	100	<88 or <82
Consortium to Establish a Registry for Alzheimer's Disease	30	Composed of 5 established cognitive tests. Measures verbal fluency, modified Boston Naming test, word list learning, constructional praxis and word list recall and recognition discriminability	100	<85
Clock Drawing Tests				
Sunderland	5	Measures attention and calculation by evaluating hand and number placement (each with different instructions and scoring systems)	10	<6
Shulman			5	<3
Rouleau			10	<8
Saint Louis University Mental Status Examination	7[‡]	Measures attention, calculation, immediate and delayed recall, animal naming, digit span, clock drawing and figure recognition/size differentiation	30	<27

[†], data from Breton *et al.* (72) (excluding Saint Louis University Mental Status Examination). [‡], data from Tariq *et al.* (76). MCI, mild cognitive impairment.

to note that the USPSTF recommendation applies to a general community-dwelling population of adults 65 years or older without recognized signs or symptoms of cognitive impairment. The American Academy of Neurology recommends that clinicians should assess for MCI in patients who have a self-concern or for whom a close contact voices a concern about memory or impaired cognition (29).

Screening tests typically include simple tasks to assess one or more domains of cognitive function. There are several screening tests available. The MMSE is a commonly used method for cognitive screening (69,70). Keles *et al.* used a Turkish version of the MMSE and Ballantyne *et al.* used a validated telephone MMSE (58,59). Other screening tests include clock drawing test (CDT, with several variations), Memory Alteration Test (M@T), Quick Screen for MCI, Addenbrook's Cognitive Examination Revised (ACE-R), Consortium to Establish a Registry for Alzheimer's Disease (CERAD), Saint Louis University Mental Status (SLUMS) Examination and Montreal Cognitive Assessment (MoCA) (71-80). Descriptive and statistical characteristics of each screening test can be found in *Tables 2*,*3*, respectively. Breton *et al.*, performed a meta-analysis of almost 60 studies evaluating the outcomes of 7 different cognitive screening tests (72). A notable finding in their study, which can be useful to a urologist interested in screening for cognitive function, is that the quickest mean administration time reported is 5 minutes, for the CDT, M@T and the Quick Screen for MCI; MMSE at 10 minutes and MoCA at 10–12 minutes had the next lowest administration times. Tariq *et al.*, in one of the first studies evaluating SLUMS, reported the mean administration time of 7 minutes (76). Regarding cognitive screening test accuracy, Pinto *et al.* performed a meta-analysis of 80 studies comparing MoCA to MMSE and found that

Table 3 Statistical characteristics of screening tests for MCI

Test name	Accuracy in detecting MCI (area under SROC)[†]	Sensitivity[†]	Specificity[†]
Mini-Mental Status Examination	0.758	0.664	0.735
Montreal Cognitive Assessment	0.847	0.812	0.812
Memory Alteration Test	0.961	0.951	0.84
Quick Screen for Mild Cognitive Impairment	0.836	0.77	0.789
Addenbrooke's Cognitive Examination Revised	0.839	0.824	0.777
Consortium to Establish a Registry for Alzheimer's Disease	0.856	0.824	0.76
Clock Drawing Tests[‡]			
Sunderland	0.84	0.726	0.879
Shulman	0.86	0.82	0.757
Rouleau	0.709	0.605	0.801
Saint Louis University Mental Status Examination[§]	N/A	0.73–0.95	0.65–0.81

[†], data from Breton *et al.* (72) (excluding Clock Drawing Tests and Saint Louis University Mental Status Examination). [‡], data from Park *et al.* (77). [§], data from Tariq *et al.* (76) and Spencer *et al.* (81). MCI, mild cognitive impairment; SROC, summary receiver operated curve; N/A, not applicable.

MoCA was superior to MMSE in discriminating between individuals with MCI and normal cognition and similar in accuracy in detecting dementia (73). Breton *et al.* reported sensitivities and specificities for MCI diagnosis: M@T had 95.1% sensitivity and 84% specificity; ACE-R has 82.4% sensitivity and 77.7% specificity; CERAD had 82.4% sensitivity and 76% specificity; MoCA had 81.2% sensitivity and 74% specificity; Quick Screen for MCI had 77% sensitivity and 78.9% specificity; and MMSE had 66.4% sensitivity and 73.5% specificity (72). The authors note that the studies that evaluated the CDT found heterogeneous results, so sensitivities and specificities could not be quantified. However, Park *et al.* reported a meta-analysis of several variations of the CDT (77); CDT-Sunderland had 72.6% sensitivity and 87.9% specificity, CDT-Shulman had 82% sensitivity and 75.7% specificity and CDT-Rouleau had 60.5% sensitivity and 80.1% specificity (77). Tariq *et al.* reported sensitivity and specificity of SLUMS for MCI with different groupings based on level of education: for those with less than a high school education, SLUMS had 92% sensitivity and 81% specificity; for those with high school education or higher, SLUMS had a 95% sensitivity and 76% specificity (76). While these results are encouraging, Spencer *et al.*, in a systematic review of SLUMS reported slightly lower sensitivities and specificities (81). Further, it is important to note that there are no meta-analyses published regarding studies that have evaluated SLUMS since the data is less robust. Thus, three screening tests, M@T, Quick Screen for MCI and SLUMS can be administered in a timely manner with useful accuracy (72,76).

While screening tests can adequately detect cognitive impairment, these tests are typically not intended to diagnose MCI or dementia. Instead, a positive screening test leads to additional, more formal assessments to confirm the diagnosis of a neurocognitive disorder and determine its subtypes (29,71). Further, there is concern about what interventions can be done to prevent progression of impaired cognition and if these interventions are beneficial (71). However, early identification of cognitive impairment, even subjective impairment, can help prosthetic urologists in terms of anticipating postoperative issues or complications with the aforementioned implants. If a urologist understands a patient's type or severity of cognitive impairment, they can set up processes preoperatively to ensure patient compliance and may recommend closer surveillance postoperatively to limit complications and device misuse.

Lavi *et al.*, in a review of physical and cognitive decline in aging men who desire AUS implantation, describe an algorithm that can be used to address a patient's risk for future cognitive decline before implanting an AUS (51). They propose first assessing and counseling regarding a patient's fitness (i.e., his physical health and comorbidities) followed by a hand grip test to assess for manual dexterity. Once these have been measured, a urologist should use

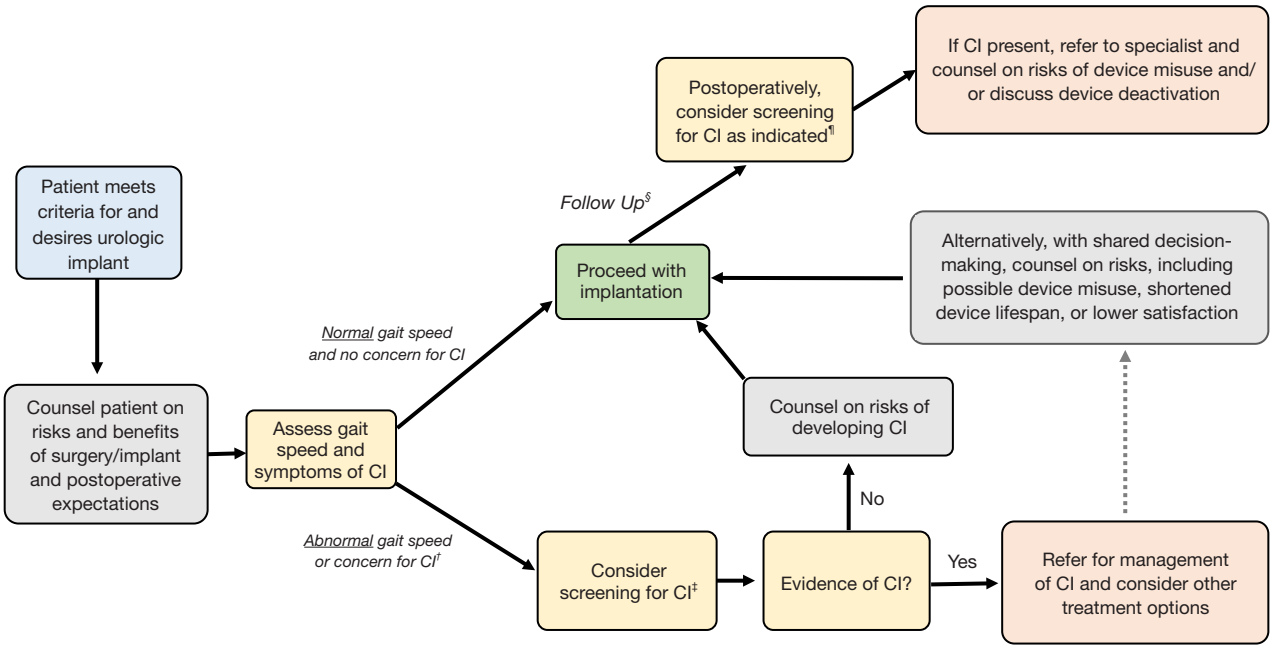

Figure 1 Algorithm for screening patients who desire urologic implant for cognitive impairment. †, Concern for impaired cognition as assessed by urologist or as reported by patient, caretaker or family member. ‡, See Tables 2,3 for some available screening tests for cognitive impairment. Test choice based on urologist familiarity and available time. Alternatively, urologist may recommend consultation with neurocognitive disorder specialist. §, Regular, longitudinal follow-up recommended. Protocol per urologist discretion. ¶, Based on urologist discretion. Can consider assessment based on development of abnormal gait speed or concerns of newly developed symptoms of cognitive impairment. CI, cognitive impairment.

gait speed to predict future cognitive impairment (51,82); if abnormal, then a urologist should use one of the aforementioned cognitive impairment screening tests and should counsel the patient about the increased risks of implantation. We have created an algorithm that may prove useful for urologists who place the aforementioned implants (*Figure 1*). While neither our nor Lavi *et al.*'s algorithms have been studied, they can be used as reasonable starting points to consider prior to implantation of any urologic device in patients with or at risk for cognitive impairment.

Conclusions

There are limited data available on the association of neurocognitive disorders and urologic implants. With the general population aging and thus more patients developing bothersome ED, SUI and OAB, there will likely be a higher demand for three common implants in urology, the penile prosthesis, AUS and SNM, in the older population. Along with aging, often comes MCI or dementia, which can complicate matters if such cognitively impaired patients have had a urologic device implanted. While AUS outcomes may be slightly worse in the setting of cognitive impairment, SNM is efficacious in this population in the short term. There are several tests that providers can quickly use to screen for cognitive impairment, including M@T, Quick Screen for MCI and SLUMS; this screening may allow for appropriate preoperative counseling and closer postoperative monitoring and thus, could prevent complications. Further studies are required to assess outcomes in these populations and to describe how to properly assess for cognitive impairment in a way that is both beneficial for the patient and convenient and efficient for a urologist. This research will be important to help inform guidelines regarding the most appropriate manner to manage and survey this vulnerable patient population.

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References

1. Chierigo F, Capogrosso P, Dehò F, et al. Long-Term Follow-Up After Penile Prosthesis Implantation-Survival and Quality of Life Outcomes. J Sex Med 2019;16:1827-33.
2. Palmisano F, Boeri L, Ievoli R, et al. Ten-year experience with penile prosthetic surgery for the treatment of erectile dysfunction: outcomes of a tertiary referral center and predictors of early prosthetic infection. Asian J Androl 2022;24:32-9.
3. Miller LE, Khera M, Bhattacharyya S, et al. Long-Term Survival Rates of Inflatable Penile Prostheses: Systematic Review and Meta-Analysis. Urology 2022;166:6-10.
4. Koch GE, Kaufman MR. Male Stress Urinary Incontinence. Urol Clin North Am 2022;49:403-18.
5. Plata M, Zuluaga L, Santander J, et al. Performance of the artificial urinary sphincter implantation in men with urinary incontinence: Results from a contemporary long-term real-world nationwide analysis. Neurourol Urodyn 2022;41:1573-81.
6. Sacomani CAR, Zequi SC, Costa WHD, et al. Long-term results of the implantation of the AMS 800 artificial sphincter for post-prostatectomy incontinence: a single-center experience. Int Braz J Urol 2018;44:114-20.
7. Tilborghs S, De Wachter S. Sacral neuromodulation for the treatment of overactive bladder: systematic review and future prospects. Expert Rev Med Devices 2022;19:161-87.
8. Gandhi S, Gajewski JB, Koziarz A, et al. Long-term outcomes of sacral neuromodulation for lower urinary tract dysfunction: A 23-year experience. Neurourol Urodyn 2021;40:461-9.
9. Leong RK, Marcelissen TA, Nieman FH, et al. Satisfaction and patient experience with sacral neuromodulation: results of a single center sample survey. J Urol 2011;185:588-92.
10. Ko OS, Bennett NE Jr. Ambicor Two-Piece Inflatable Penile Prosthesis: Background and Contemporary Outcomes. Sex Med Rev 2018;6:319-27.
11. Léon P, Chartier-Kastler E, Rouprêt M, et al. Long-term functional outcomes after artificial urinary sphincter implantation in men with stress urinary incontinence. BJU Int 2015;115:951-7.
12. Barham DW, Pyrgidis N, Gross MS, et al. AUA-recommended Antibiotic Prophylaxis for Primary Penile Implantation Results in a Higher, Not Lower, Risk for Postoperative Infection: A Multicenter Analysis. J Urol 2023;209:399-409.
13. Hsu B, Hirani V, Waite LM, et al. Temporal associations between sexual function and cognitive function in community-dwelling older men: the Concord Health and Ageing in Men Project. Age Ageing 2018;47:900-4.
14. Chung E. Sexuality in Ageing Male: Review of Pathophysiology and Treatment Strategies for Various Male Sexual Dysfunctions. Med Sci (Basel) 2019;7:98.
15. Saxer S, Halfens RJ, de Bie RA, et al. Prevalence and incidence of urinary incontinence of Swiss nursing home residents at admission and after six, 12 and 24 months. J Clin Nurs 2008;17:2490-6.
16. Tienza A, Robles JE, Hevia M, et al. Prevalence analysis of urinary incontinence after radical prostatectomy and influential preoperative factors in a single institution. Aging Male 2018;21:24-30.
17. Lightner DJ, Gomelsky A, Souter L, et al. Diagnosis and

Treatment of Overactive Bladder (Non-Neurogenic) in Adults: AUA/SUFU Guideline Amendment 2019. J Urol 2019;202:558-63.
18. Gacci M, Sakalis VI, Karavitakis M, et al. European Association of Urology Guidelines on Male Urinary Incontinence. Eur Urol 2022;82:387-98.
19. Sakakibara R, Uchiyama T, Yamanishi T, et al. Dementia and lower urinary dysfunction: with a reference to anticholinergic use in elderly population. Int J Urol 2008;15:778-88.
20. Ballert KN, Bales GT. Dementia and Overactive Bladder. Curr Bladder Dysfunct Rep 2013;8:57-61.
21. Vespa J, Medina L, Armstrong DM. Demographic Turning Points for the United State: Population Projections for 2020 to 2060. Current Population Reports. 2020 2023 Mar 14. p. 25-1144. Available online: https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf
22. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. Fifth Edition. American Psychiatric Association; 2013. Available online: https://dsm.psychiatryonline.org/doi/abs/10.1176/appi.books.9780890425596
23. Sachdev PS, Blacker D, Blazer DG, et al. Classifying neurocognitive disorders: the DSM-5 approach. Nat Rev Neurol 2014;10:634-42.
24. Petersen RC. Mild Cognitive Impairment. Continuum (Minneap Minn) 2016;22:404-18.
25. Rajan KB, Weuve J, Barnes LL, et al. Population estimate of people with clinical Alzheimer's disease and mild cognitive impairment in the United States (2020-2060). Alzheimers Dement 2021;17:1966-75.
26. ; Owens DK, Davidson KW, et al. Screening for Cognitive Impairment in Older Adults: US Preventive Services Task Force Recommendation Statement. JAMA 2020;323:757-63.
27. Bischkopf J, Busse A, Angermeyer MC. Mild cognitive impairment--a review of prevalence, incidence and outcome according to current approaches. Acta Psychiatr Scand 2002;106:403-14.
28. Ward A, Arrighi HM, Michels S, et al. Mild cognitive impairment: disparity of incidence and prevalence estimates. Alzheimers Dement 2012;8:14-21.
29. Petersen RC, Lopez O, Armstrong MJ, et al. Practice guideline update summary: Mild cognitive impairment: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. Neurology 2018;90:126-35.
30. Suskind AM, Walter LC, Jin C, et al. Impact of frailty on complications in patients undergoing common urological procedures: a study from the American College of Surgeons National Surgical Quality Improvement database. BJU Int 2016;117:836-42.
31. Brennan MS, Barlotta RM, Simhan J. Frailty Assessments in Surgical Practice: What is Frailty and How Can It Be Used in Prosthetic Health? Sex Med Rev 2018;6:302-9.
32. Zillioux J, Slopnick EA, Vasavada SP. Third-line therapy for overactive bladder in the elderly: Nuances and considerations. Neurourol Urodyn 2022;41:1967-74.
33. Suskind AM, Kowalik C, Quanstrom K, et al. The impact of frailty on treatment for overactive bladder in older adults. Neurourol Urodyn 2019;38:1915-23.
34. Madbouly K, AlHajeri D, Habous M, et al. Association of the modified frailty index with adverse outcomes after penile prosthesis implantation. Aging Male 2017;20:119-24.
35. Mulcahy JJ. The Development of Modern Penile Implants. Sex Med Rev 2016;4:177-89.
36. Burnett AL, Nehra A, Breau RH, et al. Erectile Dysfunction: AUA Guideline. J Urol 2018;200:633-41.
37. Sedigh O, Rolle L, Negro CL, et al. Early insertion of inflatable prosthesis for intractable ischemic priapism: our experience and review of the literature. Int J Impot Res 2011;23:158-64.
38. Nehra A, Alterowitz R, Culkin DJ, et al. Peyronie's Disease: AUA Guideline. J Urol. 2015;194:745-53.
39. Chung E, Solomon M, DeYoung L, et al. Clinical outcomes and patient satisfaction rates among elderly male aged ≥75 years with inflatable penile prosthesis implant for medically refractory erectile dysfunction. World J Urol 2014;32:173-7.
40. Villarreal HG, Jones L. Outcomes of and satisfaction with the inflatable penile prosthesis in the elderly male. Adv Urol 2012;2012:240963.
41. Habot B, Abramovitch I, Leibovitz A. The geriatric patient with penile prosthesis. J Am Geriatr Soc 1994;42:355-6.
42. Luna E, Garden B, Rodriguez D, et al. Permanent Deactivation of Inflatable Penile Prosthesis via Puncture. Urology 2022;165:54-8.
43. Mendez MF, Shapira JS. Hypersexual behavior in frontotemporal dementia: a comparison with early-onset Alzheimer's disease. Arch Sex Behav 2013;42:501-9.
44. De Giorgi R, Series H. Treatment of Inappropriate Sexual Behavior in Dementia. Curr Treat Options Neurol 2016;18:41.
45. Tsai SJ, Hwang JP, Yang CH, et al. Inappropriate sexual behaviors in dementia: a preliminary report. Alzheimer

Dis Assoc Disord 1999;13:60-2.
46. Mahieu L, Anckaert L, Gastmans C. Intimacy and Sexuality in Institutionalized Dementia Care: Clinical-Ethical Considerations. Health Care Anal 2017;25:52-71.
47. Mohan C, Sonntag E, Ehlers M, et al. Challenging Ethical Scenarios in the Surgical Treatment of Erectile Dysfunction: A Survey of High-Volume Penile Prosthesis Surgeons. Urology 2021;148:166-72.
48. Beauchamp TL, Childress JF. Principles of biomedical ethics. Edicoes Loyola; 1994.
49. Sandhu JS, Breyer B, Comiter C, et al. Incontinence after Prostate Treatment: AUA/SUFU Guideline. J Urol 2019;202:369-78.
50. Toniolo I, Mascolini MV, Carniel EL, et al. Artificial sphincters: An overview from existing devices to novel technologies. Artif Organs 2023;47:617-39.
51. Lavi A, Boone TB, Cohen M, et al. The Patient Beyond the Sphincter-Cognitive and Functional Considerations Affecting the Natural History of Artificial Urinary Sphincters. Urology 2020;137:14-8.
52. Chung E, Wang J, Cartmill R. Is artificial urinary sphincter surgery safe and effective in elderly males aged 70 years and above? Low Urin Tract Symptoms 2022;14:416-20.
53. Ziegelmann MJ, Linder BJ, Rivera ME, et al. Outcomes of artificial urinary sphincter placement in octogenarians. Int J Urol 2016;23:419-23.
54. Medendorp AR, Anger JT, Jin C, et al. The Impact of Frailty on Artificial Urinary Sphincter Placement and Removal Procedures. Urology 2019;129:210-6.
55. Kosmadakis G, Smirloglou D, Gobou A, et al. End-stage renal disease due to hydronephrosis in a patient with artificial urinary sphincter. Int J Artif Organs 2011;34:1106-8.
56. Wolski Z, Tworkiewicz M, Szabela-Polak A. Psychological aspect of qualification to implant an artificial urethral sphincter AMS 800. Cent European J Urol 2012;65:21-3.
57. Raup VT, Eswara JR, Marshall SD, et al. Artificial Urinary Sphincters for Treatment of Urinary Incontinence in Elderly Males. Urol Int 2016;97:200-4.
58. Keles A, Onur R, Aydos M, et al. The Role of Educational Level and Cognitive Status in Men Undergoing Artificial Urinary Sphincter Implantation. Urology 2021;147:243-9.
59. Ballantyne CC, Sharma D, Rapp DE, et al. Prevalence of Cognitive Impairment and Sphincter Misuse Among Men With Artificial Urinary Sphincters. Urology 2021;148:292-6.
60. O'Connor RC, Nanigian DK, Patel BN, et al. Artificial urinary sphincter placement in elderly men. Urology 2007;69:126-8.
61. Steele SS. Sacral nerve stimulation: 50 years in the making. Can Urol Assoc J 2012;6:231-2.
62. Chai TC, Birder LA. Physiology and Pharmacology of the Bladder and Urethra. In: Partin AW, Dmochowski RR, Kavoussi LR, et al., editors. Campbell-Walsh-Wein Urology. 12th ed. Philadelphia: Elsevier; 2021. p. 2461-513.
63. Clemens JQ. Basic bladder neurophysiology. Urol Clin North Am 2010;37:487-94.
64. Palmer MH, German PS, Ouslander JG. Risk factors for urinary incontinence one year after nursing home admission. Res Nurs Health 1991;14:405-12.
65. Zillioux J, Lewis KC, Hettel D, et al. Cognitive impairment does not impact sacral neuromodulation implant rates for overactive bladder. Neurourol Urodyn 2023;42:623-30.
66. Shenhar C, Booher J, Gleich L, et al. OM12 Cognitive impairment, technophilia & device utilization in an older population of patients undergoing sacral neuromodulation for OAB. Neurourology and Urodynamics 2023;42:S157.
67. Larrieu S, Letenneur L, Orgogozo JM, et al. Incidence and outcome of mild cognitive impairment in a population-based prospective cohort. Neurology 2002;59:1594-9.
68. Manly JJ, Tang MX, Schupf N, et al. Frequency and course of mild cognitive impairment in a multiethnic community. Ann Neurol 2008;63:494-506.
69. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.
70. Newkirk LA, Kim JM, Thompson JM, et al. Validation of a 26-point telephone version of the Mini-Mental State Examination. J Geriatr Psychiatry Neurol 2004;17:81-7.
71. Patnode CD, Perdue LA, Rossom RC, et al. Screening for Cognitive Impairment in Older Adults: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA 2020;323:764-85.
72. Breton A, Casey D, Arnaoutoglou NA. Cognitive tests for the detection of mild cognitive impairment (MCI), the prodromal stage of dementia: Meta-analysis of diagnostic accuracy studies. Int J Geriatr Psychiatry 2019;34:233-42.
73. Pinto TCC, Machado L, Bulgacov TM, et al. Is the Montreal Cognitive Assessment (MoCA) screening superior to the Mini-Mental State Examination (MMSE) in the detection of mild cognitive impairment (MCI) and Alzheimer's Disease (AD) in the elderly?. Int Psychogeriatr 2019;31:491-504.
74. Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening

tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695-9.
75. Rami L, Molinuevo JL, Sanchez-Valle R, Bosch B, Villar A. Screening for amnestic mild cognitive impairment and early Alzheimer's disease with M@T (Memory Alteration Test) in the primary care population. Int J Geriatr Psychiatry 2007;22:294-304.
76. Tariq SH, Tumosa N, Chibnall JT, et al. Comparison of the Saint Louis University mental status examination and the mini-mental state examination for detecting dementia and mild neurocognitive disorder--a pilot study. Am J Geriatr Psychiatry 2006;14:900-10.
77. Park J, Jeong E, Seomun G. The clock drawing test: A systematic review and meta-analysis of diagnostic accuracy. J Adv Nurs 2018;74:2742-54.
78. O'Caoimh R, Gao Y, McGlade C, et al. Comparison of the quick mild cognitive impairment (Qmci) screen and the SMMSE in screening for mild cognitive impairment. Age Ageing 2012;41:624-9.
79. Mioshi E, Dawson K, Mitchell J, et al. The Addenbrooke's Cognitive Examination Revised (ACE-R): a brief cognitive test battery for dementia screening. Int J Geriatr Psychiatry 2006;21:1078-85.
80. Chandler MJ, Lacritz LH, Hynan LS, et al. A total score for the CERAD neuropsychological battery. Neurology 2005;65:102-6.
81. Spencer RJ, Noyes ET, Bair JL, et al. Systematic Review of the Psychometric Properties of the Saint Louis University Mental Status (SLUMS) Examination. Clin Gerontol 2022;45:454-66.
82. Kikkert LHJ, Vuillerme N, van Campen JP, et al. Walking ability to predict future cognitive decline in old adults: A scoping review. Ageing Res Rev 2016;27:1-14.

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