Cognition in Clients with Acute Tetraplegia: Why Assessment Matters

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Cognition in Clients with Acute Tetraplegia:

Why Assessment Matters

May 2016

This evidence project, submitted by

Olivia Allen, OTS
Michael DeWilde, OTS
Jon-Erik Golob, OTS

has been approved and accepted
in partial fulfillment of the requirements for the degree of
Master of Science in Occupational Therapy from the University of Puget Sound.

Project Chairperson: Tatiana Kaminsky, PhD, OTR/L

OT 635/636 Instructors: George Tomlin, PhD, OTR/L, FAOTA; Sue Doyle, PhD, OTR/L, CFE

Director, Occupational Therapy Program: Yvonne Swinth, PhD, OTR/L, FAOTA

Dean of Graduate Studies, Sunil Kukreja, PhD

Key words: spinal cord injury, tetraplegia, cognition, assessment
Abstract

The authors of this research project collaborated with Sarah Bicker, OTR/L, an acute care therapist working at Harborview Medical Center in Seattle, WA to investigate two clinical questions: [1] “What is the correlation between high-level (C1-C7) spinal cord injury (SCI) and cognitive impairment?” [2] “Which assessments are most effective for evaluating cognition in adult clients who have very limited motor and/or verbal abilities and could potentially be used with clients who have acute high-level spinal cord injuries?” A review of the research revealed that common comorbidities, including orthostatic hypotension, sleep apnea, and traumatic brain injury, often affect cognition in clients with high-level SCI. Unfortunately, no specific cognitive assessments have been developed for individuals in this population that can accommodate for limited motor and/or verbal abilities. Some assessments are more accommodating of limited motor and/or verbal ability and have potential for application for individuals with high-level SCI but there is a need for research applying these assessments to this specific population.

This research and its implications were presented at in-service at Harborview Medical Center to promote knowledge translation from research to practice. To monitor the impact of this presentation, the authors administered a survey at the end of the in-service to determine the usefulness of this research and whether it could affect established procedures of care. Future recommendations following this research include advocating for proper evaluation of cognition in clients with acute high-level SCI early in the rehabilitation process, promoting greater awareness of comorbidities that may impact cognitive function, and conducting further research on the application of certain verbal and motor-free cognitive assessments to this population.
Executive Summary

The original research question consisted of two parts: [1] Is there a correlation between high-level spinal cord injury (C1-C7) and cognitive impairment? [2] What assessments are available for evaluating cognition in these clients given that they are often motorically and verbally limited (due to ventilator)?

Research revealed that there are several comorbidities that commonly occur following SCI that negatively impact cognitive function: orthostatic hypotension, sleep apnea, and traumatic brain injury (TBI). Of the comorbidities, TBI may be the most important for individuals with high-level SCI in relation to cognitive impairment. Studies contained samples in which 60% - 74% of individuals SCI had a co-occurring TBI, with highest rates (70% - 77%) among those with high-level SCI. However, one study estimated that TBI was undiagnosed in more than 50% of individuals with high-level SCI. Furthermore, TBI is more likely to be undiagnosed if the injury did not occur through a motor vehicle accident.

A thorough search of the existing literature revealed that there are no specific assessments for cognitive impairment with this population. Some assessments exist, such as the Preliminary Neuropsychological Battery and the Test of Nonverbal Intelligence, which rely less on motor/verbal ability and may be useful with clients with high-level SCI. However, research has not been conducted on the validity and reliability of these tools with this population. If cognitive impairment in clients with high-level SCI is not identified, clinicians and doctors may interpret symptoms of cognitive impairment as noncompliant behaviors or maladaptive reactions to the injury. It is important that cognitive impairment is correctly identified so that clients may receive the most appropriate rehabilitative care.

Recognizing conditions that may cause cognitive impairment is an important step in providing appropriate and high-quality care for these clients in the acute stage. Clinicians that understand the implications of comorbid conditions such as orthostatic hypotension, sleep apnea, and TBI may be better prepared to refer clients as soon as possible for formalized cognitive evaluation. Also, clinicians that understand the need for cognitive assessments for clients with high-level SCI may be better equipped to
advocate for the development of tools that can appropriately evaluate cognitive function given the unique needs of this population.

These research findings were presented to clinicians at Harborview Medical Center in Seattle, WA, to facilitate translation of knowledge into practice. The presentation occurred on April 22, 2016 and was attended by approximately 20 acute rehabilitation therapists including occupational therapists, physical therapists, and speech language pathologists. To measure outcomes of the knowledge translation process, a survey was given to attendees regarding effectiveness of the presentation and whether the information presented could affect standards of practice in the future. The survey results will be available to us on May 1, 2016.
COGNITION IN CLIENTS WITH ACUTE TETRAPLEGIA

Critical Appraisal of Topic (CAT)

Focused Questions:
What is the correlation between high-level spinal cord injury (C1-C7) and cognitive impairment? Which assessments are most effective for evaluating cognition in adult clients who have very limited motor and/or verbal abilities and could potentially be used with clients who have acute high-level spinal cord injuries?

Prepared By:
Olivia Allen, Michael DeWilde, Jon-Erik Golob

Date Review Completed:
November 17, 2015

Clinical Scenario:
Our clinician collaborator, Sarah Bicker, OTR/L, works in the acute care setting at Harborview Medical Center in Seattle, WA. She specifically works with clients with neurological impairments, and she has special interest in clients with spinal cord injury (SCI). Ms. Bicker and her colleagues in acute care would like to explore the relationship between cognitive impairments and high-level SCI. These clinicians are also interested in learning the best way to assess cognition in this population, as motor control becomes severely impaired when the spinal cord is damaged at a cervical level. Additionally, when these clients are in acute care, many of them are ventilator-dependent, causing further difficulty with verbal communication. Our clinician collaborator is interested in exploring which cognitive assessments can be appropriately administered when a client has a significant loss of communication or motor control.

Review Process

Procedures for the selection and appraisal of articles

Inclusion Criteria:
- Published after 1980
- Published in or translated to English
- Adult participants with spinal cord injury OR motor and/or language deficits
- Assessments of cognition that are non-motor and/or non-language dependent OR correlations between spinal cord injury and cognitive impairments

Exclusion Criteria:
- Child participants under age 16 with motor and/or language deficits
- Articles in which the full text not available through the University of Puget Sound library system
- Articles published in non-peer-reviewed journals.
### Search Strategy

<table>
<thead>
<tr>
<th>Search terms</th>
<th>Date</th>
<th>Database</th>
<th>Initial Hits</th>
<th>Articles excluded</th>
<th>Selected for review</th>
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<tr>
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<tr>
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<td>MEDLINE, CINAHL, ERIC</td>
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<td>0</td>
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<tr>
<td>cogn* AND assess* AND (SCI OR quadriplegia OR tetraplegia) AND (motor free OR motor-free OR non-verbal OR non verbal)</td>
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<td>MEDLINE, CINAHL, ERIC</td>
<td>5</td>
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<td>2</td>
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Quality Control/Peer Review Process:

We began our search using terms specific to our question such as spinal cord injury, cognition, and assessment, as well as relevant synonyms or alternate spellings. We found few results that related to our question and met our inclusion criteria. We sought guidance from our faculty mentor, Sue Doyle, PhD, OTR/L, regarding how to come up with more effective search terms. With Dr. Doyle’s assistance, we reframed our question and inclusion criteria to search specifically for nonverbal and/or motor-free assessments that could potentially be applied to this population. We added in key terms such as “nonverbal” and “motor-free,” which resulted in additional findings. Reference and citation tracking were also used with relevant articles, which resulted in the discovery of an additional article included in this review. After the initial searches were completed and articles reviewed, searches were conducted a second time by a team member to ensure all relevant articles were included. This procedure resulted in the identification of several additional articles.

A proposal of our CAT topic was reviewed by our faculty mentor, Sue Doyle, PhD, OTR/L, our committee chair, Tatiana Kaminksy, PhD, OTR/L, and student peers to help us refine our question and search strategy. We kept our inclusion and exclusion criteria relatively broad due to the limited amount of research on this topic. Even keeping these qualifiers broad, most articles on a given search did not meet inclusion/exclusion criteria, and needed to be excluded. Due to the lack of relevant research on our specific question about assessments, the nature of some of the articles included in this review do not directly relate to our question, but contain information or findings that could potentially be applied to this population in future research.
Two articles were received and added in at a later date, as they were access through inter-library loan. One article was removed upon further review, due to lack of relevance in regard to the research question. This critical appraisal was reviewed by Sue Doyle, PhD, OTR/L, Tatiana Kaminsky, PhD, OTR/L, and Sarah Bicker, OTR/L.

### Results of Search

**Summary of Study Designs of Articles Selected for the CAT Table**

<table>
<thead>
<tr>
<th>Pyramid Side</th>
<th>Study Design/Methodology of Selected Articles</th>
<th>Number of Articles Selected</th>
</tr>
</thead>
</table>
| **Experimental** | ___Meta-Analyses of Experimental Trials  
___Individual Blinded Randomized Controlled Trials  
_1_Controlled Clinical Trials  
___Single Subject Studies | 1 |
| **Outcome** | ___Meta-Analyses of Related Outcome Studies  
___Individual Quasi-Experimental Studies  
_4_Case-Control Studies  
___One Group Pre-Post Studies | 4 |
| **Qualitative** | ___Meta-Syntheses of Related Qualitative Studies  
___Small Group Qualitative Studies  
___brief vs prolonged engagement with participants  
___triangulation of data (multiple sources)  
___interpretation (peer & member-checking)  
___a posteriori (exploratory) vs a priori (confirmatory) interpretive scheme  
___Qualitative Study on a Single Person | 0 |
| **Descriptive** | _2_Systematic Reviews of Related Descriptive Studies  
_10_Association, Correlational Studies  
_1_Multiple Case Studies (Series), Normative Studies  
_1_Individual Case Studies | 14 |

**Comments:** Due to the nature of our question and its focus on correlations and assessments, the majority of our research articles are descriptive. **TOTAL number of articles – 19**
## Results

### Association of high-level SCI to cognitive impairment

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Objectives</th>
<th>Study Design/Level of Evidence</th>
<th>Participants: Sample Size, Description Inclusion and Exclusion Criteria</th>
<th>Interventions &amp; Outcome Measures</th>
<th>Summary of Results</th>
<th>Study Limitations</th>
</tr>
</thead>
</table>
| Roth, Davidoff, Thomas, Doljanac, Dijkers, Berent, Morris, Yarkony, 1989 | examine cognitive deficits in acute SCI patients; compare with control group | O3 Case-control AOTA Level II | $N = 142$
SCI group: $n = 81$, age mean = not specified, range = 18-55
SCI level: cervical $n = 35$, thoracic $n = 34$, lumbosacral $n = 12$

*Inclusion*: acute traumatic SCI;
*Exclusion*: recent history of closed head injury;
Control group: $n = 61$, paid volunteers. Matched with SCI group for age, gender, educational level, geographic location | HCT (deficits in cognition), VOCAB of the Wechsler Adult Intelligence Scale, Mental Control Subtest of the Wechsler Memory Scale, PA Subtests of the WMS-Russell Adaptation (verbal retention), RAVLT-B | performance levels for SCI group on most assessments significantly more impaired than performance levels of control group in a post-acute setting. | no examination of potential influences of age, gender, education, level of injury, depression, or alcohol/substance abuse on neuropsychological performance. |
| Dowler, O’Brien, Haaland, Harrington, Fee, Fiedler, 1995 | compares the cognitive functioning of patients with chronic SCI to a control group | O3 Case-control, pre-existing groups AOTA Level II | $N = 139$
SCI group, $n = 75$, age mean = 45.8, range = not specified
SCI level: paraplegia $n = 66$; tetraplegia $n = 9$ | comprehensive neuropsychological battery administered to both groups; examined processing speed, memory, attention/executive functioning, visuospatial skills, & emotional status | processing speed was significantly impaired in SCI group
memory, visuospatial, attention/executive functioning skills were not significantly impaired in SCI group. | does not include acute SCI, only chronic ($\geq 1$ year post injury, mean = 17 years post injury); hx of closed head injury not examined. |
**Inclusion:** SCI through traumatic event;  
**Exclusion:** history of neurological problems prior to SCI, past admittance to inpatient alcohol treatment program, admittance to psychiatric unit prior to SCI, color blindness;  
Control group: \( n = 64, \) friends/relatives of SCI group, recruits from same medical center as SCI group. Matched with SCI group for age, gender, educational level, handedness, and estimated premorbid intellectual level  

Murray, Asghari, Egorov, Rutkowska, Siddall, Soden, & Ruff, 2007  
compare participants’ perception of their pre-morbid (before injury) function and post morbid (after injury) function at initial survey and again after 6 months.  

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Design</th>
<th>Participants</th>
<th>Inclusion</th>
<th>Exclusion</th>
<th>Outcome Measures</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| D2 Cross sectional study | AOTA level IV | \( N = 63; \) age mean = 43.5 (SD = 14.2), range = not specified | SCI level: paraplegia: \( n = 37; \) tetraplegia: \( n = 26 \) | \( dx \) of SCI, English speaking, age 18 to 65 yrs  
\( hx \) of acquired brain disorder, no serious psych disorder | Objective cognitive assessment - RNBI; Subjective cognitive assessment - QOL | Convenience sample; relies on participant self-report which may be negatively skewed due to depression and adjustment to injury; small sample size; lack of control group. |
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>N</th>
<th>Variables</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolonen, Turkka, Salonen, Ahoniemi, Alaranta, 2007</td>
<td>D3 Normative study</td>
<td>31</td>
<td>SCI level: paraplegia n = 15; tetraplegia n = 16</td>
<td>American Congress of Rehabilitation Medicine diagnostic criteria for mild TBI were administered to participants; Assessments were performed with neuropsychological exams and MRI. 23 of the 31 participants (74%) met diagnostic criteria for TBI; 19 had sustained loss of consciousness or posttraumatic amnesia; 4 had a focal neurological finding and 21 had neuropsychological findings apparently due to TBI; trauma-related MRI abnormalities detected in 10 participants; TBI classified as moderate to severe in 17 patients, mild in 6 patients. Small sample size; geographic setting of study/participants not specified; time since injury not specified; examines post acute population.</td>
</tr>
<tr>
<td>Macciocchi, Seel, Thompson, Byams, &amp; Bowman, 2008</td>
<td>D2 Prospective cohort</td>
<td>189</td>
<td>SCI level: paraplegia n = 93; age mean = 29.1; tetraplegia n = 96; age mean = 27.9</td>
<td>60% of SCI sample also had TBI (n = 118) mild TBI = 34%; mild complicated TBI = 10%; moderate TBI = 6%; severe TBI = 10%; PTA duration, GCS total scores, and CT scan findings most significant discriminating variables for diagnosing TBI with traumatic SCI; participants with SCI levels C1-C4 had a higher incidence (70%-77%) of TBI compared to participants with SCI levels C5-C8 (59%-67%) or levels T1-S3 (11%-59%).</td>
</tr>
<tr>
<td>Bradbury, Wodchis, Mikulis, Pano, Hitzig,</td>
<td>O3 Case control study</td>
<td>20</td>
<td>SCI w/ TBI group: n = 10 SCI level: C4-L4</td>
<td>Inpatient rehabilitation length of stay, health care costs, clinical resource allocation, behavioral and critical incidents, FIM, Personality Assessment. Neuropsychological test performance significantly worse in SCI w/ TBI group (sig. range: ’p &lt; 0.01’ to ’p = 0.08’), FIM cognition score did not does not look specifically at high-level SCI; Inpatient setting as opposed to acute.</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Description/Findings</td>
<td>Inventory, neuropsychological assessment findings</td>
<td>Costs and Length of Stay</td>
<td></td>
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<tr>
<td>McGillivray, Ahmad, Craven, &amp; Green, 2008</td>
<td>experiencing both SCI and TBI compared to those experiencing only SCI. AOTA level II SCI only group: n = 10 SCI level: C4-L1 Inclusion: Age &gt;18, 2-6 months post SCI. Exclusion: Presence of a known or suspected neurodegenerative disorder, acquired language disorder precluding neuropsychological testing, or dx of psychotic disorder.</td>
<td>discriminate due to ceiling effects, greater evidence of psychopathology was observed in SCI w/ TBI group; individuals with SCI and TBI had a longer length of stay in inpatient rehab (138.3 ± 69.71 days) compared to those with just SCI (100.30 ± 41.41 days) which approached significance (p = 0.08); average cost for a patient with SCI and TBI was $169,638 ± $83,945 compared to SCI only with $130,774 ± $90,630, though this did not reach significance (p = 0.17); costs may decreased by early implementation of care specialized to TBI such as procedural learning and errorless learning.</td>
<td>mild to moderate TBI may be missed in clients with SCI during the acute care phase, despite high rates of co-occurrence (up to 60%); rates of co-occurring TBI are highest in patients with SCI levels C1 - C4; symptoms of missed TBI may be perceived as noncompliance, maladaptive reactions to SCI, low motivation; rate and degree of progress during rehab can be affected by TBI and is important for clinicians to be aware of</td>
<td></td>
</tr>
<tr>
<td>Kushner &amp; Alvarez, 2014</td>
<td>describe incidence and clinical implications of the co-occurrence of TBI and SCI only the introductory section of this article was considered for this review D1 Review of related descriptive studies / narrative literature review AOTA Level V did not detail search strategy, or inclusion / exclusion criteria for studies included in review</td>
<td>no outcome measures used or described</td>
<td>weak methodology and evidence level; no systematic strategy described for inclusion/exclusion of research in this review</td>
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</tbody>
</table>


<table>
<thead>
<tr>
<th>Study</th>
<th>Methodology</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macciocchi, Seel, Warshowsky, Thompson, &amp; Barlow, 2012</td>
<td>D2 prospective, longitudinal cohort, AOTA level IV</td>
<td>TBI showed impairments in FIM comprehension ($p = 0.018$), problem-solving ($p = 0.004$), and memory ($p &lt; 0.000$) scores at admission, and FIM memory scores ($p = 0.006$) at discharge; TBI also related to lower attention ($p = 0.027$) and working memory ($p = 0.026$) scores on neuropsych tests than clients with tetraplegia and no TBI. TBI was not related to time from injury to acute rehab admission, length of stay, and FIM motor scale scores. TBI negatively impacted cognition and neuropsych test performance in clients with acute tetraplegia. Few participants with moderate to severe TBI, which are diagnoses most likely to affect cognition; upper extremity ASIA motor scores explained a large portion of discharge FIM motor variance for those with tetraplegia, which may have obscured the relationship between TBI and motor skill acquisition.</td>
</tr>
<tr>
<td>Arzaga, Shaw, &amp; Vasile, 2003</td>
<td>D1 Review of related descriptive studies / narrative literature review, AOTA Level V</td>
<td>Sxs of mild to moderate brain injury may be mislabeled as depression, denial, personality disorder, ICU psychosis, or maladjustment; males between the ages of 15 to 35 years are most affected; incidence of dual diagnosis is 24% to 59%; mild to moderate head injury often first noticed when unable to perform functional activities; a comprehensive neuropsych evaluation is key to understand effects of brain injury.</td>
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Table: Methodology and Results

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</tr>
<tr>
<td>Sharma, Bradbury, Mikulis, &amp; Green, 2014</td>
<td>determine the frequency of missed acute care TBI diagnoses in patients with traumatic SCI, examine risk factors for missed TBI diagnosis</td>
<td>D2 Correlational study</td>
</tr>
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<td>Jegede, Rosado-Rivera, Bauman, Cardoza, Sano, Moyer, Brooks, &amp; Wecht, 2010</td>
<td>determine cognition in hypotensive and normotensive clients with SCI</td>
<td>D2 Correlational study</td>
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</tr>
<tr>
<td>Phillips, Warburton, Ainslie, Krassioukov, 2014</td>
<td>to examine the link between BP and cognitive impairment in individuals with high-level SCI, and to examine how cognition is affected by pharmacologically manipulated BP</td>
<td>E3 Controlled clinical trial</td>
</tr>
<tr>
<td>Sajkov, Marshall, Walker, Mykytyn, McEvoy, Wale, Flavell, Thornton, &amp; Antic, 1998</td>
<td>investigate the correlation between sleep apnea and cognitive disturbance in individuals with tetraplegia.</td>
<td>D2 Correlational study</td>
</tr>
</tbody>
</table>
## Effectiveness of cognitive assessments for adults with high-level SCI

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Measures</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall, Cohen, Whith, Call, &amp; Werner, 1999</td>
<td>D2 Correlational study</td>
<td>SCI level at admission: C1-C3 n = 131, C4 n = 456, C5 n = 541, C6 n = 290, C7 n = 165, C8 n = 52</td>
<td>FIM motor and cognitive scales scored by observation in IP rehab (admission &amp; discharge), follow-up ratings obtained by interview.</td>
<td>Very modest gains observed in cognition subscale between admission and discharge in high tetraplegia group; most patients reached the “ceiling” on the cognition subscale by discharge and almost all by 1 year postinjury; the FIM cognition subscale is not sensitive to the subtle cognitive disabilities seen in this population.</td>
</tr>
<tr>
<td>Davidoff, Roth, Haughton, &amp; Ardner, 1990</td>
<td>D2 Correlational study</td>
<td>SCI group: n = 41</td>
<td>Participants were evaluated with comprehensive, motor-free, neuropsychological test battery: HCT booklet form, VOCAB of the WAIS-R, LM and PA subtests of the WMS, and RAVLT.</td>
<td>No relationships between neuropsychological test results and FIM subscale scores; this was attributed to a ceiling effect in FIM subscale scores.</td>
</tr>
</tbody>
</table>

### Additional notes:
Inpatient rehab setting may not apply to acute pts; cross-sectional as opposed to longitudinal design.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Sample</th>
<th>Inclusion</th>
<th>Exclusion</th>
<th>PNB</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cossa, Fabiani, Farinato, Laiacoma, &amp; Captani, 1999</td>
<td>Correlational study</td>
<td>TBI group: <em>n</em> = 40; age mean = 29.5, range = 15 - 75</td>
<td><em>Inclusion:</em> clients with ‘severe’ TBI, inpatient setting, age between 15 - 75 years, time since injury 10 - 283 days.</td>
<td><em>Exclusion:</em> not specified</td>
<td>PNB measures dimensions of non-symbolic and symbolic reasoning; allows pts to answer simple “yes” or “no” to each task.</td>
<td>PNB may be a useful tool to assess general cognitive level in pts with severe motor and verbal impairments, though it might not adequately differentiate types of cognitive impairment; fair but statistically significant correlation (<em>r</em> = 0.51) found between PNB and more complex neuropsychological battery.</td>
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<td></td>
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<td>Control group: <em>n</em> = 34 without significant psychiatric or internal disease</td>
<td></td>
<td></td>
<td>conducted with clients who were slightly more responsive than the PNB was designed for; correlations between PNB and complex neuropsychological battery were modest; not applied to clients with SCI.</td>
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</tr>
<tr>
<td>Hobson, Leeds, &amp; Meara, 2003</td>
<td>Case control study</td>
<td>Stroke group: <em>n</em> = 149; age mean = 72.8, range = not specified</td>
<td><em>Inclusion:</em> admission to specialist stroke unit, dx of stroke;</td>
<td><em>Exclusion:</em> fluctuant delirium, severe aphasia, severe life threatening comorbidity, unable to give consent</td>
<td>PNB may be a useful tool for cognitive screening post-stroke.</td>
<td>did not actually test on pts with aphasia; not applied to clients with SCI.</td>
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<tr>
<td></td>
<td></td>
<td><em>N</em> = 271; age mean = 72.7, range = not specified</td>
<td>Stroke group: <em>n</em> = 149; age mean = 72.8, range = not specified</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><em>Inclusion:</em> admission to specialist stroke unit, dx of stroke;</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><em>Exclusion:</em> fluctuant delirium, severe aphasia, severe life threatening comorbidity, unable to give consent</td>
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<td></td>
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<td></td>
<td>aphasia assessed with BDAE; cognition assessed with CAMCOG-R, and the PNB (both administered on same day).</td>
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<td></td>
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<td></td>
<td>internal reliability for all domains of PNB &gt; 0.70; test-retest reliability <em>r</em> = 0.74; criterion validity between CAMCOG-R &amp; PNB <em>r</em> = 0.77; PNB sensitivity = 71%; specificity = 93%</td>
<td></td>
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<tr>
<td>Control group:</td>
<td>n = 122; age mean = 72.6, range = not specified</td>
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</table>

## Multiple Assessments

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Type of Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christy &amp; Friedman, 2005</td>
<td>D2 Correlational study</td>
<td>Multiple Assessments</td>
</tr>
<tr>
<td></td>
<td>AOTA level IV</td>
<td>Control group: n = 122; age mean = 72.6, range = not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inclusion: LH lesions from stroke or brain damage, at least 6 mo post, typical hearing and vision; Exclusion: hx of psychiatric dx, substance abuse, or learning disability</td>
</tr>
<tr>
<td></td>
<td>N = 18; age mean = 58.4, range = not specified</td>
<td>BDAE, the RCPM and the TONI given to all participants within the context of a larger study; 7 pts were also given an extended repetition test.</td>
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<tr>
<td></td>
<td></td>
<td>RCPM correlated to comprehension subtest of BDAE (r = 0.56, p &lt; 0.05); RCPM nearly significant with severity in the BDAE (r = .41, p = .10); no severity relationship with the TONI; overall TONI better than BDAE as a measure of general cognition in pts with aphasia.</td>
</tr>
<tr>
<td>Wilson, Hinchcliffe, Okines, Florschutz, &amp; Fish, 2011</td>
<td>D4 Case study</td>
<td>Review reports of neuropsychological assessments for clients with LIS; determine if a client with LIS has normal cognition</td>
</tr>
<tr>
<td></td>
<td>AOTA level IV</td>
<td>N = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27 y/o female, basilar artery thrombosis resulting in LIS</td>
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<tr>
<td></td>
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<td>varied tests addressing <strong>premorbid function</strong>: Spot-the-word (from the Speed and Capacity of language processing); <strong>language</strong>: TRG-2, Graded Naming Test; <strong>memory</strong>: Recognition Memory Test, Doors recognition memory sub-test, Picture and face recognition from RBMT-3, CVLT, Autobiographical Memory Interview; <strong>visuo-perceptual function</strong>: VOSP, Picture Completion subtest (from WAIS-3), CVLT, Autobiographical Memory Interview; <strong>visuo-spatial functioning</strong>: VOSP, Manikin Test; <strong>executive function</strong>: MCST, BSAT; <strong>non-verbal reasoning</strong>: Matrix Reasoning (from WAIS-3), RSPM</td>
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<tr>
<td></td>
<td></td>
<td>above average on Matrix Reasoning, BSAT, CVLT, MCST average on Spot the Word, Graded Naming Test, Picture &amp; Face Recognition, VOSP, Autobiographical Memory Interview, TRG-2 below average on RSPM, Picture Completion, Manikin test, Recognition Memory Tests words and faces assessments together show intact cognitive function in most areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Statistical measures not reported; assessments not used on clients with SCI; only one client studied with a diagnosis that already implied intact cognition; looks at only a special subsection of the population.</td>
</tr>
</tbody>
</table>
## Abbreviations List:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASIA</td>
<td>American Spinal Injury Association</td>
</tr>
<tr>
<td>BP</td>
<td>blood pressure</td>
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<tr>
<td>BDI</td>
<td>Beck Depression Inventory</td>
</tr>
<tr>
<td>BDAE</td>
<td>Boston Diagnostic Aphasia Examination</td>
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<tr>
<td>CAMCOG-R</td>
<td>Cambridge Cognitive Examination - Revised</td>
</tr>
<tr>
<td>COWAT</td>
<td>Controlled Oral Word Association Test</td>
</tr>
<tr>
<td>CVLT (-II)</td>
<td>California Verbal Learning Test (-II)</td>
</tr>
<tr>
<td>FIM</td>
<td>Functional Independence Measure</td>
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<tr>
<td>GCS</td>
<td>Glasgow Coma Scale</td>
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<tr>
<td>HCT</td>
<td>Halstead Category Test</td>
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<tr>
<td>LIS</td>
<td>Locked-In Syndrome</td>
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<tr>
<td>LM</td>
<td>Logical Memory Subtest of WMS</td>
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<tr>
<td>LOC</td>
<td>Loss of consciousness</td>
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<tr>
<td>MCST</td>
<td>Modified Card Sorting Test</td>
</tr>
<tr>
<td>MVC</td>
<td>motor vehicle collision</td>
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<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>NART</td>
<td>New Adult Reading Test</td>
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<tr>
<td>NVC</td>
<td>neurovascular coupling</td>
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<tr>
<td>PA</td>
<td>Paired Associates Subtest of WMS</td>
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<tr>
<td>PA-SAT</td>
<td>Paced Auditory Serial Addition Test</td>
</tr>
<tr>
<td>PCA</td>
<td>posterior cerebral artery</td>
</tr>
<tr>
<td>PETCO2</td>
<td>partial pressure of exhaled carbon dioxide</td>
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<tr>
<td>PNB</td>
<td>Preliminary Neuropsychological Battery</td>
</tr>
<tr>
<td>PTA</td>
<td>post-traumatic amnesia</td>
</tr>
<tr>
<td>QOL</td>
<td>quality of life</td>
</tr>
<tr>
<td>RA-VLT</td>
<td>Rey Auditory Verbal Learning Test</td>
</tr>
<tr>
<td>RBMT-3</td>
<td>Rivermead Behavioural Memory Test-3</td>
</tr>
<tr>
<td>RCPSM / RSPM</td>
<td>Raven’s Colored / Standard Progressive Matrices</td>
</tr>
<tr>
<td>SCI</td>
<td>spinal cord injury</td>
</tr>
<tr>
<td>SDMT</td>
<td>Symbol Digit Modality Test</td>
</tr>
<tr>
<td>TBI</td>
<td>traumatic brain injury</td>
</tr>
<tr>
<td>TONI</td>
<td>Test of Nonverbal Intelligence</td>
</tr>
<tr>
<td>TRG-2</td>
<td>Test of Reception of Grammar-2</td>
</tr>
<tr>
<td>VOCAB</td>
<td>Vocabulary Subtest</td>
</tr>
<tr>
<td>VOSP</td>
<td>Visual Object and Space Perception Battery</td>
</tr>
<tr>
<td>WAIS (-R), (-3)</td>
<td>Wechsler Adult Intelligence Scale (-Revised), (-3)</td>
</tr>
</tbody>
</table>
Summary of Key Findings

Correlation between high-level SCI and cognitive impairment:

**Summary of Experimental Studies**

One level E3 experimental study found cerebrovascular reserve and hypotension occur in clients with SCI (C4-T5), and can lead to cognitive impairment. This study also found that midodrine can help reduce orthostatic hypotension and improve cerebrovascular functioning, in turn improving cognition. It is possible, however, that cognition in the participants of this study was also affected by factors such as TBI or other medications, confounding the experimental results (Phillips et al., 2014).

**Summary of Outcome Studies**

Three outcome studies looked at SCI, all with findings indicating cognition could be negatively impacted following SCI. A level O3 study found that individuals with SCI had significantly lower cognitive assessment scores than individuals without SCI in a post-acute care setting (Roth et al., 1989). Another O3 study indicated that cognitive impairment may be affected selectively. This study found that processing speed was significantly impaired for individuals with SCI, while memory, visuospatial, attention and executive functioning skills were not significantly impaired (Dowler et al., 1995). Another O3 study found that individuals with only an SCI diagnosis had better cognitive ability than those with comorbid SCI and TBI diagnoses (Bradbury et al., 2008). These studies did not all exclusively or specifically look at acute, high-level SCI, though they do indicate that cognition can be affected in populations with SCI.

**Summary of Descriptive Studies**

Nine descriptive studies were related to comorbid diagnoses with SCI. Studies found that certain diagnoses that impact cognition are commonly comorbid with SCI. A D2 study found that 60% of an SCI sample had co-occurring TBI, with most TBI being mild (Macciocchi et al., 2008). Furthermore, a D3 study found that 74% of a sample with SCI also had TBI, with most TBI being moderate to severe (Tolonen et al., 2007). Another D3 study indicated that TBI was a significant risk factor for cognitive impairments in individuals with acute tetraplegia (Macciocchi et al., 2012). These findings are corroborated by a level D2 study which showed that individuals greater than six months post-SCI self-reported decreased cognitive function after SCI (Murray et al., 2007). A D1 review of related descriptive studies found that TBI may be missed in clients with SCI during the acute care phase and that rates of co-occurring TBI are highest in patients with SCI levels C1 - C4. This study detailed how symptoms of missed TBI may be perceived by clinicians and healthcare providers as noncompliance, maladaptive reactions to SCI, or low motivation, though the research description provided for this article was weak (Kushner & Alvarez, 2014). Another D1 study found the symptoms of mild to moderate brain injury may be mislabeled as depression, denial, personality disorder, ICU psychosis, or maladjustment. This study found that males between the ages of 15 to 35 years are most affected, and that mild to moderate head injury is often first noticed when individuals are unable to perform functional activities (Arzaga et al., 2003). Moreover, a D2 study found a rate of missed TBI diagnoses for people with SCI to be over 50%. TBI was missed 75% of the time for clients with non-motor vehicle collision related injuries, whereas it was missed about 40% of the time with motor vehicle collision related injuries (Sharma et al., 2014). Another D2 study of all SCI levels (majority of participants with tetraplegia) found that 53% of SCI patients had co-occurring hypotension. A comparison between the hypotensive and normotensive participants found that the hypotensive group had decreased memory, attention, and processing speed (Jegede et al., 2009). Finally, a D2 study
found that severe sleep hypoxia due to sleep apnea, a common comorbid diagnosis with SCI, is correlated to impairments in cognitive function (Sajkov et al., 1998).

**Effectiveness of cognitive assessments for adults with high-level SCI:**

**Summary of Outcome Studies**

An O3 study supported use of the PNB as a reliable and valid assessment, with fair sensitivity and strong specificity for use with clients with aphasia (Hobson et al., 2003).

**Summary of Descriptive Studies**

Five descriptive studies related to the usability of cognitive assessments for individuals with impaired motor and/or verbal function were reviewed. One D2 study showed that the Preliminary Neuropsychological Battery (PNB) may be a useful tool to assess general cognitive level in patients with severe TBI, though it might not differentiate types of cognitive impairment (Cossa et al., 1999). This study was done on clients with TBI and may not directly apply to clients with SCI. Another D2 study on clients with aphasia showed the TONI to be an adequate assessment of cognition (Christy & Friedman, 2005). Again, this study was not conducted on individuals with SCI, thus the results may not translate to the population in question. Additionally, a D2 study found that the FIM cognition subscale was not sensitive to the cognitive disabilities seen in an inpatient rehab setting across all SCI levels, and may serve better as a general screen of cognition than an assessment of complex cognitive functioning (Hall et al., 1999). This was backed by another D2 study that found no relationships between neuropsychological test results and FIM subscale scores, attributing the findings to a ceiling effect in FIM subscale scores (Davidoff et al., 1990). A D4 study provided a framework for a battery of cognitive assessments a client with locked-in syndrome (i.e. severely verbally and motorically limited) to look at premorbid function (Spot-the-word from the Speed and Capacity of language processing), language (TRG-2, Graded Naming Test), memory (Recognition Memory Test, Doors recognition memory sub-test, Picture and face recognition from RBMT-3, CVLT, Autobiographical Memory Interview), visuo-perceptual function (VOSP, Picture Completion subtest from WAIS-3), visuo-spatial functioning (VOSP, Manikin Test), executive function (MCST, BSAT), and non-verbal reasoning (Matrix Reasoning from WAIS-3, RSPM) (Wilson et al., 2011). These descriptive studies may provide useful information about cognitive assessments that may have potential to be applied with individuals with high-level SCI. However, lack of research on this specific population indicates that further research is needed to determine whether or not these assessments may prove useful for clients with acute, high-level SCI.

**Implications of Findings**

**Implications for Consumers:**

Adults with high-level spinal cord injuries and their families should be aware of the rates of cognitive impairment after injury. Knowing about the high rates of TBI after SCI may allow them to ask for appropriate testing, as TBI can have a dramatic effect on the rehabilitation process, and is often missed. It is especially important for clients with high-level SCI to advocate for cognitive testing, as TBI is most commonly missed in these people. Clients and their families should also be aware of other common issues after SCI that can affect cognition such as sleep apnea, hypotension, and various medications. This information can allow clients to advocate for adequate cognitive assessment and rehabilitation. Identifying issues and getting services in an early stage after injury could provide better outcomes for these clients. If clients themselves are unable to advocate due to limited language or
physical abilities, caregivers should be informed about the potential for cognitive impairments and other complications in their loved ones so that they can ask for appropriate assessment and therapy.

**Implications for Practitioners:**

According to this research, cognitive impairment most often occurs following traumatic SCI and practitioners should treat clients with this in mind. Not only is there a high incidence of co-occurring TBI and SCI, but TBI diagnoses are often missed and/or misinterpreted by practitioners. It is also important for practitioners to be aware that the type of accident can impact their readiness to diagnose TBI. For example, individuals in an MVA are more likely to be diagnosed with TBI than those who were not, but otherwise experienced the same injury. Practitioners should be aware of the possibility of cognitive impairments in patients with SCI, regardless of whether the client has received a diagnosis of TBI. Not only does TBI affect cognition in this population, but evidence also demonstrates that patients with SCI are more likely to have cognitive impairments when they also exhibit other complicating conditions such as hypotension, sleep apnea, or prolonged LOC at the time of injury. Monitoring and treatment of these common comorbidities can potentially serve to reduce the incidence of cognitive impairment in individuals with SCI. Practitioners may want to consider how they approach treatment in clients with these comorbidities, and may want to do a formal assessment of cognition. If not all SCI patients in the can be assessed for cognition in the acute setting (as is preferable), practitioners should at least prioritize such assessment to this higher risk segment of the SCI client population. Early identification of cognitive impairment can improve client outcomes and reduce hospital costs.

Unfortunately, cognition is difficult to assess when both verbal communication and motor control have been severely impacted or lost altogether in a traumatic event. There are few tools to measure all aspects of impaired cognition in detail, but assessments such as the PNB and TONI have shown potential for clients with verbal and motor impairments. Research has shown that the FIM cognitive subscale should not be used as a cognitive evaluation due to ceiling effects, though it may have potential to be used as a gross screen. Practitioners should keep in mind that using the FIM as a screen may not detect more subtle or mild cognitive impairments. Additionally, the Wilson et al. (2011) article detailed a comprehensive neuropsychological battery of various assessments for a client with locked-in syndrome, which may have potential to be applied to this population in the future.

Beyond direct treatment, practitioners should advocate for further research to be done in the area of cognitive assessment specifically with this population, so that these clients may be better served.

**Implications for Researchers:**

Research is still needed on cognitive assessment for clients with high-level SCI. There are cognitive assessments that are motor and/or language free, but there is a lack of research exploring the use of these types of assessments on populations with high-level SCI. Right now we can only postulate as to which assessments may be appropriate, but there is no solid research base to inform clinical decisions. Research is needed regarding the validity and reliability of such cognitive assessments (e.g., PNB, TONI) when used with this population. Clinicians currently do not have an effective, evidence-driven method of measuring cognition in clients in acute care who have very limited motor and verbal abilities due to high-level SCI. Research on this topic is important, as it could potentially affect the prognosis and functional outcomes for these clients, especially if they can be identified early on in the rehabilitation process.
In terms of the relation of cognitive impairment and high-level SCI, connection between high-level SCI and diagnoses that are commonly associated with cognitive impairment is strongly supported. Further research into methods that minimize these common comorbidities that lead to cognitive impairment, such as maintaining stable blood pressure and reducing hypoxic sleep apnea in an acute care setting, is indicated by the findings of this review.

**Bottom Line for Occupational Therapy Practice/ Recommendations for Best Practice:**

Even in the acute setting, occupational therapists should advocate for the assessment of cognition for every patient with a high-level SCI through formalized neuropsychological testing, while also looking for opportunities to advocate for further research and the development of new, more specialized cognitive assessment tools for OT practitioners to use. Occupational therapists should be mindful that clients without the ability to communicate through language or motor-skills may not be capable of self-advocacy in the acute stage of their rehabilitation and therefore must rely more on the advocacy of the occupational therapist and other practitioners. As found in this critical appraisal, cognitive impairments often show up first during functional activities, thus may be first noticed by OT. Practitioners may misinterpret signs of cognitive impairment as depression, maladaptive responses to injury, or low motivation, and OT clinicians should be mindful of this when treating this population. Currently, the practice in acute care as reported by our clinician advisor is that patients with high-level SCI are not typically assessed for cognitive deficits in acute care. The research in this critical appraisal suggests this current practice may not be in the best interest of these clients at the beginning stage of their rehabilitation. New effort should be made to examine changes in cognition for clients with acute SCI, so that they may be better served by the care received and their rehabilitative potential may be fully realized.
Involvement Plan

Introduction

Through conversation with our clinical collaborator, we worked to identify which findings of our research were most salient to the setting, and what should be communicated to professionals at Harborview. These include the connection between high-level spinal cord injury (SCI) and cognitive impairment, conditions and risk factors associated with cognitive impairment in individuals with high-level SCI, assessments that are not useful for identifying cognitive impairment, and assessments that may be useful or have been used to identify cognitive impairment for individuals with limited motor and verbal abilities. In addition, some implications for OT were identified as useful to highlight as well. These include acknowledging the difficulty for OTs to identify cognitive impairment in individuals with high-level SCI and the importance of collaboration with speech language pathologists (SLPs) to identify cognitive impairment as they have more tools to interact with non-verbal and motor impaired individuals, and are often the professionals that assess cognition at Harborview.

Hoffmann, Bennett, and Del Mar (2009) detail Grol and Wensing’s Plan and Prepare model of research implementation, which we used to identify potential barriers and problems that may prevent successful knowledge translation to clinicians. Using the model, we made a plan for how to best address the barriers, with a list of products, tasks, and a timeline for implementation. The primary barrier we identified was that the implications of our findings do not directly provide a roadmap for new intervention or assessment strategies for OTs working with individuals with high-level SCI in acute care. Additionally, OTs working in the acute setting may not be completing complex functional tasks that would help them to pick up on more subtle cognitive deficits. Through the Plan and Prepare Model it was determined that the most useful strategy for educating OTs at Harborview was through an in-service session. The in-service consisted of a presentation that highlighted the key points and implications of our findings. The presentation’s purpose was to raise the issue of clinical judgment and decision-making for patients with SCI, in which TBI and cognitive impairments are often missed and could adversely affect treatment if not identified. While the research may not suggest the use of a specific assessment for cognition, we
advocated for formalized evaluation earlier in the rehabilitation process by making clinicians aware of some of the key risk factors to look for. Our presentation included the use of PowerPoint as a visual aid for presenting the comprehensive findings of our study, as well as a brochure with important takeaways for attendees to reference both during and after the presentation. A short survey was distributed at the end to gather information on the effectiveness of the presentation. The in-service presentation will run about 30 minutes, with time afterward for questions and discussion.

**Context**

Harborview is run with a hierarchical management structure with set procedures and standards of practice set for specific areas within the hospital. Changing or modifying these procedures is not a quick process. Currently, the policy when treating clients with high level SCI is to assume unimpaired cognition. As we have learned through our research, this may lead to missed diagnoses of brain injury or cognitive impairment that could adversely affect client outcomes. While we brought up this issue during our in-service, we do not expect to inspire massive changes in policy through one presentation. We hope to have successfully educated therapists about how they can best advocate for these clients and provide best practice through identifying risk factors and raising awareness about the rates of comorbidities that may impact cognitive functioning. We encouraged OTs to utilize referrals to speech language pathologists (SLPs) more readily in the acute setting for clients who may have cognitive impairment. While our recommendation was that SLPs are involved with all high-level SCI clients to facilitate cognitive screening, the changes that come from our presentation are likely to be on an individual or potentially departmental level among neuro-rehabilitation specialists at Harborview.

The makeup of attendees at our in-service potentially affected the knowledge translation process. The number of clinicians that attended was robust, yet manageable at around 20 clinicians. The specific disciplines of clinicians present may have affected how they interpreted our findings, since our research was done from an OT perspective. We made an attempt to present our findings in a way that was applicable to all neuro-rehabilitation specialists, though our project has an acute OT focus which may limit the generalizability or effectiveness of our knowledge translation.
Outcomes to Be Monitored

Due to the fact that our research findings did not provide a specific framework for changing practice, it is difficult to directly monitor efficacy outcomes of our presentation. A survey was given to assess the effectiveness of our knowledge translation, based around a readiness-to-change model (Law & MacDermid, 2008). Questions were asked in order to assess subjective understanding of the presentation, prior understanding of the subject in relation to the information presented (precontemplation), current attitude toward high-level SCI and cognition (contemplation), and potential for change in practice behaviors in the future (preparation).

Knowledge Translation

An in-service was given at Harborview Medical Center in Seattle, WA, consisting of slides to assist with an oral presentation, a tri-fold brochure for reference during and after the in-service, and a survey to measure effectiveness of the in-service. These products have been attached to the paper for reference. (See appendix.)

Presentation Slides

A slideshow was created as a visual aid for the in-service presentation. This contained main points from our research and citations for discussed articles. The slides contained an introduction to the nature of the research project and research questions, as well as the results found in the literature. Key implications for practitioners were also highlighted in the slides. The slideshow was designed for all rehabilitation specialists, including occupational therapists, physical therapists, and speech language pathologists, and therefore contained more complex medical and rehabilitation technology.

Brochure

When creating the brochure, it was difficult to narrow down a complex topic into a 2-sided page for a tri-fold brochure, maintain the integrity of the findings, and make it easy to understand. To accomplish this, key points were taken from the research paper, then were categorized as either areas relevant to raising awareness or actionable items for the clinicians at Harborview. While a complex
understanding of medical terms/abbreviations was expected of our audience, we opted to remove jargon, abbreviations (with the exception of SCI and TBI), and complex wording as much as possible in order to lower the cognitive load required when going over the brochure and facilitate understanding of the material.

Effectiveness Survey

A survey was created to gauge the effectiveness of the in-service. Questions were asked in order to assess subjective understanding of the presentation, prior understanding of the subject in relation to the information presented, current attitude toward high-level SCI and cognition, and potential for change in practice behaviors in the future.

**Project Timeline**

<table>
<thead>
<tr>
<th>Task/Product</th>
<th>Deadline</th>
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<tbody>
<tr>
<td>Revised &amp; updated CAT delivered to chair and faculty mentors</td>
<td>2/9/16</td>
</tr>
<tr>
<td>Involvement plan delivered to chair and faculty mentors</td>
<td>3/8/16</td>
</tr>
<tr>
<td>PowerPoint presentation for our in-service at Harborview, submitted to chair (Tatiana Kaminsky) and course instructor (Sue Doyle) for review</td>
<td>4/11/16</td>
</tr>
<tr>
<td>Brochure summarizing the information we found in our research, submitted to chair (Tatiana Kaminsky) and course instructor (Sue Doyle) for review</td>
<td>4/11/16</td>
</tr>
<tr>
<td>Effectiveness survey to assess the quality of the presentation and likelihood of it changing clinician perspectives and behavior, submitted to chair (Tatiana Kaminsky) and course instructor (Sue Doyle) for review</td>
<td>4/11/16</td>
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<tr>
<td>All in-service materials submitted to clinician collaborator (Sarah Bicker) for approval</td>
<td>4/18/16</td>
</tr>
<tr>
<td>Task</td>
<td>Date</td>
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<tr>
<td>Draft AOTA conference proposal</td>
<td>4/19/16</td>
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<tr>
<td>In-service presentation at Harborview</td>
<td>4/22/16</td>
</tr>
<tr>
<td>CAT final paper</td>
<td>4/26/16</td>
</tr>
<tr>
<td>Complete poster and submit to chair and faculty mentor for review</td>
<td>5/1/16</td>
</tr>
<tr>
<td>Collect results of in-service outcomes survey</td>
<td>5/1/16</td>
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<tr>
<td>Final project defense</td>
<td>5/4/16</td>
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<tr>
<td>University of Puget Sound thesis poster presentation</td>
<td>5/12/16</td>
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**Monitoring of Outcomes**

Immediately after the presentation of our research at the Harborview in-service an effectiveness survey was given to attendees. Each question on the survey contained a Likert scale with number responses from 1 (least) to 5 (most). The survey questions were: (1) How satisfied were you with the quality of this presentation, (2) How much did the presented material increase your knowledge of cognitive impairment in relation to high-level SCI?, (3) How likely are you to change your practice behaviors based on the information presented?, (4) Do you feel undiagnosed cognitive impairment in high-level SCI has a significant negative impact on overall client outcomes?, (5) Do you feel cognitive impairment among individuals with high-level SCI is left undiagnosed to a significant degree in acute care at Harborview?

These questions were aimed at determining how effective the in-service was in providing education about the prevalence and importance of identifying cognitive impairment in individuals with high-level spinal cord injury. Additionally, the survey attempted to discern the extent to which clinicians perceive cognitive impairment to be an issue with this population, and whether they feel that cognitive
impairment is often missed at Harborview. Clinicians were also asked to rate whether they felt that the information from the in-service would affect their practice. Due to our inability to monitor whether attendees do change their practice, the best option at our disposal was to ask whether or not clinicians felt that the information would change their practice. Surveys were left at the site to allow attendees time to fill them out. The completed surveys will be collected by our clinician collaborator and returned to us on May 1, 2016.

**Evaluation of Effectiveness of Tasks/Products**

Our in-service was well-attended, with roughly 20 attendees from various rehabilitation disciplines including OT, PT, and SLP. We received positive informal feedback from the attendees of our in-service, however we cannot formally evaluate our presentation’s effectiveness until we receive the completed surveys, which we expect to receive on May 1, 2016. We will add in the survey measures of our effectiveness at that time.

Overall, the in-service presentation went well and we attempted to ensure that the information was presented in a clear manner that would allow for adequate knowledge translation. It is difficult, however, to determine the true effectiveness of our knowledge translation without following up a month, six months, or even a year from now to see if any practice changes have occurred. Following up at a later date with a survey or monitoring the number of cognitive evaluation referrals at Harborview would be ideal for determining whether or not we were successful in relaying the research to practitioners.

We feel that combining verbal and written information aided in the success of our knowledge translation process. We carefully created our slideshow and oral presentation to give enough information for the main takeaways of the research without providing too much detail to take in at once. Additionally, we had several copies of our CAT paper available for attendees if they wanted more detail about any of the points brought up during the in-service. We also carefully created a brochure identified the key points in an even simpler format than the slideshow, for easy reference both during and after the presentation. We feel that providing a variety of media with varying amounts of detail will allow practitioners to
choose how in-depth they would like to get into the material, while still gleaning the main takeaway points from our research no matter which medium they reference.

**Analysis of Overall Process**

This project presented a unique learning experience unlike a typical research thesis. Having the opportunity to meet with a clinician to discuss research questions that had arisen from real-world experiences was a fascinating alternative to case studies or formulating our own topics. Combing through hundreds of research articles was challenging, but it was great practice for being efficient and critical readers of research. Our group was initially discouraged with the lack of research pertaining to our question in its original form (“What cognitive assessments exist for clients with acute high-level SCI?”) but our clinician collaborator and mentors were very helpful with assisting us in refining our research methods and re-formulating our research question based on the research that was available. While we found that there was not much research for assessments that could potentially be applied to this population, we still ended up finding clinically relevant information about rates of missed cognitive impairment and comorbid conditions that may indicate an increased risk of cognitive impairment. Through this project we were also able to identify a need for further research on cognitive assessments that can be applied to this population.

Completing all of the incremental steps of the project was challenging. Keeping track of small changes and recording detailed documentation of the methodology proved to be difficult in a group of three. The knowledge translation aspect of this project was unique and provided an interesting addition to a typical research project. However, it did feel as though we had too little time to monitor the outcomes of the knowledge translation process. It seems as though some of the intermediate assignments in between the initial CAT in the fall semester and the knowledge translation process at the end of the spring semester could have been streamlined. If this were the case, we could have potentially begun the knowledge translation piece earlier in the spring semester to allow more time to monitor outcomes and changes in practice.
We are proud to have completed our CAT, and are pleased with the positive feedback we have received about our findings from our department mentors and our clinician collaborator. The prospect of presenting our research to clinicians at Harborview Medical Center was initially daunting, but we enjoyed the experience and we are looking forward to receiving the completed surveys we left with our presentation’s attendees. We know that we may be required to do similar in-service presentations like this in Fieldwork II or places of employment, and so we feel that this initial experience will be an advantage to us as we transition into practicing occupational therapists.

**Recommendations for Future Research**

While a relative dearth of research directly relating to our research question was at times challenging, it illuminated areas in which future research can be conducted to better understand how to appropriately assess cognition in individuals with high-level SCI. We found that no specific cognitive assessments were supported for use with individuals with high-level SCI in an acute care setting. Given the identified support our research showed for a common incidence of cognitive impairment for individuals with a high-level SCI, it is imperative for research to be conducted regarding reliable, valid, and practical ways to assess cognition in this population.

Additionally, we do not believe that our identified list of common comorbidities that can cause cognitive impairment is an exhaustive one. Further research is warranted to identify additional comorbidities in this population that can impact cognition. Furthermore, no research was found on the overall rates of cognitive impairment in individuals with high-level spinal cord injury, but rather only on the rates of co-occurring conditions such as TBI. Research regarding the incidence of cognitive impairment with this population would add valuable information to practice and policy decisions related to this population.

Finally, our research did not delve deeply into the all the implications and potential ramifications for missed diagnoses of cognitive impairment in this population. Future research could focus more
specifically on the impact that undiagnosed cognitive impairment may have on the rehabilitation and health outcomes of individuals with high-level SCI.

Our research shows that the incidence of cognitive impairment with high-level SCI is a significant and serious issue with no reliable methods of assessment for OTs in an acute care setting. Continued research into the exact nature of this relationship and appropriate ways to assess its presence will create more robust best practices for clients with high-level SCI and improve long term health outcomes.
References


Appendix

Presentation Slides

Cognition and High-Level Spinal Cord Injury

Olivia Allen, OTS
Michael DeWilde, OTS
Jon-Erik Golob, OTS
University of Puget Sound MSOT Program

Research Questions

- Is there a correlation between high-level spinal cord injury (C1-C7) and cognitive impairment?

- What assessments are available for evaluating cognition in these clients given that they are often motorically and verbally limited?
Relationship Between SCI & Cognitive Impairment

- Cognition may be affected by comorbid conditions following SCI
  - Orthostatic hypotension
  - Sleep apnea
  - Traumatic brain injury

Relationship Between SCI & Cognitive Impairment

- Orthostatic hypotension
  - Orthostatic hypotension in clients with SCI (C4-T5) can lead to cognitive impairment (Phillips et al., 2014)
    - Midodrine helped to combat hypotension, improving cognition
  - 53% of participants with chronic SCI had co-occurring hypotension (of which 82% had tetraplegia)
    - Hypotensive group had decreased memory, attention, processing speed (Jegede et al, 2009)
Relationship Between SCI & Cognitive Impairment

- Sleep hypoxia due to sleep apnea
  - Commonly comorbid with SCI - 30% of sample had sleep disordered breathing, with 19% desaturating to <80% O2 during the night
  - Correlated with impairments in verbal attention and concentration, short term memory, cognitive flexibility, working memory (Sajkov et al., 1998)

Relationship Between SCI & Cognitive Impairment

- Traumatic Brain Injury
  - Rates of co-occurrence between SCI and TBI
    - 60% - 74% of participants with SCI (all levels) also had TBI (Macciocchi et al., 2008; Tolonen et al., 2007)
    - Rates highest (70-77%) among patients with C1-C4 SCI (Macciocchi et al., 2008)
  - TBI a significant risk factor for cognitive impairments in clients with SCI - especially high level SCI (Macciocchi et al., 2012)
Relationship Between SCI & Cognitive Impairment

- Traumatic Brain Injury
  - TBI may be missed in clients with SCI during acute phase
    - Rate of missed TBI could be over 50%
    - TBI missed 75% of the time for clients with non-MVA injuries; missed 40% of the time with MVA injuries
    - (Sharma et al., 2014)

Relationship Between SCI & Cognitive Impairment

- Traumatic Brain Injury
  - Missed TBI may be mislabeled or misinterpreted
    - Low motivation, maladaptive reactions to SCI, non-compliance (Kushner & Alvarez, 2014)
    - Depression, denial, personality disorder, ICU psychosis (Arzaga et al., 2003)
  - Mild to moderate head injury often first noticed during functional activities (Arzaga et al., 2003)
Assessing Cognition with this Population

- Did not find assessments specific to this population

- Potential assessments that could be used
  - Preliminary Neuropsychological Battery
    - Useful for clients with aphasia (Hobson et al., 2003)
    - Useful to assess general cognitive level in patients with severe TBI (Cossa et al., 1999)
  - Test of Nonverbal Intelligence
    - Useful for clients with aphasia (Christy & Friedman, 2005)

Assessing Cognition with this Population

- Potential assessments that could be used
  - Functional Independence Measure Cognitive Subscale
    - NOT sensitive to subtle cognitive disabilities in inpatient rehab across all SCI levels (Hall et al., 1999)
      - May be better as a general screen than an assessment of cognitive functioning
    - No clinically significant relationship between neuropsych test results and FIM subscale scores, due to ceiling effect in FIM (Davidoff et al., 1990)
Assessing Cognition with this Population

- Potential assessments that could be used
  - Battery of neuropsychological assessments used for clients with locked-in syndrome detailed by Wilson et al., 2011
    - Included many non-verbal, non-motor subtests including the WAIS-3, Digit Span and Letter-Number Sequencing Tests, Continuous Visual Memory Test, Hopkins Verbal Learning Test, Symbol Digit Modalities Test, Short Category Test
    - Could be a useful battery for this population, although it is time-intensive

Implications for Practitioners

- Risk factors for cognitive impairment after SCI include:
  - Traumatic SCI
  - High-level SCI
  - Orthostatic hypotension
  - Obstructive sleep apnea

- Watch clients with these risk factors more closely for signs of cognitive impairment and/or TBI - refer for neuropsych or cognitive eval by SLP early on if you notice signs or symptoms

- Early symptoms of traumatic brain injury may be misinterpreted as depression, maladjustment, noncompliance, denial, ICU psychosis - keep this in mind when treating this population
Implications for Practitioners

- Advocate for proper evaluation of cognition in clients with SCI early on - they may not be able to advocate for themselves.

- Potentially screen all clients with SCI considering high rates of co-occurring cognitive involvement.

- Advocate for more research to be done on cognitive assessment tools with this population - there is currently not an evidence-based assessment tool for clients with high-level SCI.

Changing Standard of Practice (Bottom Line)

- If you notice any signs or symptoms of cognitive impairment, or if your patient is exhibiting comorbidities associated with cognitive impairment, consider referring for neuropsych or cognitive evaluation as soon as possible.
References


References


References


Assessments

Unfortunately, current research does not strongly support the use of any specific motor and verbal free assessments for cognitive impairment for individuals with high-level SCI in an acute care setting, though some have been identified as having potential to be applied with further research (including the Test of Nonverbal Intelligence, Preliminary Neuropsychological Battery, and a battery of neuropsychological assessments). Further research is needed to determine which cognitive assessments may be applied to this population.

Best practice for acute care?

While occupational therapists do not currently have the tools to assess this population for cognitive impairment in the acute setting, SLPs are better equipped to communicate with and assess this population. If you suspect a cognitive impairment, or if your patient has comorbidities associated with cognitive impairment, think about involving an SLP as soon as possible with the goal of identifying whether or not cognitive impairment is present.
COGNITION IN CLIENTS WITH ACUTE TETRAPLEGIA

TBI and high-level SCI

Of the comorbidities, TBI may be the most important for individuals with high-level SCI in relation to cognitive impairment.

Research shows that more than 60% of individuals with high-level SCI have a TBI. However, TBI is undiagnosed in more than 50% of individuals with high SCI. A TBI is more likely to be diagnosed if SCI was via MVA and less likely to be diagnosed if not.

Assumptions

Current research does not support the assumption that clients with high-level SCI have unimpaired cognitive function.

Realize that your client may have undiagnosed cognitive deficits along with his or her SCI.

Difficulties with assessment

People with high-level SCI in the acute care setting are difficult to assess. The biggest factors impeding interaction and successful assessment are lack of motor control and an inability to verbally communicate. This means that assessments for this population may need to be:

- Motor-free
- Non-verbal

Symptoms of cognitive impairment may be missed

Clinicians may misinterpret cognitive impairment as:

- Noncompliance
- Maladaptive reactions to SCI
- Low motivation
- Depression
- Denial
- Personality disorder
- ICU psychosis

Cognitive impairment should be ruled out before labeling behavior as purposeful.

Exhibition of cognitive impairment

There is evidence showing that individuals with high-level SCI and cognitive impairment are more likely to exhibit slowed processing speed as opposed to other symptoms.

However, generalized cognitive impairment as caused by a comorbid status is not uncommon. Undiagnosed TBI is more likely to be mild than moderate or severe.

Connecting high-level SCI to cognitive impairment

High-level SCI is correlated with conditions that cause cognitive impairment. Unfortunately, cognitive impairment is often left undiagnosed in acute care settings. Efforts should be made to identify cognitive impairment in this population as early as possible to promote development of appropriate intervention strategies and to maximize effectiveness of care.

Comorbidities

There are several common comorbidities that negatively impact cognitive function:

- Orthostatic Hypotension
- Sleep Apnea
- Traumatic Brain Injury

Undiagnosed cognitive impairment is common:

Do not assume a client with high-level SCI does not have cognitive impairment

Things to be aware of:

- Common comorbidities can impact cognitive function
- MVA vs. non-MVA?
  Non-MVA Injury more likely to have undiagnosed cognitive impairment
- Behavior
  Atypical, disruptive, or non-compliant behavior? It may be cognitive impairment.
Effectiveness Survey

How satisfied were you with the quality of this presentation?

Least 1 2 3 4 5 Most

How much did the presented material increase your knowledge of cognitive impairment in relation to high SCI?

Least 1 2 3 4 5 Most

How likely are you to change your practice behaviors based on the information presented?

Least 1 2 3 4 5 Most

Do you feel undiagnosed cognitive impairment in individuals with high SCI has a significant negative impact on overall client outcomes?

Least 1 2 3 4 5 Most

Do you feel cognitive impairment among individuals with high SCI is left undiagnosed to a significant degree in acute care at Harborview?

Least 1 2 3 4 5 Most

Additional comments:
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