Executive Summary

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Forward

The Evidence-Based Review of moderate to severe Acquired Brain Injury (ERABI) is a joint project involving researchers in London, Ottawa and Toronto, Ontario, Canada with a mandate to develop an evidence-based review of the literature for rehabilitation or rehabilitation-related interventions for ABI. The underlying principle of the ERABI was to improve the quantity of ABI rehabilitation in the province of Ontario by synthesizing the current literature into a format utilizable by front-line clinicians and laying the foundation for effective knowledge transfer to improve programs and services.

The ERABI was designed to accomplish two objectives: 1) Identify the priority areas in rehabilitation for which strong evidence for effectiveness is lacking and therefore require further research; 2) Identify those areas where the research evidence is strong and should be transferred quickly and effectively to improve ABI programs and services.

It is now hoped that this project will produce:

1) An indispensable and authoritative guide for the evaluation and development of programs and services.
2) A credible mechanism for setting the research agenda.
3) A source of education products for consumers, caregivers and service providers.
4) A major stimulus for partnerships among consumer agencies, health care facilities, charitable organizations and research centres.
5) An excellent platform for increasing research capacity.

The ERABI is the result as enormous amount of work and dedication. In total over the course of the last 8 years we have reviewed thousands of titles. Selected and abstracts underwent a careful assessment by two members of the study team. 772 articles were carefully analyzed and summarized for this current edition of the ERABI.

This project was a true joint effort on the part of three academic centres. Many individuals participated and are acknowledged in the following pages.

Acknowledgments

An Evidence-Based Review of Rehabilitation of moderate to severe Acquired Brain Injuries is a tremendous undertaking requiring the work of many people from three different centers (London, Toronto and Ottawa).

We would like to thank the important contribution made by the Parkwood ABI team who assisted with the review of the references and abstracts and helped with editing. In particular, we would like to thank **Penny Welch-West, Connie Ferri, Leanne Togher and Margaret Weiser.** The team here at Parkwood continues to contribute their time and knowledge with each new addition.

We would like to thank all who contributed.

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Summary

The Evidence-Based Review of moderate to severe Acquired Brain Injury (ERABI) was designed to develop an evidence-based review of the literature for rehabilitation interventions for ABI. We reviewed research evidence of direct relevance and material benefit to clinicians and researchers in the rehabilitation of moderate to severe ABI patients. From this review, we developed a mechanism for continued collection and dissemination of research and information about ABI rehabilitation.

The aim of the ERABI was to:

- Be an up-to-date review of the current evidence in ABI rehabilitation.
- Provide a comprehensive and accessible review to facilitate best-practice
- Provide specific conclusions based on evidence that could be used by clinicians to help direct the care of ABI patients at the bedside and at home.

Methods

Step 1: Initially 2 individuals independently reviewed 13,640 References to determine which ones need to be abstracted. For the present update 2500 titles were reviewed. In total over the past 8 years 30,000 titles have been reviewed and considered for inclusion.

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Step 2: Initially two individuals independently reviewed 1,700 abstracts to determine which articles needed the full review. Since the project has begun and additional 7000 abstracts have been reviewed for possible inclusion.

↓

Step 3: 765 articles were selected for careful data abstraction and determination of study quality using the Downs and Black and PEDro evaluation tools. Of these 247 were RCTs, with 178 being specific to rehabilitation while 69 dealt with acute interventions. All RCTs were also evaluated using the PEDro assessment tool.

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Step 4: All information was summarized by topic and presented in table format.

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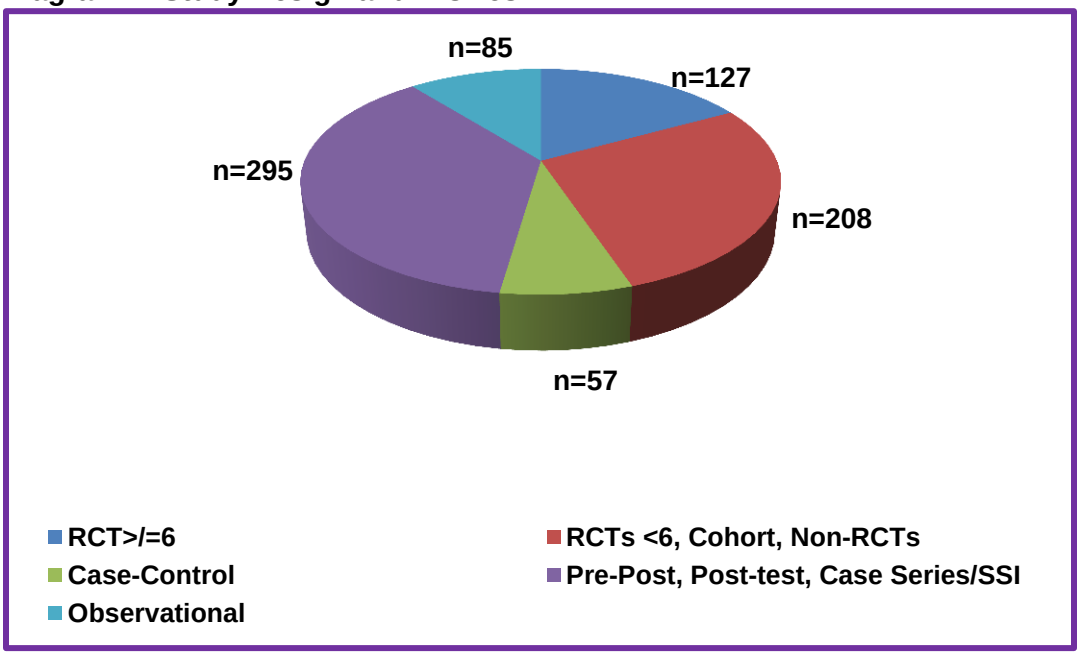
Step 5: Text was built around the Tables and the Levels of Evidence.

Diagram 1: Study Design and N sizes



Article Selection and Evaluation
Literature Search Strategy

An extensive literature search using multiple databases (CINHAHL, EMBASE, MEDLINE, Web of Science and PsycINFO) covering the years 1980 – 2012 was used to identify all published literature which evaluated the effectiveness of any treatment or intervention related to acquired brain injury. For Chapters 8 and 13 (Mental Health Issues Post ABI and Community Reintegration) databases such as ERIC, Family and Society Studies Worldwide and Social Work Abstracts were also searched. Both prospective and retrospective studies were considered, as were studies that used either experimental (randomized trials) or non-experimental designs (non-randomized trials, cohort studies, case control studies, case series). Studies cited in review articles, meta-analyses, systematic reviews, or in selected study articles but not identified through the original literature search were also included. Unpublished data or studies were not included. Reference Manager 12.0 ® was used for database management.

Specific subject headings related to acquire brain injury were used as the search terms for each database. These search terms were selected with the assistance of a medical staff librarian. Using a specific database's subject heading allowed for all other terms in the database's subject heading hierarchy related to acquired brain injury to also be included in order to broaden the search. The database subject headings used for CINHAHL were "brain injuries" and "head injuries", for EMBASE "brain injury" and "head injury" were used, for MEDLINE "brain injuries" and "craniocerebral trauma" were used, and finally for PsycINFO "brain injuries" and

"traumatic brain injury" were used as search terms.

The search strategy for **Module 3: Efficacy and Models of Care Following an Acquired Brain Injury** included a background information was identified using general internet searches, popular media links, and searches within key ABI websites. MEDLINE, CINAHL, EMBASE and PsycINFO were searched for combinations of "head injury" or "brain injury" and "rehabilitation", "outpatient", "inpatient", "models", "systems", "pre-hospital", "acute", and "therapy". Reviews and summary papers were targeted for references. Key authors were then identified and searched using MEDLINE.

The current update of **Module 4: Sensory and Motor Impairments post ABI,** paired the each word or word phrase brain injury, brain injured, closed head injury, with each: oculomotor rehabilitation, visual dysfunction, optometric rehabilitation, vision rehabilitation, vestibular dysfunction, vestibular rehabilitation, vertigo, balance problems, constraint induced movement therapy, splinting, fine motor, serial casting, orthosis, botulinum toxin, baclofen, tizanidine, electrical stimulation, exercise and aerobic training.

Searches conducted in ERIC included subject headings such as "head injury" and "behavioral interventions", "music therapy", and "multi-interventional therapy" ;"traumatic brain injury" and each of the previously mentioned heading; brain injuries and rehabilitation, "traumatic brain injuries", "acquired brain injuries", "brain injuries" and "behavioral interventions"; and "brain injuries" and "behavioral issues". A search of specific journals (Behavior Modification, Behavior Research and Therapy, Behavior therapy, Journal of Applied Behavior Analysis, Behavior Analyst and The Psychological Record) found in PsycINFO was also conducted. For the searches conducted in Family and Society Studies Worldwide and Social Work Abstracts the following search terms were used: "community reintegration", "community participation", "community rehabilitation", "community re-engagement" and "community engagement" in combination with the following: "head injury", "brain injury", "brain impaired", "brain injured", brain lesioned", "traumatic brain injury" and "acquired brain injury". We limited our search to studies dealing with rehabilitation and therapy.

For our **Module 5 - Dysphagia & Nutritional Interventions for Patients with Acquired Brain Injuries** – we not only searched the four main databases but we also searched the grey literature (dysphagia websites, various texts written by Jerri Logemann and others) to broaden our scope of the literature available. This also allowed us to examine and include the various treatments available even though many of these have not yet been tested specifically within the ABI population. In this current (2012) edition the importance of oral

hygiene post ABI was added to the dysphagia subsection of the module.

For this edition a decision was made to "*revamp*" **Module 6: Cognition Interventions Post ABI**. In an effort to clarify the information presented a reorganization of the material was needed. The chapter is now organized into 4 main sections: Remediation of Attention, Concentration & Information Processing Speed, Remediation of Learning and Memory Deficits, Remediation of Executive and General Cognitive Functioning, and Pharmacological Interventions to Assist with Cognitive Recovery Post ABI. The following search terms brain injury, brain injured, and closed head injury were matched with the following: donepezil, amantadine, pramiracetam, physostigmine, methylphenidate, bromocriptine, cerebrolysin, dual-task training, reaction time, attention retraining, attention deficits, attentional deficits, attention process training, external aids, memory, memory aid, memory training, memory retraining, memory therapy, memory rehabilitation, cognitive therapy, memory remediation, electronic aid, training intervention, learning, memory impaired, memory strategies, electrical stimulation, group therapy, group rehabilitation, goal management, cognitive rehabilitation, computer training, computer rehabilitation, and virtual reality

For **Module 7: Communication Deficits Following Acquired Brain Injury-Intervention and Treatments**, we focused only on RCTs published between 1992 and 2012. The process for module 7 is a detour from the other chapters and it was done to focus on the newest technology available to individuals who have sustained an ABI. With technology changing the study authors felt it best to look at what is available and not the techniques or methods that are not longer used. engaged in an expanded search of the literature using the subject headings in the chapter and the following: social communication (discourse, pragmatics, social communication/social cognition, social perception, self regulation and ABI, TBI or BI; verbal expression (word finding, word retrieval, naming, language formulation, verbal expression, sentence formulation) and ABI, TBI or BI; auditory or listening comprehension (auditory and listening comprehension, receptive language, inference and figurative language); reading comprehension (visual processing, and oral reading) and ABI, TBI and BI; written expression (discourse and formulation) and community and family communication, academic and academic supports and vocational communication and ABI, TBI and BI. This allowed us to capture all of the published materials available.

To allow a more thorough search for **Module 8: Mental Health Issues Post ABI** specifically for the treatment of challenging behaviors, affective disorders and substance addiction post ABI, terms such as "behavior modification', "modification, behavior", "conditioning therapy", "therapy, behavior" paired with "traumatic

brain injury", "acquired brain injury' and "brain injury" was conducted. To assist us in broadening our search of substance addiction post ABI were included the terms alcohol, substance abuse, drug abuse with brain injury, head injured, head injury and brain injured. We looked at the pharmacological treatments and non pharmacological treatments for behavioural and mental health issues that may arise as a result of the injury. Along with the five databases used in all the searches, a search through very specific journals such as: Journal of Rational Emotive Cognitive Behavior Therapy, Journal of Behavior Therapy Experiment Psychiatry, Journal of Applied Behavior Analysis, Behavior Modification, and Journal of Positive Behavior Intervention was also conducted. We limited our search to studies dealing with rehabilitation and therapy.

For **Module 9 Neuroendocrine Disorders Following Acquired Brain** Injury we used the following terms to guide in our search: incidence and prevalence of endocrine issues post ABI/TBI; laboratory testing used to diagnosis the disorders; physiological deficits such as posterior and anterior pituitary dysfunction; and treatments available. We conducted this search by using the 4 main databases and various other medical texts available to us.

To broaden our search for pediatric materials (especially materials looking at communication deficits in the pediatric population) we included the database Child Development and Adolescent Studies. Here "brain injury was paired with "communication", "speech", "language", and finally "cognitive-communication".

For **Module 15: Fatigue and Sleep Disorders post TBI** search strategies included: searching the following databases PubMed, CINAHL. EMBASE, PsycINFO using the following subject headings: fatigue or sleep disorders were paired with brain injury, head injuries, acquired brain injury and traumatic brain injury.

Module 18 Aging and Traumatic Brain Injury looks at the impact a TBI or ABI has on the elderly population. To assist us in finding the most recent literature looking at the impact a brain injury has on those over the age of 60, the following search terms were used: brain injury, traumatic brain injury, brain injured, head injured, and head injury. To allow for a thorough search the following on-line databases were used: Medline, EMBASE, CINAHL, Web of Science and PsycINFO.

A similar search was completed using the same databases for **Module 19, Traumatic Brain Injury and Animal Research**. For this search the same search terms were used coupled with animal (rats, mice, dogs, cats, etc), animal model and neuroprotec

Journals of specific importance to the project include: The Journal of Head Trauma, Brain Injury, Archives of Physical Medicine and

Rehabilitation, Neuropsychology, The Clinical Neurophysiologist, Neurorehabilitation and Stroke.

Study Inclusion Criteria

Every effort was made to identify all relevant articles that evaluated any rehabilitation intervention, which assessed any outcome measure during any timeframe within the recovery period following brain injury. Two independent reviewers (including one of the primary authors) evaluated all reference titles obtained from the various databases or from other sources. Any reference title that appeared to involve ABI and a treatment was selected. To determine if studies me the criteria for full review, all abstracts selected were by reviewed by 2 individuals (including one of the primary authors of the ERABI) working independently.

Studies where at least 50% of the population included patients with ABI and which involved the evaluation of a treatment with measurable outcomes were selected. Studies underwent full review only when 2 independent reviewers agreed that a study met the 2 inclusion criteria stated above based on the information available in the article's abstract. A third independent reviewer settled any discrepancy that arouse. Case studies with very small sample sizes were also chosen if no other studies could be found in a particular area. However, these studies were not scored.

Data Extraction

Once an article was selected for full review, the following data was extracted: authors, place and date of publication, inclusion and exclusion criteria, sample sizes, details regarding the population studied (i.e. type of injury, severity, source, sex, age, time since injury), treatment, outcome measures, and results. Articles which did not meet our definition of ABI or which did not fall under the moderate to severe range of injury severity were excluded. This data was summarized using large tables. Articles evaluating similar treatments were grouped together. The second part of the process included the assignment of a quality rating score.

Methodological Quality Assessments of RCTs

For randomized controlled trials the Physiotherapy Evidence Database (PEDro) rating scale developed by the Centre for Evidence-Based Physiotherapy (CEBP) in Australia was used (Moseley et al., 2002). (see Table 1)

http://www.pedro.fhs.usyd.edu.au/FAQs/Scale/scaleitems.htm

Studies which used a non-experimental or uncontrolled design (non-randomized comparative trials, cohort studies, or retrospective trials) cannot be evaluated using the PEDro scale. The PEDro Scale consists of 10 quality ratings each receiving either yes or no score.

Table 1: PEDro Scale
1. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received).
2. Allocation was concealed
3. The groups were similar at baseline regarding the most important prognostic indicators
4. There was blinding of all subjects
5. There was blinding of all therapist who administered the therapy
6. There was blinding of all assessors who measured at least one key outcome
7. Adequacy of follow-up *
8. Intention to treat
9. The results of between-group statistical comparisons are reported for at least one key outcome.
10. The study provides both point measures and measures of variability for at least one key outcome.

(*) For the purposes of this review, follow-up was considered adequate if all the subjects that had been originally randomized could be accounted for at the end of the study period.

The maximum score a study could receive was 10. Whenever rating discrepancies occurred, the 2 reviewers reached consensus or a third independent reviewer evaluated the study to settle any disagreements.

Methodological Quality Assessments of Non-RCTs

Since non-experimental studies were also included in our review, we also used a process by which to evaluate the methodological quality of this less rigorous form of evidence

There are many forms of non-experimentally designed study types, collectively referred to as observational designs that were included in this review. These include controlled before-and-after studies, cohort studies, case control studies, and case series or single intervention group studies.

The tool selected for the evaluation of these studies was created by Downs and Black (1998). This tool was identified in a review by the Health Technology Group (Deeks et al., 2003) as one of the most appropriate for the evaluation of non-RCTs in systematic reviews.

The tool had to be adapted slightly for use in this review. Specifically, question 27 dealing with power was omitted due to a lack of clarity in the question which could not be resolved adequately even through consultation with a biostatistician or through contact with the authors.

The Downs and Black scale consists of 27 quality ratings divided into the following sections: reporting, external validity, internal validity-bias, internal validity-confounding (selection bias), and power.

Table 2: The Downs and Black Scale (1998)

Reporting

1. Is the hypothesis/aim/objective of the study clearly described?
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?
3. Are the characteristics of the patients included in the study clearly described?
4. Are the interventions of interest clearly described?
5. Are the distributions of principal confounders each group of subjects to be compared clearly described?
6. Are the main findings of the study clearly described?
7. Does the study provide estimates of the random variability in the data for the main outcomes?
8. Have all the important adverse events that may be a consequence of the intervention been reported?
9. Have the characteristics of patients lost to follow-up been described?
10. Have actual probability values been reported (e.g. 0.035 rather than <0.05) for the main outcomes except where the probability values is less than 0.001?

External Validity

11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?
12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?
13. Were the staff, places, and faculties where the patients were treated, representative of the treatment the majority of patients receive?

Internal Validity-bias

14. Was an attempt made to blind study subjects to the intervention they have received?
15. Was an attempt made to blind those measuring the main outcomes of the intervention?
16. If any of the results of the study were based on “data dredging”, was this made clear?
17. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?
18. Were the statistical tests used to assess the main outcomes appropriate?
19. Was compliance with the intervention/s reliable?
20. Were the main outcome measures used accurate (valid and reliable)?

Internal validity – confounding (selection bias)

21. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?
22. Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?
23. Were study subjects randomized to intervention groups?
24. Was the randomized intervention assignment concealed from both patients and health care until recruitment was complete and irrevocable?
25. Was there adequate adjustment for confounding in the analyses form which the main findings were drawn?

26. Were losses of patients to follow-up taken into account?
Power 27. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?

The maximum score a study could receive on the D&B scale was 28.
Whenever rating discrepancies occurred, the 2 reviewers reached consensus or a third independent reviewers evaluated the study to settle any disagreements.

Determining Levels of Evidence

Interpreting the Results of Individual Studies
For RCTs, studies scoring 9-10 on the PEDro scale were considered methodologically to be of "excellent" quality. Studies with PEDro scores ranging from 6-8 were considered to be of "good" quality, while studies scoring between 4-5 were of "fair" quality. Studies that scored below 4 were felt to be of "poor" quality. The authors arrived at these descriptive terms of quality assessment arbitrarily in an effort to simplify the interpretation of results. As mentioned previously, studies employing a non-experimental or uncontrolled design were considered an inferior form of evidence. They were used to formulate conclusions only in the absence of RCTs.

Formulating Conclusions Based on Levels of Evidence
The Levels of evidence used to summarize the findings are based on the modified Sackett criteria. The following definitions of evidence were used: (see Table 3)

Table 3: Modified Sackett Scale

Level 1:	Randomized controlled trial, PEDro score ≥ 6. Includes within subjects comparison with randomized conditions and cross-over designs.
Level 2:	Randomized controlled trial, PEDro score < 6, Non-RCTS and Cohort studies (using at least 2 similar groups with one exposed to a particular condition).
Level 3:	**Case-Control:** A retrospective study comparing conditions, including historical controls.
Level 4:	**Case Series, Pre-Post or Post-Study: Retrospective chart review:** A prospective trial with a baseline measure, intervention, and a post-test using a single group of subjects or a prospective post-test with two or more groups – intervention, then post-test using a single group of subjects.
Level 5:	**Observational, Case Report or Clinical Concensus:** Studies using cross-sectional analysis to interpret relations, Pre-post or case studies (n=1), Expert opinion without explicit critical appraisal, or based on physiology, biomechanics or "first principles"
Conflicting:	In the absence of evidence, agreement by a group of experts on the appropriate treatment course. Consensus opinion is regarded as the lowest form of evidence. As such, it is arguably not considered evidence at all. Disagreement between the findings of at least 2 RCTs or where RCTs are not available between two non-RCTs. Where there are more

	than 4 RCTs and the results of only one was conflicting, the conclusion was based on the results of the majority of the studies, unless the study with conflicting results was of higher quality.

The following brief summaries highlight the information provided in the ERABI and provide conclusions regarding treatments involved in Acquired Brain Injury rehabilitation.

Efficacy and Models of Care Following an Acquired Brain Injury

Acute Management

There is Level 2 evidence that patients cared for in a Level I trauma center achieve better outcomes than patients cared for in a Level II center (Dubose et al., 2008).

There is Level 2 evidence that staff with more dedicated commitment to trauma care leads to better patient outcomes (Harris et al., 2008).

There is Level 2 evidence suggesting that a reduction in the time spent in acute care and in a rehabilitation facility does not have a negative impact on overall patient outcomes (Hawkins et al., 2005).

There is Level 4 evidence indicating the overall cost of care is higher for those who sustain a severe TBI versus those who sustain a moderate TBI (McGarry et al., 2002).

There is Level 4 evidence that adherence to BTF guidelines for acute care results in improved outcomes and decreased mortality (Bulger et al., 2002; Fakhry et al., 2004; Palmer et al., 2001).

Inpatient Rehabilitation (Timing and Intensity)

Improved Functional Outcomes

There is Level 4 evidence that inpatient rehabilitation improves self-care and mobility (Sahgal & Heinemann, 1989)

Based on the findings from two case series, there is Level 4 evidence that inpatient rehabilitation significantly improves functional outcome, as measured by the FIM (Whitlock, Jr. & Hamilton, 1995; Gray & Burnham, 2000; Schlageter et al., 1993).

There is Level 4 evidence that over a quarter of patients admitted to inpatient rehabilitation experience good outcome or moderate disability six months post-injury, as measured by the GOS (Whitlock, Jr., 1992)

There is Level 2 evidence that readmission to inpatient rehabilitation at more than twelve months post-injury is related to statistically significant improvement on the BI at discharge for over 50% of patients (Tuel et al., 1992).

Intensity of Inpatient Rehabilitation

Based on the findings from a single RCT, there is Level 1 evidence that increasing rehabilitation intensity reduces length of stay (Shiel et al., 2001).

Based on the findings from a single RCT, there is Level 1 evidence that intensive rehabilitation improves functional outcome, as measured by FIM and GOS scores, at two and three months post-injury, but not necessarily at six months and beyond (Zhu et al., 2001).

There is Level 2 evidence that multidisciplinary inpatient rehabilitation seems to be more effective than a single discipline approach (Semlyen et al., 1998).

There is Level 2 evidence that therapy intensity predicts motor functioning, but not cognitive gain (Cifu et al., 2003).

There is a reciprocal relationship between cognitive function and community integration (Cicerone et al., 2004)..

There is Level 4 evidence that patients with a long length of stay who receive high-intensity rehabilitation fair better on the Rancho Los Amigos Scale at discharge than those who receive low-intensity rehabilitation (Spivack et al., 1992).

There is Level 4 evidence that earlier time from injury onset to rehabilitation admission results in improved functional outcomes (Tepas, III et al., 2009).

Timing of Rehabilitation
Based on the findings from several studies, there is Level 2 evidence that early rehabilitation is associated with better outcomes (Edwards, McNeil, & Greenwood, 2003; Wagner et al., 2003; Mackay, Bernstein, Chapman, Morgan, & Milazzo, 1992; Sandhaug et al., 2010; Tepas, III et al., 2009; High Jr. et al., 2006) such as: shorter comas and lengths of stay, higher cognitive Levels at discharge, better FIM scores, and a greater likelihood of discharge to home.

Factors Affecting the Timing of Inpatient Care

Etiology and Inpatient Rehabilitation

There is Level 3 evidence that inpatient brain injury rehabilitation results in significantly greater gains in total FIM change, self-care, and social cognition for patients with TBI than patients with brain tumors (O'Dell et al., 1998). However, there are no statistically significant differences between the two groups regarding FIM efficiency and length of stay.

Age and Inpatient Rehabilitation
There is Level 3 evidence that inpatient rehabilitation results in a higher rate of change on functional measures in patients aged 18-54 than patients aged 55 years or older (Cifu et al., 1996).

Occupation and Inpatient Rehabilitation
Based on the findings of one case series, there is Level 4 evidence that inpatient rehabilitation results in successful return to work and return to duty for the majority of military service members (Braverman et al., 1999)

Transitional Living Setting and Inpatient Rehabilitation
There is Level 2 evidence that a transitional living setting during the last weeks of inpatient rehabilitation results in greater independence in activities of daily living than inpatient rehabilitation alone (McLaughlin & Peters, 1993).

Outpatient Rehabilitation
There is Level 1 evidence that a fitness center-based program is not better than a home-based program for improving cardio-respiratory fitness (Ownsworth et al., 2008;

Powell et al., 2002; Hassett et al., 2009).

There is Level 3 evidence that multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge (Willer et al., 1999).

There is Level 2 evidence that varied outpatient therapy can be used to improve varied targeted outcomes (Ponsford et al., 2006; Cusick et al., 2003).

There is Level 2 evidence that behavioural and cognitive skills post ABI can be improved by participating in neurorehabilitation or neurobehavioural programs (Braunling-Mcmorrow et al., 2010).

Community Rehabilitation

There is Level 1 evidence that structured multidisciplinary rehabilitation in community setting can improve social functioning (Powell et al., 2002).

There is Level 4 evidence that community-based social and behavioural rehabilitation of at least six months results in greater independence, higher social activity levels, and less need for care support (Wood et al., 1999).

There is Level 4 evidence that patients with a dual-diagnosis of TBI and substance abuse who participate in a community-based treatment program generally do not become chemical-free. This is due to both an inability to keep them in the program for the six-month period desired and the failure of clients to follow recommendations for additional rehabilitation or psychiatric treatment at discharge (Blackerby & Baumgarten, 1990).

There is Level 2 evidence from one RCT that direct patient involvement in neurorehabilitation goal setting results in a significant improvement in obtaining goals from pre-test to post-test that are then maintained at a follow-up of two months (Webb & Glueckauf, 1994).

Based on the findings from two pre-post studies, there is Level 4 evidence that participation in a comprehensive day treatment program reduces impaired self-awareness and distress. It also improves societal participation at one-year follow-up (Malec, 2001; Malec & Moessner, 2000).

There is Level 2 evidence suggesting rehabilitation issues regarding communication and employment are present years post rehabilitation (Klonoff et al., 2006; Olver, Ponsford, & Curran, 1996).

Vocational Rehabilitation

There is Level 4 evidence that vocational rehabilitation results in greater total taxpayer benefits than either total program operational costs or government costs (Abrams et al., 1993).

There is Level 4 evidence that after vocational rehabilitation the majority of subjects have fair or good adjusted outcome, while more than half become gainfully employed or

full-time students (Klonoff et al., 1998).

There is Level 4 evidence that individuals with the most significant cognitive impairments benefit the most from vocational rehabilitation services (Johnstone et al., 1999).

There is Level 4 evidence that individuals with severe head injury do benefit from supported employment services (Wehman et al., 1989).

Supported Employment
There is Level 3 evidence from one case control study and Level 4 evidence from one case series that supported employment improves the Level of competitive employment outcomes particularly for ABI survivors who are older, have more education, have no prior work experience or who have suffered more severe injuries (Wehman et al., 1989a; Gamble & Moore, 2003).

Support Groups
Based on three non-RCT studies, there is Level 4 evidence that support groups generate positive results such as improving feelings of hopelessness, coping with depression, and improving psychosocial functioning (Armengol, 1999; Hibbard et al., 2002; Ownsworth et al., 2000).

Complete Care Pathways
There is insufficient evidence to draw any conclusions regarding the ideal structure of a complete model of ABI care (Harradine et al., 2004; Mellick, et al., 2003; Khan et al., 2002).

Motor and Sensory Impairment Remediation Post Acquired Brain Injury

Constraint Induced Movement Therapy
There is Level 4 evidence for the effectiveness of modified constraint induced movement therapy in improving upper extremity use post ABI. (Page & Levine, 2003; Shaw et al., 2005)

Hand Splinting
There is Level 1 evidence based on a single RCT that nocturnal hand splinting does not improve range of motion, function or pain control post ABI (Lannin et al., 2003).

Fine Motor Control Interventions in ABI Patients.
Based on a single RCT, there is Level 1 evidence that functional fine motor control retraining activities results in improved fine motor coordination in addition to re-establishing life skills (Neistadt, 1994).

There is Level 2 evidence that visual feedback grip force training improved tracking and transfer performance (Kriz et al., 1995).

Use of Serial Casting to Manage Lower Extremity Spasticity

There is Level 1 evidence based on one small RCT that serial casting does induce transient increases in range of motion; however, these effects were noted for only one day post treatment (Moseley et al., 2008).

There is Level 2 evidence based on a single RCT that serial casting does reduce ankle plantar flexion contractures due to spasticity of cerebral origin (Moseley, 1997).

There is Level 3 evidence that short duration (1 to 4 days) serial casting has a significantly lower complication rate than longer duration (5 to 7 days) serial casting; however, there was no difference in range of motion outcome (Pohl et al., 2002).

Based on a single RCT there is Level 2 evidence that casting alone is as effective as casting and botulinum toxin injections for treating plantar flexion contractures due to spasticity of cerebral origin (Verplancke et al., 2005).

Treatment of Ankle Plantarflexion Contractures with Adjustable Orthosis

There is Level 4 evidence that a pre-fabricated, adjustable ankle foot orthosis does reduce ankle plantar flexion contractures due to spasticity of cerebral origin (Grissom & Blanton, 2001).

Botulinum Toxin Injections

There is Level 2 evidence based on one cohort study and Level 4 evidence from 3 studies that botulinum toxin type A injections may be effective in the management of localized spasticity following ABI (van Rhijn et al., 2005; Fock et al., 2004; Yablon et al., 1996; Ashford & Turner-Stokes, 2009).

There is Level 1 evidence from one RCT that botulinum toxin type A injections reduce spasticity, regardless of the method of drug administration (Mayer et al., 2008).

Percutaneous Phenol Block to Reduce Spasticity

There is Level 4 evidence that phenol nerve blocks reduce contractures and spasticity at the elbow, wrist and finger flexors for up to 5 months post injection (Keenan et al., 1990; Garland et al., 1984).

Electrical Stimulation to Reduce Spasticity

There is Level 4 evidence that electrical stimulation is effective for decreasing lower extremity spasticity for up to 24 hours (Seib et al., 1994).

Effect of Oral Anti-Spasticity Agents

Based on a single RCT, there is Level 1 evidence that Tizanidine improves lower and upper extremity spasticity compared to a placebo (Meythaler et al., 2001).

There is Level 4 evidence that Baclofen improves lower extremity spasticity but not upper extremity spasticity (Meythaler et al., 2004).

Effect of Intrathecal Baclofen on Spasticity

Based on a single RCT, there is Level 1 evidence that bolus intrathecal baclofen injections produce short-term (up to 6 hours) reductions in upper and lower extremity spasticity (Meythaler et al., 1996).

There is Level 4 evidence to suggest that prolonged intrathecal baclofen results in longer-term (3 months, and

1 year) reductions in spasticity in both the upper and lower extremities following an ABI (Becker et al., 1997; Meythaler et al., 1999; Meythaler et al., 1999; Meythaler et al., 1997; Stokic et al., 2005; Dario et al., 2002; Francois et al., 2001; Francisco et al., 2005).
Based on a single study, there is Level 4 evidence to suggest that intrathecal baclofen results in short-term improvements in walking performance, particularly gait velocity, stride length, and step width (Horn et al., 2005).

Exercise Interventions Post ABI

Partial Body Weight Supported Gait Training Post ABI
Based on two RCTs, there is Level 1 evidence that partial body weight supported gait training does not provide any added benefit over conventional gait training in ambulation, mobility or balance (Wilson et al., 2006; Brown et al., 2005).

Directed Therapy at Specific Deficits
There is Level 1 evidence based on a single RCT that specific sit-to-stand training results in improved abilities (Canning et al., 2003).

There is Level 2 evidence that reach training with an embedded intervention is more effective than a traditional reaching exercise program (Sietsema et al., 1993).

There is Level 2 evidence that a specific balance and coordination training program is significantly more effective for improving balance and coordination compared to a traditional muscular training program (Dault & Dugas, 2002)

There is Level 2 evidence that a virtual reality based balance retraining program is as effective at improving balance through a conventional balance retraining program (Sveistrup et al., 2003).

Effects of Aerobic Training to Influence Aerobic Capacity Post ABI
Based on a single RCT, there is Level 1 evidence that aerobic exercise improves aerobic capacity following ABI (Bateman et al., 2001).

Exercise to Improve Health Promotion and Self-Esteem post-ABI
Based on the findings of two small RCTs, there is Level 1 evidence that participation in an exercise program improves health promotion and self-esteem post-ABI (Blake & Batson, 2009; Driver et al., 2006).

Visual Dysfunctions

There is Level 1 evidence to suggest the computer based restitution training is effective in improving the vision of those who sustain a TBI (Kasten et al., 2000; Kasten et al., 1998).

There is Level 4 evidence showing that base-in prisms and bi-nasal occluders are effective in treating ambient vision disturbances resulting from an ABI (Padula et al., 1994).

There is Level 4 evidence indicating the prismatic spectacle lenses is

effective in correcting vertical heterophoria in ABI patients with post-concussive symptoms (Doble et al., 2010).

There is Level 4 evidence that rehabilitation programs directed at improving visual function improves functional outcomes such as reading in patients post-ABI (Schlageter et al., 1993; Gianutsos et al., 1988; Williams, 1995; Ciuffreda et al., 2006).

Vestibular Dysfunction

There is Level 1 evidence suggesting that home based exercise programs do increase functional balance in children who have sustained an ABI or have been diagnosed with CP (Katz-Leurer et al., 2009; Katz-Leurer et al., 2008).

There is Level 4 evidence to support using a combined aerobic dancing, slide and step training program to reduce balance and coordination deficits post ABI (Dault & Dugas, 2002).

There is Level 4 evidence from one SSI, that habituation training was beneficial in reducing provoked vertigo following a severe TBI (Godbout, 1997).

There is Level 4 evidence that vestibular rehabilitation programs improve symptoms of vertigo in patients after a TBI (Gurr & Moffat, 2001).

Pain Post TBI

There is Level 4 evidence supporting the use of CBT to reduce post traumatic headaches in those who have sustained a mild to severe TBI (Gurr and Coetzer, 2005).

There is Level 2 evidence suggesting that biofeedback is effective in the treatment of post traumatic headaches (Tatrow et al, 2003; Ham and Packard 1996).

There is Level 1 evidence suggesting pregabalin is effective in reducing central neuropathic pain caused by injuries to the brain or spinal column (Vranken et al., 2008).

There is Level 2 evidence suggesting the use of cold packs is not as effective as manual therapy in reducing post traumatic headaches (Jensen et al., 1990).

There is Level 4 evidence suggesting oxycodone is effective in reducing pain following traumatic injuries including mild TBI (Franceschi et al., 2008)

Dysphagia & Nutritional Interventions for Patients with Acquired Brain Injuries

Dysphagia

The incidence/prevalence of dsyphagia following ABI

The incidence of dysphagia in patients entering rehabilitation post-ABI ranges from 25% to 78%. This incidence has been shown to vary depending on the definition of dysphagia used and the acuity of the patient at admission. An incidence of 42% to 65% in patients admitted to a TBI rehabilitation unit have been

observed in more recent studies (Winstein, 1983; Cherney & Halper, 1996; Field & Weiss, 1989; Halper et al., 1999; Mackay et al., 1999b; Schurr et al., 1999).

Incidence of Aspiration Post-ABI
The incidence of aspiration post-ABI occurs in approximately 30 to 50% of ABI patients with dysphagia, which represents 10-20% of rehabilitation admissions (Schurr et al., 1999; Mackay et al., 1999b; O'Neil-Pirozzi et al., 2003).

The incident of silent aspiration in ABI patients has not been well documented. Such cases may be missed in the absence of VMBS studies (Muller-Lissner et al., 1982; Terre & Mearin, 2009; Lazarus & Logemann, 1987).

Relationship Between Pneumonia and Dysphagia/Aspiration
The risk of developing pneumonia appears to be proportional to the severity of the aspiration.

There is Level 4 evidence indicating those with a lower GCS, FIM and RLAS score are more likely develop pneumonia while being tube fed (Hansen et al., 2008)

Assessment of Dysphagia Post ABI
The risk of dysphagia related aspiration is proportional to the initial severity of head injury. A history of tracheostomy or mechanical ventilation may also be associated with increased risk of aspiration (Cherney & Halper, 1996; Mackay et al., 1999a; Mackay et al., 1999b; Morgan & Mackay, 1999).

Videofluoroscopic Modified Barium Swallow (VBMS) Studies
VBSM (or MBS) studies may be used as a tool to assist in dysphagia management and identification of aspiration in the ABI population.

Flexible Endoscopic Evaluation of Swallowing (FEES) using Stroke as a Model of Care
There is inconclusive evidence to suggest FEES is more sensitive than VMBS when assess patients for swallowing difficulties or aspiration post stroke. Further study needs to be done (Aviv et al., 2000; Leder & Espinosa, 2002).

Pulse Oximetry Using Stroke as a Model of Care
There is limited evidence supporting the use of pulse oximetry to detect aspiration in patients who have had a stroke (Collins & Bakheit, 1997; Sherman et al., 1999)

Oral Hygiene
There is Level 2 evidence supporing the need for good oral care post TBI (Zasler et al., 1993).

Management of Dysphagia using Stroke as a Model of Care
There is consensus opinion that acute patients should be NPO until swallowing ability has been determined (Heart and Stroke Foundation of Ontario, 2002).

There is consensus opinion that a trained assessor should screen all acute patients for swallowing difficulties as soon as they are able (Heart and Stroke Foundation of Ontario, 2002).

There is consensus opinion that a speech and language pathologist should assess all patients who fail swallowing screening and identify the appropriate course of treatment (Heart and Stroke Foundation of Ontario, 2002).

There is consensus opinion that an individual trained in low-risk feeding strategies should provide feeding assistance or supervision to patients where appropriate (Heart and Stroke Foundation of Ontario, 2002).

There is consensus opinion that a dietitian should assess the nutrition and hydration status of patients who fail the swallowing screening (Heart and Stroke Foundation of Ontario, 2002).

Feeding Strategies in Dysphagia
In stroke patients, there is Level 4 evidence that individuals with dysphagia should feed themselves to reduce the risk of aspiration (Heart and Stroke Foundation of Ontario, 2002). There are no such studies in ABI.

For stroke patients who require assistance to feed there is consensus opinion that low-risk feeding strategies by trained personnel should be employed (Heart and Stroke Foundation of Ontario, 2002). There are no such consensus statements made for ABI.

Nutrition

Incidence of Malnutrition
Two studies were found assessing malnutrition in brain injured patients; however, only one reported seeing signs of malnutrition in patients within the first two months post injury (French & Merriman, 1999; Krakau et al., 2007). The results of one study indicate the incidence of obesity was comparable to normal (French & Merriman, 1999)

Hypermetabolism Post ABI
Based on a series of studies, there is Level 4 evidence of a hypermetabolic state in the acute period following ABI. The extent of the response can be moderated by barbiturates (Clifton et al., 1984; Young et al., 1985; Robertson et al., 1984; Dempsey et al., 1985; Bruder et al.,1994; Weekes & Elia, 1996).

Routes of Nutrient Administration
There is Level 2 evidence suggesting enteral nutrition and parenteral nutrition is effective in providing an increase in calories to ABI patients (Meirelles and de-Aguilar-Nascimento, 2011).

There is conflicting data when looking at the nitrogen balance of ABI patients as to which method of feeding if most effective (Meirelles and de-Aguilar-Nascimento, 2011; Nataloni et al., 1999).

Based on a single RCT, there is Level 2 evidence that TPN can safely be administered without causing serum hypersomolality or influencing intracranial (ICP) pressure levels or ICP therapy in post-ABI patients Borzotta et al., 1994).

Based on one case-control study there is Level 3 evidence that parenteral nutrition is more costly

compared to enteral nutrition (Ott et al., 1999).

Enhanced Enteral Nutrition
There is Level 1 evidence based on a single RCT that enhanced enteral nutrition can reduce the incidence of infection, and reduce both the ventilator dependency period and ICU stay (Falcao & Aguilar-Nascimento, 2004).

Timing of Enteral Nutrition
There is Level 2 evidence suggesting that initiating enteral feeding at goal rate will increase the percentage of prescribed energy and protein actually received Minard et al., 2000; Taylor and Fettes 1998; Taylor et al., 1999).

Timing of Parenteral Nutrition
There is Level 2 evidence that early parenteral nutrition support of closed head-injury patients appears to modify immunologic function by increasing CD4 cells, CD4-CD8 ratios, and T-lymphocyte responsiveness to Con A (Sacks et al., 1995).

Types of Feeding Tubes
There is Level 1 evidence that the risk of developing pneumonia is higher among ventilated patients fed by a naso-gastric tube compared with a gastrostomy tube (Kostadima et al., 2005).

Metoclopramide and Enteral Nutrition
There is Level 1 evidence indicating that meoclopramide is not effective as an aid to gastric emptying (Nursal et al., 2007).

Zinc Supplementation
Based on a single RCT there is Level 1 evidence that zinc supplementation in ABI patients has a positive effect on neurological recovery as measured by the Glasgow Coma Scale (Young et al., 1996). However, no significant improvement in mortality rates could be attributed to zinc supplementation.

Growth Hormone
Based on a two RCTs, there is conflicting evidence the IGF-I is effective in enhancing growth hormone in those who have sustained a TBI (Behrman et al., 1995; Hatton et al., 2006).

Increased Nitrogen Feeds
Based on a single RCT, there is Level 2 evidence that high nitrogen feedings of approximately 2 g protein/kg are necessary to restore the substantial nitrogen loses that occur post-ABI (Twyman, 1997).

Branched-Chain Amino Acids
There is Level 2 evidence that supplementation of BCAAs in post-ABI patients enhances recovery of cognitive function, without negatively effecting tyrosine and tryptophan concentration (Aquilani et al., 2005).

Cognition Interventions Post ABI

Remediation of Attention, Concentration & Information Processing Speed

Drill & Practice

There is Level 2 evidence to suggest that specific structured training programs designed to improve attention are ineffective or at best equivocal in their effects on attention (Novack et al., 1996; Niemann et al., 1990; Park et al., 1999; Ponsford & Kinsella, 1988)

Dual Task Training
There is Level 2 evidence that dual task training has a positive effect on divided attention (Couillet et al., 2010)

There is Level 2 evidence that dual-task training is effective on the speed of processing (Fasottiet al., 2000)

There is Level 3 evidence that individuals with a TBI perform poorly on dual task activities due to their inability to maintain a measure of sustained attention (Dockree et al., 2006).

Reaction Time
There is Level 3 evidence that reaction times of those with TBI are slower than the reaction times of those without (Azouvi et al., 2004; Stuss et al., 1989).

Remediation of Learning and Memory Deficits

External Aids
There is Level 1 evidence supporting the use of active or high tech external aids (assistive technology) as an compensatory strategy for memory impairments. (Lemoncello et al., 2011; Shum et al.,2011; McDonald et al., 2011; Ownsworth & McFarland, 1999; Watanabe et al., 1998; Wilson et al., 2001; Wilson et al., 2005)

There is Level 2 evidence supporting the use of passive or no tech/low tech aids in improving memory impairments post ABI (Fish et al., 2007; Manasse et al., 2005; Wilson et al., 1997; Hart et al., 2002; Wright et al., 2001a; Wright et al., 2001b; Schmitter-Edgecombe et al., 1995; van den Broek et al., 2000)

Computer-Assisted Training
There is conflicting evidence supporting the use of computer assisted cognitive retraining as an adjunct to the rehabilitation program, especially regarding attentional retraining following brain injury. Although some improvement in memory was found in a few of the studies it was not found in all. General cognitive functioning did appear to benefit from computer assisted cognitive retraining; however, further study confirming these findings need to be conducted (Ruff et al., 1994; Middleton et al., 1991; Chen et al., 1997; Wood & Fussey, 1987; Gray et al., 1992; Kim et al., 2000; Tam & Man, 2004; Sohlberg et al., 2003; Dou et al., 2006)

Virtual Reality and Cognitive Functioning
There is Level 2 evidence of a positive impact on visual and verbal learning post exercise intervention for brain injury survivors (Grealy et al., 1999).

There is Level 3 evidence from one study indicating that VR programs do not enhance cognitive functioning

post TBI in individuals who have sustained a TBI (Zhang et al., 2001).

Internal Aids
There is Level 2 evidence (from several studies) that internal strategies appear to be an effective aid in improving recall performance (Potvin et al., 2011; Twum & Parente, 1994; Berg et al., 1991; Milders et al., 1995).

There is Level 3 evidence from several case-control studies that also suggest internal strategies appear to assist in improving recall performance (Constantinidou & Neils, 1995; Ewert et al., 1989; Goldstein et al., 1990; Milders et al., 1998; Tailby & Haslam, 2003).

Memory Programs

There is Level 2 evidence indicating that memory-retraining programs appear effective, particularly for functional recovery although performance on specific tests of memory may or may not change (Ryan & Ruff, 1988)..

There is Level 3 evidence supporting spaced retrieval practice as an effective method of improving memory post ABI (Sumowski et al., 2010).

There is Level 3 evidence suggesting that the spacing of repetitions improves memory post ABI (Hillary et al., 2003).

Cranial Electrotherapy Stimulation and Memory
There is Level 1 evidence, from one RCT, that cranial electrotherapy stimulation did not help to improve memory and recall following brain injury (Michals et al., 1993).

Remediation of Executive and General Cognitive Functioning

Group Interventions
There is conflicting evidence supporting the use of group-based interventions to treat executive dysfunction post ABI (Novakovic-Agopian et al., 2011; Ownsworth et al., 2000; Parente et al., 1999; Ownsworth et al., 2008; Amos, 2002; Finset et al., 1995).

Goal Management Training
There is Level 2 evidence to suggest that goals training is effective in improving attention and executive control (Levine et al., 2000).

There is Level 4 evidence, based on a single group intervention, that goal planning in the form of leisure activities is effective for achieving identified goals following injury (Walker et al., 2005).

Cognitive Rehabilitation Functioning
There is conflicting evidence as to the effectiveness of cognitive rehabilitation programs focusing on memory strategies and selective attention (Vas et al., 201; Dirette et al., 1999; Ruff et al., 1989; Salazar et al., 2000; Neistadt, 1992).

There is Level 2 evidence that general cognitive rehabilitation therapy post acquired brain injury is effective for improving cognition. Although there are variable strategies and protocols for cognitive rehabilitation, all comprehensive

interventions appear to provide some benefit (Rath et al., 2003; Cicerone et al., 2004)

There is Level 4 evidence that working memory training is effective in recovering the central executive system of working memory (Serino et al., 2007).

There is Level 4 evidence that an outpatient day program is effective for assisting brain injury survivors in returning to competitive employment (Ben Yishay et al., 1987).

Pharmacological Interventions to Assist with Cognitive Recovery Post ABI

Donepezil
Based on a single RCT, there is Level 1 evidence that Donepezil improves attention and short-term memory (Zhang et al., 2004).

Methylphenidate
Although several of the studies reviewed found methylphenidate did improve cognitive functioning post ABI, the results were conflicting. To date there is no clear evidence supporting the administration of methylphenidate in individuals who have a moderate to severe ABI (Kim et al., 2006; Plenger et al., 1996; Speech et al., 1993; Whyte et al., 2004).

Sertraline
There is Level 1 evidence showing that sertraline does not improve cognitive functioning in individuals who have sustained a moderate to severe ABI (Banos et al., 2010)

Amantadine
There is level 2 evidence that amantadine does not help to improve learning and memory deficits based on the conclusion of a single group intervention study (Kraus et al., 2005)

There is Level 2 evidence from one RCT that amantadine does not help to improve overall cognitive functioning based on the conclusions of a single RCT (Schneider et al., 1999).

Pramiracetam
Based on a single RCT there is Level 1 evidence that pramiracetam produces significant clinical improvements on males' memory which is sustained at one month following discontinuation of the drug (McLean Jr. et al., 1991).

Physostigmine
Based on a single RCT, there is Level 1 evidence that physostigmine improves memory in men with brain injury (Cardenas et al., 1994)

There is Level 5 evidence, from one case study, that physostigmine combined with a memory training programme produces a clinically significant improvement in memory function, but does not produce significant changes in attention, concentration, cognitive flexibility or motor speed (McLean, Jr. et al., 1987)

Bromocriptine
Based on two RCTs there is conflicting evidence supporting bromocriptine to enhance cognitive

functioning (McDowell et al., 1998; Whyte et al., 2008).

There is Level 4 evidence that bromocriptine improves all motivational deficits except mood (Powell et al., 1996).

The Level 5 evidence, from one observational study that bromocriptine significantly improves memory impairments (Dobkin & Hanlon, 1993).

Cerebrolysin
There is Level 4 evidence that cerebrolysin, a neurotrophic and neuroprotective medication appears to have potential benefit to improve outcome and cognitive functioning post-brain injury; however, controlled trials will be necessary to evaluate this further (Alvarez et al., 2003).

Growth Hormone Replacement Therapy
There is Level 1 evidence suggesting rhGH does assist in cognitive
functioning in individuals who are GHD post ABI (High, Jr. et al., 2010).

There is Level 2 evidence showing the administration of rhGH does improve cognitive rehabilitation in those who have sustained a moderate to severe TBI (Reimunde et al., 2011).

Communication Deficits Following Acquired Brain Injury-Intervention and Treatment

Attention and Concentration

There is Level 2 evidence from a study suggesting specific structured training programs are not effective in improving attention post ABI. (Novack et al. 1996)

Results from several studies indicate there is Level 2 evidence that dual task training has a positive effect on divided attention and is effective on speed of processing (Couillet et al., 2010; Fasotti et al., 2009)

There is Level 1 evidence suggesting Attention Process Training (APT) improves cognitive function (Sohlberg et al., 2000).

Based on the results of an earlier study there is Level 2 evidence supporting the use of computer assisted technology to enhance concentration and attention post ABI. (Ruff & Bergquist, 1994)

Although TEACHware is no longer available, based on this one RCT, there is Level 2 evidence that this computer-based program designed to remediate cognitive-communication skills, improved cognitive and communication outcomes in individuals with ABI (Thomas-Stonell et al., 1994).

Based on the results of a study there is Level 2 evidence suggesting the use of a calendar did not improve patients' orientation to time and date. (Watanabe et al. 1998),

Verbal Memory and New Learning
There is Level 2 evidence supporting the use of electronic calendars to assist in improving memory post-ABI

(McDonald et al. 2011; Bergquist et al., 2009).

Results from a study show there is Level 2 evidence suggesting virtual reality exercise programs have a positive impact on learning and working memory. (Grealy et al. 1999)

There is Level 2 evidence suggesting memory group interventions can improve everyday memory functioning (Thickpenny-Davis & Barker-Collo, 2007).

There is Level 1 evidence, from one RCT, that cranial electrotherapy stimulation did not help to improve memory and recall following brain injury (Michaels et al., 1993).

Results from one RCT indicate there is Level 2 evidence suggesting general cognitive functioning does benefit from computer assisted cognitive retraining. Further study confirming these findings need to be conducted (Dou et al., 2006).

There is Level 2 evidence that internal memory strategies appear to be an effective aid in improving recall performance (Berg et al., 1991; Milders et al., 1995)

There is Level 2 evidence from one RCT to support the use of visual imagery techniques to improve prospective memory. (Potvin et al., 2011)

There is Level 1 evidence, based on one study suggesting that modeling techniques (patient mirroring target) are more effective then hand-over-hand moulding techniques. (Zlotowitz et al. 2010)

Verbal Expression and Discourse

There is Level 2 evidence from one RCT suggesting the LSVT and TRAD programs work equally well in improving the intelligibility and everyday communication of individuals with non-progressive dysarthria (Wenke et al., 2011).

Based on a single RCT there is Level 1 evidence that some patients with severe head injuries may improve their ability to communicate "yes/no" responses after undergoing consistent training and environmental enrichments. (Barreca et al. 2003)

Social Communication and Pragmatics

Results of the study conducted by Radice-Neumann et al. (2009) indicate there is Level 1 evidence from one RCT to show that social communication skills training improve communication skills.

There is Level 1 evidence from one RCT to suggest interventions designed to improve the ability to recognize emotional prosody were minimally effective (McDonald et al., 2012).

There is Level 2 evidence to show that pragmatic interventions including role-playing, improve a variety of social communication skills as well as self-concept and self-confidence in social communications. (Dahlberg et al., 2007)

Based on one there is Level 2 evidence that conversation group therapy has a beneficial effect on pragmatic and quality of life concerns in ABI patients. (Braden et al., 2010)

Reasoning, Problem Solving and Executive Function

There is Level 1 evidence to suggest sort term intensive training benefits gist-reasoning which benefits executive function post TBI (Vas et al., 2001).

There is Level 2 evidence from one study to suggest group treatment of problem solving deficits is effective in improving executive function, problem solving self-appraisal and self-appraised emotional self-regulation (Rath et al., 2003).

There is Level 2 evidence from one study suggesting a goals training group is effective in improving attention and executive control. (Chen et al., 2011)

There is conflicting evidence supporting the use of group-based interventions to treat executive dysfunction post ABI (Novakovic-Agopian et al.,2011; Parente et al., 1999; Ownsworth et al., 2008).

There is Level 2 evidence, based on a single RCT that goal management training is effective for improving paper and pencil everyday tasks and meal preparation skills for persons with an ABI. (Levine et al., 2000)

Training Communication Partners

There is Level 2 evidence to support the effectiveness of interventions that focus on training the communication partners of individuals with severe ABI (Togher et al., 2004).

There is Level 2 evidence supporting the training of paid caregivers to allow them to communicate more effectively with those who sustain an ABI; thus allowing those with ABI to improve their communication skills (Behn et al., 2012)

Pharmaceutical Treatments

The findings of one RCT suggest there some evidence to support the use of Methylphenidate to enhance cognitive function post ABI, although the findings were not significant (Kim et al., 2006).

Based on a single RCT, there is Level 1 evidence that Donepezil improves attention and short-term memory post ABI (Zhang et al., 2004).

Based on a two RCTs there is conflicting evidence supporting the use of Bromocriptine to enhance cognitive functioning (Whyte et al., 2008; McDowell et al., 1998).

There is Level 2 evidence that Amantadine does not help to improve learning and memory deficits based on the conclusions of one study (Schneider et al. 1999).

There is Level 1 evidence that Citicoline does not enhance functional or cognitive functioning in individuals who have sustained a TBI (Zafonte et al., 2012).

Mental Health Issues Post Acquired Brain Injury

Depression

Pharmacological Treatment for Depression

There is conflicting evidence that sertraline is effective in the treatment of major depression post TBI (Ashman et al., 2009; Lee et al., 2005; Fann et al., 2000).

There is Level 2 evidence that citalopram aids in the reduction of depression post ABI (Rapoport et al., 2008; Rapoport et al., 2010).

There is Level 4 evidence that citalopram and carbamazepine may be efficacious in the treatment of depression, anxiety and mood disorders (Perino et al., 2001).

There is Level 2 evidence to suggest that the administration of desipramine assists in improving mood and reducing depression (Wroblewski et al., 1996).

Non-Pharmacological Treatments for Depression

There is Level 2 evidence that both cognitive remediation and day treatment are associated with a decrease in depressed mood (Ruff & Niemann, 1990).

There is Level 4 evidence that persons with TBI who exercise have less depressed mood than person with TBI who do not exercise (Gordon et al., 1998).

There is Level 4 evidence that a mindfulness-based stress reduction program may be efficacious in reducing depressed mood (Bedard et al., 2003).

There is Level 4 evidence that thirty minutes of a weak complex (1MicroT) burst-firing magnetic field across the temporoparietal regions once per week for five weeks may be efficacious in the treatment of depression (Baker-Price & Persinger, 2003).

There is Level 3 evidence that music therapy does improve depression and anxiety post ABI (Thaut et al., 2009; Guetin et al., 2009).

There is Level 4 evidence that Systematic Motivational Counseling may reduce a negative affect (Cox et al., 2003).

There is Level 2 evidence that teaching coping skills to individuals post TBI helps to reduce their levels of anxiety and depression (Anson & Ponsford, 2006b; Anson & Ponsford, 2006a).

Non-Pharmacological Interventions for the Treatment of Anxiety Post ABI

There is Level 1 evidence from one RCT that Cognitive Behavioral Therapy does reduce anxiety post ABI (Hsieh et al.,2012; Hodgson et al., 2005).

There is Level 5 evidence from a case study that biofeedback-assisted relaxation training may be efficacious in alleviating anxiety-related symptoms (Holland et al., 1999).

Obsessive Compulsive Disorders (OCD) Post ABI
Although OCD has been Identified post ABI there does not appear to be a consistent method of treatment (Arco, 2008; Bilgic et al., 2004; Max et al., 1995; Childers et al., 1998).

Non-Pharmacological Interventions for Psychiatric Disorders Post ABI
There is Level 3 evidence that standard inpatient psychiatric treatment may be efficacious in decreasing psychiatric symptoms at discharge. However, patients without a history of TBI seem to improve more from inpatient psychiatric treatment than patients with a history of TBI (Burg et al., 2000).

Challenging Behaviours

Pharmacological Treatments for Agitation and Aggression

Amantadine
There is Level 2 evidence that Amantadine does not help to improve behaviour following brain injury (Schneider et al., 1999).

Anti-Convulsant Medication to Reduce Aggressive Behaviour
There is Level 4 evidence that Carbamazepine decrease the incidence of aggressive behaviours (Azouvi et al., 1999; Lewin & Sumners, 1992).

There is limited Level 5 evidence, from two case studies, to suggest that lamotrigine helps to reduce inappropriate behaviours post TBI. More research is needed, with a greater number of subjects, to validate these findings (Pachet et al., 2003; Chahine & Chemali, 2006).

There is Level 5 evidence that valproic acid decreases the incidence of aggressive behaviors (Wroblewski et al., 1997).

There is Level 4 evidence that divalproex decreases the incidence of aggressive behavior post TBI (Chatham Showalter & Kimmel, 2000).

Antidepressants to Reduce Aggressive Behaviour
There is Level 4 evidence that sertraline HCL and amitriptyline decrease the incidence of aggressive behaviors (Kant et al., 1998; Mysiw et al., 1988)

Beta Blockers used to Reduce Aggression Post ABI

Pindolol
There is Level 1 evidence that pindolol decreases aggression following brain injury (Greendyke & Kanter, 1986).

Propranolol
There is Level 1 evidence that propranolol may reduce agitated symptoms following brain injury (Greendyke et al., 1986; Brooke et al., 1992).

Buspirone
There is Level 5 evidence, from one case study, to suggest that buspirone may be effective for reducing symptoms of agitation following brain injury. More research is needed (Levine 1988).

Antipsychotics used to Reduce Aggression Post ABI

Quetiapine
There is Level 4 evidence (from one small study) to suggest that quetiapine helps to reduce aggressive behaviour (Kim & Bijlani, 2006).

Ziprasidone
There is Level 4 evidence from one study to suggest that ziprasidone assists in the controlling of aggressive behaviours post TBI (Noe et al., 2007).

Lithium Carbonate
There is Level 5 evidence to suggest that an antimanic agent (lithium carbonate) reduces aggressive/agitated behavior following a TBI (Glenn et al., 1989; Bellus et al., 1996).

Sexually Disinhibited Behavior Post ABI
There is Level 4 evidence that an antiandrogen and counseling reduces sexually aggressive behavior (Emory et al., 1995).

Methotrimeprazine
There is Level 4 evidence that methotrimeprazine is safe and effective for controlling agitation after ABI (Maryniak et al., 2001).

Methylphenidate
There is Level 1 evidence (from one RCT) demonstrating the effectiveness of methylphenidate on performance speed (Whyte et al., 2004) .

There is Level 2 evidence (from one RCT) to suggest that treatment with methylphenidate following brain injury can significantly reduce anger (Mooney & Haas, 1993)

Droperidol
There is Level 4 evidence that administration of single-dose droperidol calms brain-injured, agitated patients more quickly than other agents (Stanislav & Childs, 2000).

Haloperidol
There is Level 4 evidence that haloperidol does not have a negative effect on the success of rehabilitation (Rao et al., 1985).

Specific Behavioural Techniques
There is Level 4 evidence to suggest that anger self- management training is effective in reducing irritability and anger after TBI (Hart et al., 2012).

There is Level 4 evidence that behavioural approach using antecedent management and/or feedback of consequences reduces undesirable behaviour (e.g., aggression/agitation) (Wesolowski et al., 1999; Schlund & Pace,1999; Burke et al., 1988).

Multi-intervention Training Programs
There is Level 1 evidence that social skills training has limited impact on changing inappropriate behaviours and mood disturbances of those who have sustained a severe TBI (McDonald et al., 2008).

There is Level 4 evidence that social skills training reduces aggressive behaviour (O'Leary, 2000; Brotherton et al., 1988).

There is Level 2 evidence that Natural Setting Behaviour Management may help to change behaviour (Carnevale et al., 2006).

There is Level 2 evidence that participating in a Coping Skills Group assists in improving adaptive coping in the long term (Anson & Ponsford, 2006b).

There is Level 2 evidence based on one RCT that anger management reduces aggressive behavior (Medd & Tate, 2000).

Music Therapy
There is Level 2 evidence from one non-RCT to suggest that music therapy reduces agitation post PTA (Baker, 2001).

There is Level 4 evidence that music therapy reduces psychomotor agitation post coma following severe TBI in a slow-to-recover group (Formisano et al., 2001).

There is Level 4 evidence to suggest that music therapy improves the mood of ABI adults (Baker et al., 2005).

Addictive Behaviours Post ABI

Substance Abuse Treatment Programs

There is Level 2 evidence suggesting that neither education nor motivational interviewing has a significant impact on excessive alcohol consumption post TBI (sander et al., 2012, Tweedy et al., 2012).

There is Level 2 evidence supporting the use of financial incentives to encourage participants to continue with their substance addiction therapy following an ABI: however, addressing the barriers preventing individuals from attending was not found to be successful (Corrigan & Bogner, 2007)

Neuroendocrine Disorders Following Acquired Brain Injury

Syndrome of Inappropriate Secretion of ADH (SIADH)
Results from two studies found that who had sustained a severe ABI were more likely to develop symptoms of SIADH. In both studies the authors suggested restricting fluid intake to assist in the resolution of symptoms (Doczi et al., 1982; Born et al., 1985)

Diabetes Insipidus (DI)
Results of the studies indicate that DI is associated with lower GCS, lower GOS, and higher mortality rates (Hatton et al., 2006; Hadjizacharia et al., 2009; Agha et al., 2005).

There is Level 2 evidence suggesting IGF-I given post ABI may improve clinical outcomes in patients with DI (Hatton et al., 2006)

Anterior Pituitary Dysfunction

Studies have shown that those who suffer from moderate to severe TBIs are at greater risk for developing hormonal deficiencies. This may lead to a poorer outcome following a TBI as hypopituitarism has been shown to negatively influence recovery

Post-Traumatic Seizure Disorder

Studies of Risk Factors for Late Post-Traumatic Seizures
There are several patient and injury characteristics that increase the likelihood for the development of late PTS. Some important patient characteristics include: Increasing age premorbid alcohol abuse and family history In terms of injury characteristics, markers of increasing injury severity such as penetrating injuries and depressed skull fracture increase the risks of late PTS. A seizure occurring immediately after the injury substantially increases the risk of late PTS. As the severity of brain injury increases the period of time for which a survivor is at risk of developing the PTS also increases.

Seizures which occur after the first week of the injury have an increased chance of seizure recurrence.

Seizure Prevention or Prophylaxis
Based on meta-analysis and the findings of this review there is Level 1 evidence that anticonvulsants given during the first 24 hours post-ABI reduce the occurrence of early seizures (within the first week post-injury) (Glotzner et al., 1983; Dikmen et al. 1991; Temkin et al., 1989; Temkin et al., 1990; Temkin et al., 1999; Schierhout & Roberts, 2001).

There is Level 1 evidence to suggest levetiracetam is as safe and effective as phenytoin in treatment and prevention of seizures in individuals in the intensive care unit post ABI (Szaflarski et al., 2010).

There is Level 1 evidence based on multiple RCTs that anticonvulsants, given shortly after the onset of injury, do not reduce mortality or persistent vegetative state or the occurrence of later seizures (>one week post-injury) (Young et al., 1983b; Young et al., 1983c; Young et al., 1983a; McQueen et al., 1983; Glotzner et al., 1983; Dikmen et al., 1991; Temkin et al., 1990; Temkin et al., 1999)

There is Level 1 evidence that seizure prophylactic treatment with either phenytoin or valproic acid results in similar incidences of early or late seizures and similar mortality rates (Temkin et al., 1999).

There is Level 1 evidence that both phenytoin and carbamazepine have negative effects on cognitive performance, particularly on tasks with motor and speed components (Smith, Jr. et al., 1994), which theoretically may have a negative impact upon learning during rehabilitation.

There is Level 2 evidence that glucocorticoid exposure after brain injury is not associated with a decrease in late seizures, and early exposure (< 2 days after injury) is

associated with increased seizure activity (Watson et al., 2004).

There is Level 4 evidence that methylphenidate for the treatment of cognitive and behavioral problems can be safely used in brain injured patients at risk for posttraumatic seizures as it is not associated with an increase in seizure frequency (Wroblewski et al., 1992)

There is Level 5 evidence that acute intramuscular Midazolam can be used for acute seizure cessation (Wroblewski & Joseph, 1992).

Post-Traumatic Seizure Prophylaxis in Children
There is Level 1 evidence, from one study, that phenytoin does not reduce the occurrence of early seizures in children (Young et al., 2004). Moreover, there is also Level 1 evidence that phenytoin is ineffective in reducing late seizures in children (Young et al., 1983).

Surgical Excision of the Post-Traumatic Seizure Focus
There is Level 4 evidenced that a subgroup of ABI patients where the seizure focus can be accurately localized would benefit from surgical excision (Marks et al., 1995).

Heterotopic Ossification and Venous Thromboembolism

Heterotopic Ossification

Physiotherapy and Range of Motion Exercises
There is Level 4 evidence that forceful manipulation under general anesthesia increases range of motion in patients with HO following brain injury (Garland et al., 1982).

Continuous Passive Motion
There is Level 5 evidence that continuous passive motion reduces the development of heterotopic ossification in severe head injury patients (Linan et al., 2001).

EHDP (Ethylhydroxybiphosphonate)
There is Level 2 evidence that etridonate (EHDP) reduces the development of heterotopic ossification in severe head injury patients (Spielman et al., 1983).

Surgical Excision
There is Level 4 evidence that surgical excision of heterotopic ossification improves clinical outcomes (Ippolito et al., 1999c; Ippolito et al., 1999b; Ippolito et al., 1999a; Fuller et al., 2005; Moore, 1993; de Palma et al., 2002; Melamed et al., 2002; Lazarus et al., 1999; Kolessar et al., 1996; Charnley et al., 1996)

Venous Thromboembolism

Pharmaceutical Therapies
There is Level 2 evidence supporting the administration of LMWH within the first 72 hours post ABI to reduce the risk of developing DVTs and PEs post injury.

There is Level 2 evidence supporting the administration of fondaparinux in patients who have sustained a TBI (Lu et al., 2011).

There is Level 2 evidence that administering LMWH (enoxaparin) or heparin post ABI does not increase the risk of intracranial bleeding (Kim et al., 2002).

LMWH vs Low-Dose Heparin
There is Level 1 evidence that low-molecular-weight heparin is more effective than low-dose unfractionated heparin in preventing venous thromboembolism after severe trauma (Geerts et al., 1996).

Combination Treatments
There is Level 1 evidence suggesting that low-molecular-weight heparin is as effective and safe as unfractionated heparin for the prevention of pulmonary embolism (Decousus et al., 1998).

Based on the findings of a single RCT there is Level 1 evidence that low-molecular weight heparin, combined with compression stockings are more effective than compression stockings alone for the prevention of venous thromboembolism after elective neurosurgery and does not cause excessive bleeding (Agnelli et al., 1998).

There is Level 2 evidence that intermittent pneumatic compression devices alone are as effective as low molecular weight heparin for the prevention of DVT in ABI patients (Davidson et al., 1993).

There is Level 4 evidence that a combination of low-dose heparin (LDH) and sequential compression devices (SCDs) demonstrate no advantage over SCD alone in reducing DVT rates in critically ill patients (Velmahos et al., 1998)

There is Level 4 evidence that intermittent pneumatic compression devices are as effective as low molecular weight heparin for the prevention of DVT in ABI patients (Kurtoglu et al., 2004).

Neuropharmacology

Pharmacological Therapy to Enhance Recovery

Amantadine
There is conflicting evidence regarding the effectiveness of amantadine to improve overall cognitive functioning based on the conclusions of two RCTS (Meythaler et al., 2002; Schneider et al., 1999).

Nimodipine
Based on a single RCT, there is Level 1 evidence that nimodipine does not have a significant affect on outcome (Bailey et al., 1991)

Cerebrolysin
There is Level 4 evidence that cerebrolysin improves bioelectrical activity, cognitive performance, and clinical outcome (Alvarez et al., 2003).

Dextroamphetamine
There is Level 4 evidence that dextroamphetamine enhances recovery and functional status during rehabilitation therapy (Hornstein et al., 1996).

Dexamethasone
There is Level 5 evidence, from one case study, that Dexamethasone is

effective for decreasing intracranial pressure (Du Plessis, 1992).

Levodopa/Carbidopa
There is Level 4 evidence that the use of levodopa/carbidopa results in functional, cognitive, and behavioural improvement (Lal et al., 1988)

Disorders of Arousal and Attention
Methylphenidate
Based on two RCTs, there is Level 1 evidence that in the adult population Methylphenidate significantly improves attention after AB (Plenger et al., 1996).

Based on a single RCT, there is Level 1 evidence that in the pediatric population Methelphenydate does not produce significant differences in attention, behavior, memory, or processing speed (Williams et al., 1998).

Based on four RCTs, there is conflicting evidence as to whether Methylphenidate improves memory or other cognitive deficits (Tiberti et al., 1998; Speech et al., 1993; Gualtieri & Evans, 1988; Whyte et al., 2002).

There is Level 4 evidence that methylphenidate does not affect heart rate and blood pressure (Burke et al., 2003).

Bromocriptine
Based on a single RCT there is Level 2 evidence that bromocriptine has demonstrated improved abilities in executive control after single dose administration (McDowell et al., 1998).

There is Level 4 evidence that bromocriptine may possibly help TBI patients in a vegetative state emerge into a minimally conscious state. (Passler & Riggs, 2001).

Tricyclic Antidepressants
There is Level 5 evidence that the tricyclic antidepressants desipramine and amitriptyline significantly affect neurological recovery by improving both arousal and initiation (Reinhard et al., 1996).

There is Level 5 evidence that the tricyclic antidepressant protriptyline is a possible stimulant medication when traditional stimulant medications are ineffective (Wroblewski et al., 1993).

Agitation and Emotional Regulation Post-ABI

Antidepressants
There is Level 2 evidence that sertraline HCL and amitriptyline decrease the incidence of aggressive behaviours (Kant et al., 1998; Mysiw et al., 1988).

Pindolol
There is Level 1 evidence that pindolol decreases aggression following brain injury (Greendyke & Kanter, 1986).

Propranolol
There is Level 1 evidence that Propranolol may reduce agitated symptoms following brain injury (Greendyke et al., 1986).

Buspirone
There is Level 5 evidence, from one case study, to suggest that buspirone may be effective for reducing symptoms of agitation following brain injury. More research is needed (Levine, 1988).

Methotrimeprazine
There is Level 4 evidence that in most cases methotrimeprazine is safe and effective for controlling agitation after ABI (Maryniak et al., 2001).

Methylphenidate
There is Level 2 evidence to suggest that treatment with methylphenidate following brain injury can significantly reduce anger as measured using several anger outcome measures (Mooney & Haas, 1993).

Droperidol (Inapsine)
There is Level 4 evidence that administration of single-dose droperidol calms brain-injured, agitated patients more quickly than other agents (Stanislav & Childs, 2000).

Haloperidol
There is Level 4 evidence that haloperidol does not have a negative effect on the success of rehabilitation (Rao et al., 1985).

Valproic Acid and Divalproex
Based on a single RCT, there is Level 1 evidence that valproic acid does not have any significant neuropsychological side effects, does not prevent post-traumatic seizures, but is effective for controlling established seizures and stabilizing mood (Dikmen et al., 2000).

Based on finding from 2 studies, there is Level 4 evidence that valproic acid and Divalproex are effective for reducing a variety of neurobehavioral symptoms including destructive and aggressive behaviours (Wroblewski et al., 1997; Kim & Humaran, 2002; Chatham Showalter & Kimmel, 2000).

Sertraline
There is Level 2 evidence that sertraline does not affect arousal and alertness (Meythaler et al., 2001).

There is Level 2 evidence that the use of sertraline for depression also improves cognitive performance (Fann et al., 2001).

Based on two non-RCT studies, there is Level 2 evidence that Sertraline significantly improves depression, irritability, aggression, psychological distress, anger, functioning, and post-concussive symptoms (Fann et al., 2000; Kant et al., 1998).

Haloperidol
There is Level 4 evidence that Haloperidol does not have a negative effect on the success of rehabilitation (Rao et al., 1985).

Methotrimeprazine
There is Level 4 evidence that in most cases methotrimeprazine is safe and effective for controlling agitation after ABI (Maryniak et al., 2001).

Midazolam
There is Level 5 evidence, from one case study, that midazolam effectively treats behavioural problems. It also has less adverse side effects than other commonly used intramuscular drugs, such as diazepam and lorazepam (Wroblewski & Joseph, 1992).

Medroxyprogesterone Acetate
Based on one study, there is Level 4 evidence to suggest that medroxyprogesterone acetate in combination with psychological counseling effectively treats hypersexual behavior. However, the majority of patients do not remain in control once it is discontinued (Emory et al., 1995).

Lithium Carbonate
It has been suggested that lithium carbonate is useful for treating evidence behaviour and affective instability after ABI; however, it has the potential to cause neurotroxicity (Bellus et al., 1996).

Bromociptine
Based on a single RCT, there is Level 2 evidence that bromocriptine improves certain prefrontal functions such as executive functions and dual-task performance, but not others like maintaining information in working memory and control tasks (McDowell et al., 1998).

There is Level 5 evidence, from one observational study, that bromocriptine significantly improves memory impairments (Dobkin & Hanlon, 1993).

There is Level 4 evidence that bromocriptine improves all motivational deficits except mood (Powell et al., 1996).

Lithium Carbonate
It has been suggested that Lithium Carbonate is useful for treating evidence behavior and affective instability after ABI. However it has the potential to case neurotoxicity (Glenn et al., 1989).

Impaired Memory and Cognition

Bromocriptine
Based on a single RCT, there is Level 2 evidence that bromocriptine improves certain prefrontal functions such as executive functions and dual-task performance, but not others like maintaining information in working memory and control tasks (McDowell et al., 1998).

There is Level 5 evidence, from one observational study, that bromocriptine significantly improves memory impairments (Dobkin & Hanlon, 1993).

There is Level 4 evidence that bromocriptine improves all motivational deficits except mood (Powell et al., 1996).

Pramiracetam
Based on a single RCT, there is Level 1 evidence that pramiracetam produces significant clinical improvements on males' memory, which is sustained at one month

following discontinuation of the drug (McLean, Jr. et al., 1991).

Physostigmine
Based on a single RCT, there is Level 1 evidence that Physostigmine improves memory in men with brain injury (Cardenas et al., 1994).

There is Level 5 evidence, from one case study, that Physostigmine combined with a memory training programme produces a clinically significant improvement in memory function, but does not produce significant changes in attention, concentration, cognitive flexibility, or motor speed. (McLean, Jr. et al., 1987).

Donepezil
Based on a single RCT, there is Level 1 evidence that Donepezil improves memory deficits following ABI (Zhang et al., 2004).

Based on two studies, there is conflicting evidence that donepezil improves cognitive functioning (Walker et al., 2004; Whelan, Walker, & Schultz, 2000).

Fluoxetine
There is Level 4 evidence that fluoxetine improves mood and working memory (Horsfield et al., 2002).

Lamotrigine
There is Level 4evidence that more patients than expected who receive lamotrigine experience cognitive improvement and are discharged to the community (Showalter & Kimmel, 2000)

Seizure Disorders

Midazolam
There is Level 5 evidence, from one case study, that midazolam effectively treats acute seizures (Wroblewski & Joseph, 1992). It also appears to have less adverse side effects than other commonly used intramuscular drugs, such as diazepam and lorazepam.

Carbamazepine
There is Level 4 evidence that carbamazepine improves seizure control while being less harmful to cognitive function and behaviour than other anticonvulsants (Wroblewski, Glenn, Whyte, & Singer, 1989).

There is Level 4 evidence that carbamazepine may reduce agitation (Azouvi et al., 1999).

Phenytoin
There is Level 1 evidence that Phenytoin reduces the occurrence of early seizures (within the first week post-injury) (Temkin et al., 1990; Young et al., 1983b)

There is Level 1 evidence that phenytoin does not reduce the incidence of late seizures (> 1 week post-injury). (Young et al., 1983a; Temkin et al., 1990; McQueen et al., 1983).

There is Level 2 evidence that phenytoin does not reduce the incidence of early (Young et al., 2004) (within the first week post-injury) or late (Young et al., 1983) (>

1 week post-injury) seizures in children.

Treatment of Spasticity

Baclofen
Based on a single RCT, there is Level 1 evidence that bolus intrathecal baclofen injections produce short-term (up to 6 hours) reductions in upper and lower extremity spasticity (Meythaler et al., 1996).

There is Level 4 evidence to suggest that prolonged intrathecal baclofen results in longer-term (3 months, and 1 year) reductions in spasticity in both the upper and lower extremities following an ABI (Stokic et al., 2005; Becker et al., 1997; Dario et al., 2002; Francois et al., 2001; Francisco et al., 2005; Meythaler et al., 1999; Meythaler et al., 1997; Meythaler et al., 1999)

Based on a single study, there is Level 4 evidence to suggest that intrathecal baclofen results in short-term improvements in walking performance, particularly gait velocity, stride length, and step width (Horn et al., 2005).

There is Level 4 evidence that orally delivered baclofen controls and reduces spasticity resulting from ABI (Meythaler et al., 2004)

Tizanidine
Based on a single RCT, there is Level 1 evidence that Tizanidine is effective for decreasing spasticity caused by ABI (Meythaler et al., 2001).

Botulinum Toxin
There is Level 4 evidence that Botulinum Toxin type A injections may be effective in the management of localized spasticity following ABI. (van Rhijn et al., 2005; Fock et al., 2004; Yablon et al., 1996).

Community Reintegration

Independence and Social Integration
There is Level 1 evidence suggesting that self-awareness training has little impact on the individuals awareness of their disability (Goverover et al., 2007)

There is Level 2 evidence that rehabilitation, whether hospital-based (outpatient) or community-based, does improve the level of independence for persons with an acquired brain injury as confirmed by a number of non-randomized studies. These effects were maintained one to three years later (Malec et al., 1993; Carnevale, 1996; Powell et al., 2007).

There is Level 3 evidence indicating that community based life skills training does improve community integration, although it has little effect on an individual's satisfaction with life (Wheeler et al., 2007; Goranson et al., 2003; Cusick et al., 2003).

There are fewer studies showing positive effects of general rehabilitation efforts on social integration. However, there is limited evidence for the positive effects of community-based rehabilitation programs that use a peer or

supported relationship model of intervention (Feeney et al., 2001).

Caregiver Burden

Primary caregivers of ABI survivors experience significant levels of stress, burden, and depression. The presence of cognitive, behavioral, and emotional changes in patients are strong predictors of anxiety and depression upon caregivers and relatives.

There is Level 2 evidence that social work liaison alleviates caregiver burden, and improves satisfaction and mastery (Albert et al., 2002).

Based on a single RCT, there is Level 2 evidence that behavioral management in combination with caregiver education does not decrease caregiver burden (Carnevale et al., 2002).

Based on a single RCT, there is Level 2 evidence that an educational program provided to caregivers and their family member with ABI will decrease caregiver burden (Sinnakaruppan et al., 2005).

There is Level 2 evidence supporting the need for increased caregiver support (Kreutzer et al., 2009a; Kreutzer et al., 2009b; Davis et al., 2009).

Life Satisfaction

The relationship between life satisfaction and patients disability does not appear to be a linear one, since life satisfaction as reported by individuals with severe disabilities may not significantly differ from individuals who obtain good recovery and little or no disabilities (Mailhan et al., 2005).

There is Level 2 evidence that more intensive and structured cognitive rehabilitation therapy provided in both groups and individual settings improves participants' satisfaction with community integration and cognitive functioning outcomes compared with standard, less structured multidisciplinary rehabilitation (Cicerone et al., 2004).

There is a reciprocal relationship between cognitive function and community integration (Waehrens & Fisher, 2007).

There is Level 2 evidence that there is a reciprocal relationship between cognitive function and community integration (Armengol, 1999)

There is Level 4 evidence that they improve measures of hopelessness leading to a greater sense of control and empowerment (Vandiver & Christofero-Snider, 2000).

Productivity

Following ABI those patients who reintegrate into vocational activities return to lower levels of employment or schooling and only a small number are able to return to vocational activities which are comparable to pre-morbid levels (Walker et al., 2006; Klonoff et al., 2001).

There is Level 2 evidence indicating that returning to work helps to reduce levels of depression (McCrimmon & Oddy, 2006).

There is Level 2 evidence that cognitive strategies increase the proportion of patients who successfully return to full time vocational activities following brain injury (Parente & Stapleton, 1999; O'Reilly et al., 1990).

There is Level 2 evidence that supported employment strategies following brain injury cause improvements in competitive job placement and retention (Wall et al., 1998; Gamble & Moore, 2003; Wehman et al., 1988).

There is Level 2 evidence that vocational rehabilitation strategies are more effective when they are implemented earlier following the injury (Buffington & Malec, 1997).

Return to Driving

Return to driving appears to be more likely for patient with less severe injuries (Hawley, 2001).

Based on a retrospective study, there is Level 4 evidence that participation in a multidisciplinary rehabilitation program increases the percentage of patients who return to driving following an ABI (Leon-Carrion et al., 2005).

There is a high incidence of accidents in ABI survivors who return to driving which may be related to patients prematurely returning to driving (Pietrapiana et al., 2005).

Paediatric Interventions in Acquired Brain Injury Rehabilitation

Hypothermia

There is conflicting evidence supporting the use of hypothermia and its effectiveness in decreasing the risk of poor outcomes with children post ABI
(Li et al., 2008; Bayir et al., 2009; Adelson et al., 2005; Hutchison et al., 2008).

Fluid Resuscitation

There is Level 1 evidence that use of hypertonic saline in the ICU setting results in a lower frequency of multiple early complications and a shorter ICU stay compared with lactated Ringer's solution (Simma et al., 1998; Khanna et al., 2000).

Treatments to Promote Emergence from Coma in Children

Amantadine

There is Level 1 evidence that amantadine improves the level of consciousness in children post ABI (Vargus et al., 2010; McMahon et al., 2009)

There is Level 1 evidence, from one RCT, that amantadine and pramipexole improves the levels of consciousness in TBI children and adolescents (Patrick et al., 2006)

There is Level 4 evidence that dopamine-enhancing drugs facilitate rate recovery post-traumatic brain injury (Patrick et al., 2003).

Decompressive Craniectomy

There is Level 1 evidence that in children, decompressive craniectomy reduces elevated ICP but does not significantly improve clinical outcomes post ABI (Taylor et al., 2001).

There is level 4 evidence to suggest children do benefit from decompressive craniectomies post ABI (Adamo et al., 2009).

Feeding
There is Level 5 evidence that food texture and the person feeding are important factors when feeding a person post acquired brain injury (DeMatteo et al., 2002).

Behavioural Interventions for Children with ABI
There is Level 4 evidence that behavioural therapies for children with ABI are effective at reducing or eliminating problematic behaviours (Mottram & Berger-Gross, 2004; Feeney & Ylvisaker, 1995; Glang et al., 1997; Pruneti et al., 1989; Slifer et al., 1993; Slifer et al., 1995; Slifer et al., 1996; Slifer et al., 1997; Zencius et al.,1989; Selznick & Savage, 2000; Hartnedy & Mozzoni, 2000; Feeney & Ylvisaker, 2003; Gardner et al., 2003).

Cognitive Interventions for Children with ABI
There is Level 1 evidence from two RCTs that have found programmes designed to deal with cognitive impairments do improve aspects in sustained attention, selective attention and memory (van't Hooft et al., 2005; van't Hooft et al., 2007).

Little is currently known with respect to family factors that influence treatment, behavioural therapies for pre-school children, and therapy for behaviours beyond the scope of externalizing problems.

Remediation of Learning and Memory
There is Level 2 evidence that intellectual function is significantly increased with cognitive rehabilitation. Little is currently known with respect to generalization of cognitive functioning beyond test-specific skills assessed in the studies (Melchers et al., 1999).

Remediation of Executive Functioning
There has been little research examining the remediation of executive functioning abilities of children following brain injury. Little is currently known with respect to generalization of cognitive functioning beyond test-specific skills assessed in the studies (Suzman et al., 1997).

Injury-Related Information Intervention for Children with ABI
Based on the findings of a single RCT with a small sample size there is Level 2 evidence that injury-related information interventions do not improve knowledge or awareness of injury-related deficits, memory function or behavioural problems in children (Beardmore et al., 1999).

Cognitive Interventions for Children
There is Level 4 evidence that suggest that cognitive therapies for children with ABI lead to improved cognitive functioning (Suzman et al., 1997)

Vestibular Dysfunction Post ABI
There is Level 1 evidence suggesting that home based

exercise programs do increase functional balance in children who have sustained an ABI or have been diagnosed with CP (Katz-Leuer et al., 2009; Katz-Leurer et al., 2008).

Communication
There is Level 4 evidence that peer-group training of pragmatic language skills may benefit children with communication deficits following brain injury (Wiseman-Hakes et al., 1998).

Family Supported and Web-based Interventions
There is Level 1 evidence from one RCT that web-based programs are effective in reducing depression symptomology, internalization of problems and the total amount of adolescent-parent conflicts (Wade et al., 2008).

There is Level 2 evidence to suggest that family-based interventions may be more beneficial for improving outcomes of children with brain injury than usual, clinician-directed care based interventions based on the results of two RCTs (Braga et al., 2005; Wade et al., 2004).

There is Level 2 evidence that web-based systems can improve problem-solving abilities for the child with brain injury, as well as the family members (Wade et al., 2006).

Community-based Interventions
There is Level 4 evidence that a multidisciplinary outpatient program may improve functional abilities following brain injury for children (Emanuelson et al., 2003).

Social Reintegration for Children Following Brain Injury
It has been suggested that interventions directed at strengthening the soical interactions of children with brain injury may be benefical; however, more research is required prior to making a more definitive conclusion (Glang et al., 1997).

Pharmacological Interventions

Amantadine
There is Level 2 evidence that the use of amantadine can decrease the amount of behaviours among ABI children (Beers et al., 2005).

There is Level 3 evidence that amantadine facilitates rate recovery post-traumatic brain injury (Green et al., 2004).

Dexamethasone
There is Level 1 evidence based on three RCTs that administration of dexamethasone inhibits endogenous production of glucocorticoids and has no proven impact on recovery post brain injury (Kloti et al., 1987; Fanconi et al., 1988; Dearden et al., 1986).

Methylphenide Interventions in Children with ABI
Based on two small and conflicting RCTS there is inconclusive evidence that metylphenidate interventions improved cognitive behavioural function in children post ABI (Mahalick et al., 1998; Williams et al., 1998).

Motor Rehabilitation

Bracing to Prevent Contracture in Children with ABI
There is Level 5 evidence that upper limb lycra splints improve the quality of movement in some individuals with traumatic brain injury (Corn et al., 2003).

Botulinum Toxin
There is Level 4 evidence that Botulinum toxin type A (BTX-A) is an effective treatment for children and adolescents with upper limb spasticity. (van Rhijn et al., 2005)

Constraint Induced Movement Therapy in Children with ABI
There is Level 4 evidence regarding the successful implementation of constraint induced movement therapy (CIMT) in children leading to an improvement in level of function of the affected limb(Karman et al., 2003; Cimolin et al., 2011).

Shaking Baby Syndrome (SBS)

Ophthalmological Outcomes
Studies have noted that the lack of visual response at ophthalmologic examinations of SBS individuals may lead to fatal outcomes (Kivlin et al., 2000).

The presence of poor papillary response, the presence of a RH, a midline shift, circular perimacular retinal folds and peripheral retinschisis may also lead to fatal outcomes among individuals with SBS (McCabe & Donahue, 2000).

Education and Prevention of SBS
There is Level 1 evidence supporting the role of education programs on infant crying for new or young parents (Barr et al., 2009a; Barr et al., 2009b; Dias et al., 2005).

Fatigue and Sleep Disorders Post ABI

Self-Reports of Fatigue Post ABI
Results from 4 case-control studies and 2 case series have found that individuals who sustain a TBI feel greater levels of fatigue post injury (Bushnik et al., 2008; Whiteneck et al., 2004; Borgaro et al., 2005; LaChapelle & Finlayson, 1998; Ziino & Ponsford, 2006a; Ashman et al., 2008).

Impact of Participation and Quality of Life (QOL)
There is Level 3 evidence, from one study, to suggest that higher Levels of fatigue may lead to a poorer quality of life (Cantor et al., 2008).

Vigilance and Fatigue
There is Level 3 evidence, based on one study, noting individuals who sustain a TBI do experience greater fatigue and a decrease in vigilance than those without an injury (Ziino & Ponsford, 2006).

Modafinil
There is Level 1 evidence, based on one RCT, that Modafinil is not effective in treating fatigue or excessive daytime sleepiness post ABI (Jha et al., 2008).

Cognitive Behavioural Therapy
There is Level 4 evidence, based on one study, to suggest that cognitive behavioural therapy may assist in treating insomnia and help in the management of fatigue post ABI (Ouellet & Morin, 2004).

Methylphenidate
There is Level 2 evidence, based on one cohort study, that methylphenidate does not improve the sleep-wake cycle of those who have sustained a TBI (Al-Adawi et al., 2006).

Lorazepam and Zopiclone
There is Level 1 evidence, from one RCT, that lorezapam and zopiclone work equally well in assisting with insomnia symptoms fatigue post ABI (Li Pi Shan & Ashworth, 2004).

Acute Interventions for Acquired Brain Injury

Head Posture
There is Level 2 evidence, based on one RCT, that 30 degrees of head elevation reduces intracranial pressure with concomitant increments in cerebral perfusion pressure (Winkelman, 2000).

Propofol
There is Level 2 evidence that propofol may help to reduce ICP and the need for other ICP and sedative interventions when used in conjunction with morphine (Kelly et al., 1999).

There is Level 5 evidence that infusions of propofol greater than 4mg/kg per hour should be undertaken with extreme caution (Otterspoor et al., 2008)

Mannitol
There is Level 1 evidence that sodium lactate is more effective than mannitol for the management of acute elevations in ICP (Ichai et al., 2009)

There is Level 2 evidence that higher dose mannitol is superior to conventional mannitol in improving mortality rates, and clinical outcomes (Cruz et al., 2001; Cruz et al., 2002; Cruz et al., 2004).

There is Level 2 evidence that early out of hospital administration of mannitol does not adversely affect blood pressure (Sayre et al., 1996).

There is Level 4 evidence that mannitol is effective in diminishing intracranial hypertension only when initial ICP values are elevated (Sayre et al., 1996; Hartl et al., 1997).

Midazolam
There is Level 2 evidence that midazolam has no effect on ICP. There is however conflicting evidence regarding its effect on MAP and CPP (Sanchez-Izquierdo-Riera et al., 1998; Papazian et al., 1993; Davis et al., 2001)

Opiods
There was Level 1 evidence that bolus opioid administration resulted in increased ICP (de Nadal et al., 2000; Sperry et al., 1992; Werner et al., 1995; Albanese et al., 1993; Albanese et al., 1999); however the evidence regarding the effects of opioid infusion on ICP levels is

conflicting (Albanese et al., 1993; Albanese et al., 1999)

There was Level 2 evidence that remifentanil results in faster arousal compared to hypnotic based sedation (Karabinis et al., 2004).

Hyperventilation

There is Level 2 evidence that the use of tromethamine, a weak base and buffer that crosses the blood brain barrier, can offset the deleterious effects of prolonged hyperventilation and lead to better outcomes than hyperventilation alone (Muizelaar et al., 1991).

There is Level 4 evidence that hyperoxia can counteract the deleterious effects of hyperventilation for the control ICP following brain injury (Coles et al., 2002; Diringer et al., 2000).

There is Level 4 evidence that hyperventilation below 34 torr arterial CO2 can cause an increase in regionally hypoperfused tissue (Thiagarajan et al., 1998)

Cerebrospinal Fluid Drainage

There is Level 1 evidence that cerebrospinal fluid drainage decreases intracranial pressure in the short term (Kerr et al., 2000).

Barbituates

There is conflicting evidence regarding the efficacy of pentobarbital over conventional ICP management measures (Eisenberg et al., 1988; Ward et al., 1985).

There is Level 2 evidence that there is no difference between thiopental and pentobarbital in the control of elevated ICP (Perez-Barcena et al., 2005).

There is Level 2 evidence that pentobarbital is no better than mannitol for the control of elevated ICP (Schwartz et al., 1984).

There is Level 4 evidence that barbiturate therapy may cause reversible leucopenia, granulocytopenia, and systemic hypotension (Stover & Stocker, 1998).

Based on a single study, there is Level 4 evidence that a combination barbiturate therapy and hypothermia may result in improved clinical outcomes up to 1 year post-injury (Fried et al., 1989).

Decompressive Craniectomy

There is Level 2 evidence that in adults, standard trauma craniectomy is more effective than limited craniectomy in lowering elevated ICP and leading to better GOS outcome at 6 months (Jiang et al., 2005).

There is Level 1 evidence that in children, decompressive craniectomy reduces elevated ICP but does not significantly improve clinical outcomes post-ABI (Taylor et al., 2001).

There is Level 3 evidence that resection of a larger bone flap results in greater decreases in ICP reduction after craniectomy, better patient outcomes and leads to fewer post-surgical complications (Polin et al., 1997; Skoglund et al., 2006).

Hypertonic Saline
There is Level 1 evidence that hypertonic saline reduces ICP more effectively than mannitol (Battison et al., 2005; Myburgh et al., 2007; Cooper et al., 2004; Vialet et al., 2003).

There is Level 1 evidence that treatment with hypertonic saline results in similar clinical outcome and survival when compared with treatment with Ringer's lactate solution up to 6 months post-injury (Cooper et al., 2004).

There is Level 1 evidence that in children, use of hypertonic saline in the ICU setting results in a lower frequency of multiple early complications and a shorter ICU stay compared with Ringer's lactate (Simma et al., 1998)

There is Level 1 evidence that saline solution results in decreased rates of mortality compared with albumin (Myburgh et al., 2007).

There is Level 2 evidence that hypertonic saline is similar to Ringer's lactate solution in lowering elevated ICP (Shackford et al., 1998).

There is Level 4 evidence that treatment with hypertonic saline reduces elevated ICP refractory to conventional ICP management measures (Schatzmann et al., 1998)

There is Level 4 evidence that hypertonic saline may be useful as a component of a resuscitation algorithm by increasing cerebral oxygenation (Khanna et al., 2000; Qureshi et al., 1998).

Continuous Rotational Therapy and Prone Positioning
There is Level 4 evidence that continuous rotational therapy does not worsen intracranial pressure in severe brain injury patients (Thelandersson et al., 2006).

There is Level 4 evidence that the prone position may increase oxygenation and CPP in ABI patients with acute respiratory insufficiency (Nekludov et al., 2006).

Hyperthermia
Based on the findings of this review and those of a meta-analysis, there is Level 1 evidence that hypothermia lowers elevated ICP (Resnick et al.,1994; Marion et al., 1997; Marion et al., 1997; Jiang et al., 2000; Clifton et al., 2001; Jiang et al., 2000).

There is conflicting evidence regarding hypothermia's effect on mortality or clinical outcomes (Chen et al., 2001; Polderman et al., 2002; Alderson et al., 2004).

There is Level 1 evidence that systemic hypothermia is associated with an increased incidence of pneumonia (Qiu et al., 2007; Alderson et al., 2004)..

Hypertonic Oxygen
Based on two RCTs and a meta-analysis, there is Level 1 evidence that treatment with hyperbaric oxygen positively improves mortality (Ren et al., 2001; Rockswold et al., 2001).

There is conflicting evidence that treatment with hyperbaric oxygen leads to better functional outcomes 6-12 months post-injury. (Rockswold et al.,2001).

There is only Level 4 evidence that treatment with hyberbaric oxygen temporarily lowers elevated ICP up to 6 hours post-treatment (Rockswold et al., 2001).

Corticosteroids
There is Level 1 evidence that methylprednisolone increases mortality rates in ABI patients and should not be used (Roberts et al., 2004).

There is Level 2 evidence that triamcinolone may improve outcomes in patients with a GCS<8 and a focal lesion (Grumme et al., 1995).

There is Level 1 evidence that dexamethasone does not improve ICP Levels and may worsen outcomes in patients with ICP>20mmHg (Dearden et al., 1986).

There is Level 3 evidence that glucocorticoid administration may increase the risk of developing first late seizures (Watson et al., 2004).

Progesterone
There is Level 1 evidence that progesterone improves GOS and modified FIM scores and decreases mortality rates in ABI patients (Wright et al., 2007; Xiao et al., 2008).

Bradykinin Antagonists
Based on the findings of two RCTs, there is Level 1 evidence that Bradycor (a bradykinin antagonist) is effective in preventing acute elevations in ICP post-ABI (Marmarou et al., 1999; Narotam et al., 1998).

There is conflicting evidence to support the use of bradykinin antagonists to improve functional clinical outcomes such as the GOS (Marmarou et al., 2005).

Dimethyl Sulfoxide
There is Level 4 evidence that dimethyl sulfoxide transiently reduces ICP elevations (Kulah et al., 1990; Karaca et al., 1991).

Cannabinoids
Based on the findings of one large scale multi-centre RCT there is Level 1 evidence that treatment with dexanabinol does not provide acute improvements in ICP for long-term clinical benefits post-ABI (Maas et al., 2006).

Amantadine
There is Level 1 evidence that amantadine may improve levels of consciousness and cognitive function in patients in various stages of coma (Meythaler et al., 2002b; Patrick et al., 2006; Whyte et al., 2005; Hughes et al., 2005; Saniova et al., 2004)

Sensory Stimulation
There is Level 1 evidence that multimodal sensory stimulation provided by family members improves consciousness of severe

ABI patients with a GCS between 6 and 8 (Abbasi et al., 2009).

There is Level 2 evidence to suggest that sensory stimulation may improve clinical outcomes, physiological parameters and behaviors indicative of emergence from coma post-ABI (Johnson et al., 1993; Kater, 1989; Mitchell et al., 1990; Wood et al., 1992).

Music Therapy
There is Level 4 evidence that music therapy as an adjunct to other modes of sensory stimulation may be used to promote emergence from coma post-ABI. (Noda et al., 2004).

Electrical Stimulation
There is Level 2 evidence that median nerve electrical stimulation does not improve emergence from coma post-ABI (Cooper et al., 1999).

Summary of the Levels of Evidence

Module 3 - Efficacy and Models of Care Following an Acquired Brain Injury Rehabilitation

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Patients cared for in a Level 1 trauma center achieve better outcomes than patients cared for in a Level II center.		X				
Staff with more dedicated commitment to trauma care leads to better patient outcomes.		X				
A reduction in the time spent in Acute care and in a rehab facility does not have a negative impact on overall patient outcomes		X				
The overall cost of case is higher for those who sustain a severe TBI vs those who sustain a moderate TBI.				X		
Adherence to BTF guidelines for acute care results in improved outcomes and decreased mortality				X		
Early rehabilitation in associated with better outcomes.				X		
Inpatient rehabilitation improves self-care and mobility.				X		
Inpatient rehabilitation improves functional outcome as measured by FIM.				X		
More than ¼ of patients admitted to inpatient rehabilitation experience good outcome or moderate disability on the GOS 6 months post-injury.				X		
Increasing rehab intensity reduces length of stay.	X					
Intensive rehab improves functional outcome as measured by the FIM and GOS at 2 and 3 months post injury, but not necessarily at 6 months and beyond.	X					
Multidisciplinary inpatient rehab seems to be more effective than a single discipline approach.		X				
Therapy intensity predicts motor functioning but not cognitive gain.		X				
Patients with a long length of stay who receive high-intensity rehab fair better on the RLA scale at discharge than those who receive low intensity rehab				X		
Earlier time from injury onset to rehab admission results in improved function outcomes				X		
Early rehab is associated with better outcomes (shorter comas, LOS,		X				

higher cognitive levels at discharge, better FIM scores etc).						
Inpatient brain injury rehabilitation results in significantly greater gains in total FIM change, self-care, and social cognition for patients with TBI than patients with brain tumors.			X			
Inpatient rehabilitation results in a higher rate of change on functional measures in younger patients than in older patients.			X			
Readmission to inpatient rehabilitation at more than 12 months post injury is related to statistically significant improvement at discharge for over 50% of patients.		X				
Inpatient rehabilitation results in successful return to work and return to duty for the majority of military service members.				X		
Transitional living setting during the last weeks of inpatient rehabilitation is associated with greater independence than inpatient rehabilitation alone.		X				
A fitness centre-based program is not better than a home based program, for improving cardio-respiratory fitness.	X					
Multidisciplinary outpatient rehab may improve functional outcomes up to one year post discharge.			X			
Varied outpatient therapy can be used to improve varied targeted outcomes.		X				
Behavioral and cognitive skills post ABI can be improved by participating in neurorehabilitation programs.		X				
Structured multidisciplinary rehab in community seeing can improve social functioning.	X					
Community-based programs for ABI patients are associated with greater independence, higher social activity levels, and less need for care support when they are at least six months in duration.				X		
Participants with a dual-diagnosis of TBI and substance abuse generally do not become chemical-free.				X		
Direct patient involvement in neurorehabilitation goal setting is associated with improvements in obtained those goals and maintaining them at follow-up of two months.		X				
Participation in a comprehensive day treatment program reduces impaired self-awareness and distress. It also improves societal participation at a follow-up of one year.		X				
Rehabilitation issues regarding communication and employment are		X				

present year post rehabilitation.						
A fitness center-based program is not better than a home-based program for improving cardio-respiratory fitness.	X					
Multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.	X					
Varied outpatient therapy can be used to improve varied targeted outcomes.		X				
Behavioral and cognitive skills post ABI can be improved by participating in neurorehabilitation or neurobehavioral programs		X				
Structured multidisciplinary rehabilitation in community setting can improve social functioning	X					
Community-based social and behavioral rehabilitation of at least six months results in greater independence, higher social activity levels, and less need for care support.				X		
Patients with a dual-diagnosis of TBI and substance abuse who participate in a community based treatment program generally do not become chemical-free.				X		
Direct patient involvement in neurorehabilitation goal setting results in a significant improvement in obtaining goals from pre-test to post-test that are then maintained at a follow-up of 2 months.		X				
Rehabilitation issues regarding communication and employment are present years post rehabilitation.		X				
Vocational rehabilitation results in greater total taxpayer benefits than either total program operational costs or government costs.				X		
Participants in vocational rehabilitation often have fair or good adjusted outcome, while more than half become gainfully employed or full-time students.				X		
Individuals with significant cognitive impairments benefit the most from vocational rehabilitation services.				X		
Individuals with severe head injury do benefit from supported employment services				X		
Supported employment results in patients being competitively employed more often than if they had not received supported employment.			X			
Support groups generate positive results such as improving feelings of hopelessness, coping with depression, and improving psychosocial				X		

functioning.						

Module 4 - Motor Impairment Remediation Post Acquired Brain Injury

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Modified constraint induced movement therapy may provide benefit for the more affected upper extremity post acquired brain injury.				X		
Overnight hand splinting does not provide clinical benefit for brain injury survivors.	X					
Functional fine motor control retraining activities results in improved fine motor coordination in addition to re-establishing life skills.	X					
Visual feedback grip force training improved tracking and transfer performance.		X				
Serial casting reduces ankle plantar flexion contractures due to spasticity of cerebral origin.		X				
Short duration (1 to 4 days) serial casting has a significantly lower complication rate than longer duration (5 to 7 days) serial casting. However, there is no difference in range of motion outcome.			X			
Casting alone is as effective as casting and botulinum toxin injections for treating plantar flexion contractures due to spasticity of cerebral origin.		X				
A pre-fabricated, adjustable ankle foot orthosis reduces ankle plantar flexion contractures due to spasticity of cerebral origin.				X		
Botulinum toxin type A injections may be effective in the management of localized spasticity following ABI.				X		
Patients receiving botulinum toxin type A injections did show reduced spasticity,	X					
Phenol blocks of the musculoskeletal nerve may help decrease spasticity and improve range of motion temporarily up to 5 months post injection.				X		
Electrical stimulation decreases spasticity for up to 24 hours.				X		
Oral tizanidine improves upper and lower extremity spasticity.	X					
Oral baclofen appears to improve lower extremity spasticity.				X		
Bolus injections of intrathecal baclofen produce short-term reductions in upper and lower extremity spasticity post ABI.	X					
Prolonged intrathecal baclofen reduces upper and lower extremity spasticity post ABI.				X		

Intrathecal baclofen may cause short-term improvements in walking performance.				X		
Partial body weight supported gait training is not better than conventional gait training for improving ambulation, mobility or balance.	X					
Specific sit-to-stand training results in improved abilities.	X					
Reach training with an embedded intervention is more effective than a traditional reaching exercise program.		X				
A specific balance and coordination training program is significantly more effective for improving balance and coordination compared to a traditional muscular training program.		X				
A virtual reality based balance retraining program is as effective at improving balance through a conventional balance retraining program.		X				
Engaging in exercise prior to sustaining an ABI has a positive impact on Exercise compliance post ABI.						
Aerobic exercise post acquired brain injury is effective for improving general fitness.	X					
Exercise does help improve mood and overall general health.		X				
Participating in exercise does reduce depressive symptoms and improve self-esteem.				X		
Exercise improves health promotion and self-esteem post-ABI.	X					
Computer based restitution training is effective in improving the vision of those who sustain a TBI.	X					
Base-in prisms and bi-nasal occluders are effective in treating ambient vision disturbances resulting from an ABI.				X		
Prismatic spectacle lenses are effective in correcting vertical heterophoria in ABI patients with post concussive symptoms.				X		
Rehabilitation programs directed at improving visual function may improve visual functional outcomes post-ABI.				X		
Home based exercise programs do increase functional balance in children who have sustained an ABI or have been diagnosed with CP.	X					
Combined aerobic dancing along with slide and step training programs reduce balance and coordination deficits.				X		
Habituation training has been shown to be beneficial in reducing provoked vertigo following an ABI.				X		
A vestibular rehabilitation program improves symptoms of vertigo in				X		

patients after a traumatic brain injury.						
The use of CBT to reduce post traumatic headaches in those who have sustained a mild to severe TBI has been found to have some success				X		
Biofeedback has been shown to be effective in the treatment of post traumatic headaches.		X				
Pregabalin is effective in reducing central neuropathic pain caused by injuries to the brain or spinal column.	X					
The use of cold packs is not as effective as manual therapy in reducing post traumatic headaches.		X				
Oxycodone in modest doses is effective in reducing pain following traumatic injuries including mild TBI.				X		

Module 5 - Dysphagia & Nutritional Interventions for Patients with Acquired Brain Injuries

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
The incidence of dysphagia in patients entering rehabilitation post-ABI ranges from 25 to 78%. This incidence has been shown to vary depending on the definition of dysphagia used and the acuity of the patient at admission. An incidence of 42-56% in patients admitted to an ABI rehabilitation unit have been observed in more recent studies.						
The incidence of aspiration post-ABI occurs in approximately 30 to 50% of ABI patients with dysphagia. This represents 10-20% of rehabilitation admissions.						
The incidence of silent aspiration in ABI patients has not been well documented. Such cases may be missed in the absence of VMBS studies.						
The risk of developing pneumonia appears to be proportional to the severity of the aspiration.						
Those with a lower GCS, FIMS scores and RLA scores are more likely to develop pneumonia while being tube fed.						
The risk of dysphagia related aspiration is proportional to the initial severity of the head injury. A history of tracheostomy or mechanical ventilation may also be associated with increased risk of aspiration.				X		
VMBS (or MBS) studies may be used as a tool to assist in dysphagia management and identification of aspiration in the ABI population.						
There is inconclusive evidence to suggest FEES is more sensitive than VMBS when assessing patients for swallowing difficulties or aspiration post stroke. Further study needs to be done.						
There is limited evidence supporting the use of pulse oximetry to detect aspiration in patients who have had a stroke.						
There is a need for good oral care post TBI.		X				
There is consensus opinion that acute patients should be NPW until swallowing ability has been determined.						
There is consensus opinion that a speech and language pathologist should assess all patients who fail swallowing screening and identify the appropriate course of treatment.						
There is consensus opinion that an individual trained in low-risk						

feeding strategies should provide feeding assistance or supervision of patients where appropriate.						
There is consensus opinion that dietitian should assess the nutrition and hydration status of patients who fail the swallowing screening.						
Stroke patients with dysphagia should feed themselves to reduce the risk of aspiration. There were no such studies specific to the ABI population				X		
For stroke patients who require assistance to feed there is consensus opinion that low-risk feeding strategies by trained personnel should be employed. There are no consensus statements made specifically for ABI.						
Two studies were found assess malnutrition in brain injury patients: however, only one reported seeing signs of malnutrition in patients within the first two months post injury. The results of one study indicate the incidence of obesity was comparable to normal.						
Post ABI there is evidence supporting the presence of a hyper-metabolic state. The extent of the response can be moderated by barbiturates.				X		
Enteral nutrition is effective in providing an increase in calories to ABI patients		X				
There is conflicting data when looking at the nitrogen balance of ABI patients as to which method of feeding is most effective						X
Total parenteral nutrition (TPN) can safely be administered without causing serum hyperosmolality or influencing intracranial pressure (ICP) or ICP therapy in post-ABI patients.		X				
Parenteral nutrition is more costly compared to enteral nutrition.			X			
Enhanced enteral feeds improve a number of outcomes.	X					
Beginning enteral feeding at final rate increases the percentage of prescribed energy and protein actually received.	X					
Early parenteral nutrition support of ABI patients appears to modify immunologic function.		X				
The risk of developing pneumonia is higher among ventilated patients fed by a naso-gastric tube compared with a gastrostomy tube.	X					
Early naso jejunal hyperalimentation improves caloric intake, nitrogen intake, nitrogen balance, bacterial infection and days of stay in the intensive care unit in post-ABI patients.		X				

Meoclopramide is not effective as an aid to gastric emptying	X					
Zinc supplementation in ABI patients has a positive effect on neurological recovery as measured by the Glasgow Coma Scale. However, no significant improvement in mortality rates could be attributed to zinc supplementation.	X					
There is conflicting evidence that IGF-I is effective in enhancing growth hormone in those who have sustained an ABI.						X
High nitrogen feedings are necessary to restore massive nitrogen loses post-ABI.		X				
Supplementation of branched-chain amino acids in post-ABI patients enhances recovery of cognitive function		X				

Module 6 - Cognition Interventions Post ABI

Level of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Specific structured training programs designed to improve attention are ineffective.		X				
Dual task training has a positive effect on divided attention.		X				
Dual task training is effective on the speed of processing.		X				
Individuals with a TBI perform poorly on dual task activities due to their inability to maintain a measure of sustained attention.			X			
Reaction times of those with TBI are slower than reaction times of those without.			X			
Active or high tech external aids (assistive technology) as a compensatory strategy for memory impairments is strongly supported	X					
Passive or no tech/low tech aids in improving memory impairments post ABI has been found to be effective		X				
Although cognitive functioning does appear to benefit from computer assisted retraining the evidence supporting its application is conflicting.						X
Visual and verbal learning post exercise intervention for brain injured survivors has a positive effect.		X				
VR programs do not enhance cognitive functioning post TBI in individuals who have sustained a TBI.			X			
Internal strategies appear to be an effective aid in improving recall performance.		X				
Internal strategies appear to assist in improving recall performance.			X			
Memory retraining programs appear effective for functional recovery, although performance on specific tests of memory may or may not change.		X				
Spaced retrieval has been shown to be effective in improving memory post ABI.			X			
The spacing of repetitions improves memory post ABI.			X			
Cranial electrotherapy stimulation does not help to improve memory and recall following brain injury.	X					
Group bases intervention to treat executive dysfunction post ABI have						X

not been shown to support executive dysfunction post ABI.						
Goal management training is effective for improving paper and pencil everyday tasks and meal preparation skills for individuals with an ABI.		X				
Goal management training is effective for improving paper and pencil everydays tasks and meal preparation skills for persons with an ABI.						
Goal planning in the form of leisure activities is effective for achieving identified goals following an ABI.		X		X		
It is unclear if cognitive rehab programs focusing on memory strategies and selective attention are effective.						X
General cognitive rehab therapy post acquired brain injury is effective for improving cognition.		X				
Working memory training is effective in recovering the central executive system of working memory.				X		
Outpatient day programs are effective for assisting brain injury survivors in returning to competitive employment.				X		
Donezepil helps to improve attention and short-term memory following brain injury.	X					
The effectiveness of methylphenidate treatment to improve cognitive impairment following brain injury is unclear.						X
Sertraline has not been shown to improve cognitive functioning in those who have sustained an ABI.	X					
Amantadine does help to improve executive functioning.				X		
Amantadine does not help to improve learning and memory deficits.				X		
Pramiracetam produces significant clinical improvements on males' memory.	X					
Physostigmine improved memory in men with brain injury.	X					
Bromocriptine improves all motivational deficits except mood				X		
Bromocriptine significantly improves memory impairments					X	
There is conflicting evidence to support the use of bromocriptine to enhance cognitive functioning						X
Cerebrolysin may be beneficial for the improvement of cognitive functioning following brain injury.				X		
rhGH has been shown to assist in cognitive functioning in individuals who are GHD post ABI.	X					
The administration of rhGH does improve cognitive rehabilitation in those who have sustained a moderate to severe TBI.		X				

Module 7 - Cognitive-Communication Deficits Post ABI

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Specific structured training programs are not effective in improving attention post ABI.		X				
There is conflicting evidence supporting the use of group-based interventions to treat executive dysfunction post ABI.						X
Dual task training has a positive effect on divided attention and is effective on speed of processing		X				
Attention process training improves cognitive function	X					
The use of computer assisted technology has been found to enhance concentration attention post ABI.		X				
The computer based software TEACH-ware is designed to remediate cognitive-communication skills, improves cognitive and communication outcomes in individuals with ABI.		X				
The presence of a calendar did not improve patients' orientation to time and date.		X				
The use of electronic calendars to assist in improving memory post ATI has been found to be effective.		X				
Virtual reality exercise programs have a positive impact on learning and working memory.		X				
Memory group interventions can improve everyday memory functioning.		X				
Cranial electrotherapy stimulation did not help it improve memory and recall following brain injury.	X					
Internal memory strategies appear to be an effective aid in improving recall performance.		X				
A goal training group is effective in improving attention and executive control.		X				
Computer assisted cognitive retraining is no more effective than therapist administered memory rehab training in enhancing the memories of individual post brain injury.		X				
There is conflicting evidence to support the use of group-based interventions to treat executive dysfunction post ABI						X
Goal management training is effective for improving paper and pencil		X				

everyday tasks and meal preparation skills for persons with an ABI.						
There is evidence to support the effectiveness of interventions that focus on training the communications partners of individuals with severe ABI.		X				
The training of paid caregivers allows them to communicate more effectively with those who sustain an ABI: thus allowing those with ABI to improve their communication.		X				
There is some evidence to support the use of methylphenidate to enhance cognitive function post ABI.						
Donepezil improves attention and short term memory post ABI.	X					
There is conflicting evidence supporting the use of bromocriptine to enhance cognitive functioning.						X
Amantadine has not been shown to help improve learning and memory deficits based on the conclusions of one study.		X				
Citicoline has not been shown to enhance functional or cognitive functioning in individuals who have sustained a TBI.	X					

Module 8 - Treatment of Challenging Behaviour Following Brain Injury

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Currently the evidence supporting using sertraline in the treatment of major depression post ABI is mixed.						X
Citalopram aids in the reduction of depression post ABI.		X				
Citalopram and carbamazepine may be effective in the treatment of depression, anxiety and mood disorders.				X		
Desipramine assist in improving mood and reducing depression.		X				
Cognitive remediation and day treatments are associated with a decrease in depressed mood.		X				
Person with a TBI who exercise have experience fewer depressed moods than those who don't exercise.				X		
A mindfulness-based stress reduction program may be efficacious in reducing depressed mood.				X		
A weak complex of burst-firing magnetic field one per week may be effective in treating depression.				X		
Music therapy does improve depression and anxiety.			X			
Systematic motivational counseling may reduce negative affect.				X		
Teaching coping skills to individuals post TBI helps reduce their levels of anxiety and depression.		X				
CBT does reduce anxiety post ABI.		X				
Bio-feedback assisted relaxation training may be efficacious in alleviating anxiety related symptoms.					X	
To date there are not consistent treatments for OCD following an ABI.						
Standard inpatient psychiatric treatment may be efficacious in decreasing psychiatric symptoms at discharge.			X			
Amantadine does not help to improve negative behavior post injury.		X				
Carbamazepine decreases the incidence of aggressive behaviors.				X		
Lamotrigine helps to reduce inappropriate behaviors post TBI					X	
Valproic acid decreases the incidence of aggressive behavior					X	
Divalproex decreases the incidence of aggressive behavior post TBI				X		
Sertraline HCl and amitriptyline decrease the incidence of aggressive behaviours post ABI.				X		
Pindolol decreases aggression following brain injury.	X					

Propranolol may reduce agitated symptoms following brain injury.	X					
Buspirone may be effective for reducing symptoms of agitation following brain injury.					X	
Quetiapine helps to reduce aggressive behavior.				X		
Ziprasidone has been shown to assist in the controlling of aggressive behaviors post TBI.				X		
Lithium carbonate has been shown to reduce aggressive and agitated behavior following a TBI.					X	
Anti-androgen and counseling helps to reduce sexually aggressive behavior post ABI.				X		
Following an ABI methotrimeprazine has been shown to be safe and effective in controlling agitation.				X		
Methylphenidate has been shown to be effective on speed performance following an ABI.	X					
Methylphenidate can help reduce anger post ABI.		X				
Haloperidol appears to have little negative effect on recovery following TBI.				X		
Droperidol helps to calm brain injured and agitated patients.				X		
A behavioural approach using antecedent management along with feedback of consequences reduces undesirable behavior.				X		
Social skills training has a limited impact on changing inappropriate behaviors and mood disturbances of those who have sustained a severe TBI.	X					
Social skills training reduces aggressive behavior.				X		
A natural setting behavior management program may help to change behavior.		X				
Participating in a coping skills group assisted in improving adaptive coping in the long term.		X				
Anger management reduces aggressive behavior.		X				
Music therapy helps to reduce agitation post ABI.		X				
Music therapy improves the mood of adults who have sustained a TBI.				X		
Neither education nor motivational interviewing has a significant impact on excessive alcohol consumption post TBI.		X		X		
Financial incentives have been shown to encourage participants to continue with their substance addiction therapy following an ABI.		X				

Module 9 - Neuroendocrine Disorders Post ABI

Level of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Those who had sustained a severe ABI were more likely to develop symptoms of SIADH.						
Results of the studies indicate that DI is associated with lower CS, lower GOS and a higher mortality rate.						
IGF-I given post ABI may improve clinical outcomes in patients diagnosed with DI.		X				
Studies have shown that those who suffer from moderate to severe TBIs are at greater risk for developing hormonal deficiencies. This may lead to a poorer outcome following a TBI as hypopituitarism has been shown to negatively influence recovery.						

Module 10 - Post-Traumatic Seizure Disorder						
Levetiracetam is as safe and effective as phenytoin in treatment and prevention of seizures in the intensive care unit in individuals post ABI.	X					
Anticonvulsants given during the first 24 hours post-ABI reduce the occurrence of early seizures (within the first week post-injury).	X					
Anticonvulsants provided shortly post-ABI do not reduce long-term mortality, morbidity, or late seizures.	X					
Seizure prophylactic treatment with either phenytoin or valproic acid results in similar incidences of early or late seizures and mortality rates	X					
Both phenytoin and carbamazepine have negative effects on cognitive performance, particularly on tasks with motor and speed components.	X					
Early glucocorticoid exposure (< 2 days after injury) may increase seizures.		X				
Methylphenidate can be safely used in posttraumatic seizure patients				X		
Intramuscular midazolam may be effective for acute seizure cessation.					X	
Phenytoin does not reduce early or late seizures in children post-ABI.	X					
Surgical excision can benefit patients when the seizure focus can be accurately localized.				X		

Module 11 - Heterotopic Ossification and Venous Thromboembolism

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Forceful joint manipulation under general anesthesia increases range of motion in patients with heterotopic ossification following brain injury.				X		
Continuous passive range of motion devices may increase range of motion.					X	
Etridonate (EHDP) reduces the development of heterotopic ossification in brain injuries.		X				
Surgical excision of heterotopic ossification improves outcomes.				X		
There is no difference in venous thromboembolism events between early vs. late administration of unfractionated heparin in patients with severe closed head injury. Unfractionated heparin does not cause an increase in intracranial bleeding or deterioration.	X					
Low-molecular-weight heparin is more effective than low-dose heparin in preventing venous thromboembolism after severe trauma.	X					
Low-molecular-weight heparin is as effective and safe as unfractionated heparin for the prevention of pulmonary embolism.	X					
Low-molecular weight heparin combined with compression stockings is more effective than compression stockings alone for the prevention of venous thromboembolism after elective neurosurgery and does not cause excessive bleeding.	X					
A combination of low-dose heparin (LDH) and sequential compression devices (SCDs) demonstrate no advantage over SCD alone in reducing DVT rates in critically ill patients.				X		
Intermittent pneumatic compression devices are as effective as low molecular weight heparin for the prevention of DVT in ABI patients				X		

Module 12 – Neuropharmacology Intervention Post ABI

Level of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Bolus opioid administration resulted in increased ICP. The evidence is conflicting						X
Remifentanil results in faster arousal compared to hypnotic based sedation.		X				
Phenytoin and carbamazepine have negative effects on cognitive performance.	X					
Carbamazepine has been found to control seizures while being less harmful to cognitive function and behavior .				X		
Acute intramuscular midazolam can be used for acute seizure cessation.					X	
Phenytoin given during the first week of injury reduces the occurrence of early seizures.	X					
Phenytoin may be effective in reducing the risk of late seizures.		X				
Phenobarbital given post ABI does not reduce the risk of late seizures.		X				
Divalproex descreases the incidence of aggressive behavior post TBI.				X		
Valproic acid decreases the incidence of aggressive behaviors.					X	
Lamotrigine helps to reduce inappropriate behaviors post TBI.					X	
Cerebrolysin improves bioelectrical activity, cognitive performance, and clinical outcome.				X		
Donepezil improves attention and short-term memory.	X					
Donepezil is effective in improving memory post ABI				X		
Physostigmine improves memory in men with brain injury.	X					
Physostigmine combined with a memory training programme produces a clinically significant improvement in memory function, but does not produce significant changes in attention, concentration, cognitive flexibility or motor speed.					X	
There is conflicting evidence that sertraline is effective in the treatment of major depression post TBI.						X
Citalopram aids in the reduction of depression post ABI.		X				
Citalopram and carbamazepine may be efficacious in the treatment of anxiety and mood disorders.				X		
The administration of desipramine assists in improving mood and		X				

reducing depression.						
Sertraline and amitriptyline decrease the incidence of aggressive behaviours.				X		
Lithium carbonate reduces aggressive or agitated behaviour following a TBI.					X	
Quetiapine has to shown to help reduce aggressive behaviour.				X		
Ziprasidone assists in the controlling of aggressive behaviours post TBI.				X		
Haloperidol does not have a negative effect on the success of rehabilitation.				X		
Droperidol calms agitated behaviour of those who have sustained a TBI more quickly then other agents.				X		
Phenol nerve block reduces contractures and spasticity for 5 months post injection.					X	
Oral baclofen improve lower extremity spasticity but not upper extremity spasticity.					X	
Oral tizanidine improve lower and upper extremity spasticity.	X					
Botulinum toxin type A injections may be effective in the management of localized spasticity following ABI.		X				
Intrathecal baclofen injections produce short-term reduction in upper and lower extremity spasticity.	X					
Prolonged intrathecal baclofen results in longer-term reduction in spasticity in both the upper and lower extremities following an ABI.				X		
Intrathecal baclofen results in short term improvement in walking performance.				X		
There is conflicting evidence regarding the efficacy of pentobarbital over conventional ICP management measures.						X
There is no difference between thiopental and phenobarbital in the control of elevated ICP.		X				
Pentobarbital is no better than mannitol for the control of elevated ICP.		X				
Barbiturate therapy may cause reversible leukopenia, granulocytopenia and systemic hypotension.				X		
Barbiturate therapy and hypothermia may result in improve clinical outcomes up to one year post injury.				X		
Etridonate reduces the development of HO in severe head injury patients.		X				

Dexanabinol does not provide acute improvements in ICP or long-term clinical benefits post ABI.	X					
Pindolol decreases aggression following brain injury.	X					
Propranolol may reduce aggressive and agitated symptoms following brain injury.	X					
Sodium lactate is more effective than mannitol for the management of acute elevations in ICP.	X					
Higher doses of mannitol are superior to conventional mannitol in improving mortality rates and clinical outcomes.		X				
Early out of hospital administration of mannitol does not adversely affect blood pressure.		X				
Mannitol is effective in diminishing intracranial hypertension only when initial ICP values are elevated.				X		
Amantadine may improve levels of consciousness and cognitive function in patients in various stages of coma	X					
Amantadine facilitates the rate of recovery post TBI			X			
Amantadine does help to improve executive functioning based on the conclusions of a single group intervention. It does not improve memory or attention deficits.				X		
Amantadine does not help to improve behaviour.		X				
Dopamine-enhancing drugs facilitate rate recovery post TBI				X		
There is conflicting evidence supporting the use of bromocriptine to enhance cognitive functioning.						X
Bromocriptine improves all motivational deficits except mood.				X		
Bromocriptine significantly improve memory impairments.					X	
Dexamethasone inhibits endogenous production of glucocorticoids and has no proven impact on recovery post brain injury.	X					
Antiandrogen and counseling reduces sexually aggressive behaviour.				X		
Progesterone improves GOS and modified FIM scores and decreases mortality rates in ABI patients.	X					
There is conflicting evidence regarding the effectiveness of that administration of methylphenidate following brain injury for the improvement of cognitive functioning.						X
Methylphenidate does not improve the sleep wake cycle of those who have sustained a TBI.		X				
There is conflicting and inconclusive evidence that methylphenidate						X

interventions improve cognitive behavioural function in children post ABI.						
Modafinil is not effective in treating fatigue or excessive daytime sleepiness post ABI.	X					
ICP may be reduced by Propofol in combination with morphine.		X				
Lorezapam and zopiclone work equally well in assisting with insomnia.	X					
Midazolam has no effect on ICP.		X				
Acute intramuscular midazolam can be used for acute seizure cessation.					X	
Methylprednisolone increases mortality rates in ABI patients and should not be used.	X					
Dexamethasone does not improve ICP levels and may worsen them.	X					
Glucocorticoid administration may increase the risk of developing late seizures.			X			

Module 13 - Community Reintegration Following ABI

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
Self awareness training has little impact on the individuals awareness of their disability.	X					
Hospital-based (outpatient) or community based rehabilitation does improve the level of independence for persons with an acquired brain injury as confirmed by a number of non-randomized studies.		X				
Community based life skills training does improve community integrations, although it has little effect on an individual's satisfaction with life.			X			
There have been some positive effects noted when looking at general rehabilitation efforts on social integration.				X		
Primary care givers experience significant levels of stress, burden and depression.						
Social work liaison alleviates caregiver burden, and improves satisfaction and mastery.		X				
Behavioral management in combination with caregiver education does not decrease caregiver burden.		X				
An educational program provided to caregivers and their family member with ABI will decrease caregiver burden.		X				
There is need for increased caregiver support.		X				
The relationship between life satisfaction and patient disability does not appear to be a linear one.						
More intensive and structured cognitive rehabilitation therapy provided in both groups and individual settings improves participants' satisfaction with community integration and cognitive functioning outcomes compared with standard, less structured multidisciplinary rehabilitation.		X				
There is a reciprocal relationship between cognitive function and community integration.		X				
Social support groups improve measures of hopelessness leading to a greater sense of control and empowerment.				X		
Following an ABI, those patients who reintegrate into vocational activities return to lower levels of employment or schooling, and only a					X	

small number are able to return to vocational activities which are comparable to pre-morbid levels.						
Returning to work helps reduce levels of depression		X				
Cognitive strategies increase the proportion of patients who successfully return to full time vocational activities following brain injury.		X				
Supported employment strategies following brain injury cause improvements in competitive job placement and retention.		X				
Vocational rehabilitation strategies are more effective when they are implemented earlier following the injury.		X				
Driving appear to be more likely for patients with less severe injuries						
Participation in a multidisciplinary rehabilitation program increases the percentage of patients who return to driving following an ABI.				X		
There is a high incidence of accidents in ABI survivors who return to driving which may be related to patients prematurely returning to driving						

Module 14 - Pediatric Interventions in Acquired Brain Injury Rehabilitation

Levels of Evidence	Level 1	Level 2	Level 3	Level 4	Level 5	Conflicting
There is conflicting evidence supporting the use of hypothermia and its effectiveness in decreasing the risk of poor outcomes with children post ABI.					X	
Use of hypertonic saline in the ICU setting results in a lower frequency of multiple early complications and a shorter ICU stay compared with lactated Ringer's solution.	X					
Amantadine improves the level of consciousness in children post ABI.	X					
Amantadine and pramipexole has been shown to improve the levels of consciousness in TBI children and adolescents.	X					
Dopamine-enhancing drugs facilitate rate recovery post-traumatic brain injury.				X		
Food texture are important when feeding children post ABI					X	
Behavioural therapies for children with ABI are effective at reducing or eliminating problematic behaviours.				X		
Programs specifically designed to deal with cognitive impairments following brain injury are beneficial for the improvement of attention for a pediatric population.	X					
Intellectual function is significantly increased with cognitive rehabilitation.		X				
VR programs may help to improve attentional deficits in children post ABI			X			
The use of a pager system have been shown to in the improvement of memory and planning in adolescents with a TBI		X				
Intellectual function is significantly increased with cognitive rehab.		X				
Online aids improve executive function with those who have sustained a severe TBI.		X				
Online aids have been found to be effective in teaching problem solving skills post ABI.					X	
Peer-group training of pragmatic language skills benefit children with communication deficits following brain injury.				X		
Injury-related information interventions do not improve knowledge or awareness of injury-related deficits, memory function or behavioural		X				

problems in children.						
Home based exercise programs do increase functional balance in children who have sustained an ABI or have been diagnosed with CP.	X					
Cognitive therapies for children with ABI lead to improved cognitive functioning.				X		
Web-based programs are effective in reducing depression symptomology.	X					
Multidisciplinary outpatient programs may improve functional abilities following brain injury for children.				X		
Family-based interventions are more beneficial for improving outcomes of children with brain injury than usual, clinician-directed care based interventions.		X				
Amantadine can decrease the amount of behaviours among children with an ABI.		X				
Amantadine facilitates rate recovery post-traumatic brain injury.			X			
Administration of dexamethasone inhibits endogenous production of glucocorticoids and has no proven impact on recovery post brain injury.	X					
Amantinde and pramipexole improves the levels of consciousness in both children and adolescents who sustain an ABI	X					
Dopamine enhancing drugs facilitate rate recovery post traumatic brain injury.				X		
It is not clear if methylphenidate interventions improve cognitive behavioural function in children post acquired brain injury.						X
Upper limb lycra splints may improve the quality of movement in some children with traumatic brain injury.					X	
Botulinum toxin type A (BTX-A) is an effective treatment for children and adolescents with upper limb spasticity.				X		
Constraint induced movement therapy in children can lead to an improvement in level of functioning of the affected limb.				X		
Studies have noted that the lack of visual response at ophthalmologic examinations of SBS individuals may lead to fatal outcomes.						
The presence of poor papillary response, the presence of a RH, a midline shift, circular perimacular retinal folds and peripheral retinschisis may be more likely to lead to fatal outcomes among individuals with SBS.						

The role of education programs on infant crying for new or young parents has been found to be effective in preventing SIDS	X					

Fatigue and Sleep Disorders Post ABI						
Individuals who sustain a TBI feel greater levels of fatigue post injury.						
Higher levels of fatigue may lead to a poorer quality of life			X			
Individuals who sustain a TBI do experience greater fatigue and a decrease in vigilance than those without an injury			X			
Modafinil is not effective in treating fatigue or excessive daytime sleepiness post ABI	X					
Cognitive behavioural therapy may assist in treating insomnia and help in the management of fatigue post ABI					X	
Methylphenidata does not improve the sleep-wake cycle of those who have sustained a TBI.		X				
Lorezapam and zopiclone work equally well in assisting with insomnia symptoms fatigue post ABI.	X					

Acute Interventions for Acquired Brain Injury						
Elevating the head by 30 degrees improves intracranial and cerebral perfusion pressures.		X				
Propofol may help to reduce ICP and the need for other ICP and sedative interventions when used in conjunction with morphine		X				
Infusions of propofol greater than 4mg/kg per hour should be undertaken with extreme caution					X	
Sodium lactate is more effective than mannitol for the management of acute elevations in ICP.	X					
High dose mannitol results in lower mortality rates and better clinical outcomes compared with conventional mannitol.		X				
Early out of hospital administration of mannitol does not negatively affect blood pressure.		X				
Mannitol is effective in lowering intracranial hypertension only when initial ICP values are abnormally elevated.				X		
Midazolam has no effect on ICP.		X				
There is conflicting evidence regarding midazolam effect on MAP and CPP						X
Bolus opioid administration resulted in increased ICP.	X					
The evidence regarding the effects of opioid infusion on ICP levels is conflicting.						X
Remifentanil results in faster arousal compared to hypnotic based sedation.		X				
The use of tromethamine, a weak base and buffer that crosses the blood brain barrier, can offset the deletrious effects of prolonged hyperventilation and lead to better outcomes than hyperventilation alone.		X				
Hyperoxia can counteract the deleterious effects of hyperventilation for the control of ICP following brain injury.				X		
Hyperventilation below 34 torr arterial CO_2 can cause an increase in regionally hypoperfused tissue.				X		
Cerebrospinal fluid drainage decreases intracranial pressure in the short term.	X					
The efficacy of phentobarbital over conventional ICP management						X

measures has not yet been proven.						
There is no difference between thiopental and pentobarbital in the control of elevated ICP.		X				
Pentobarbital is not better than mannitol for the control of elevated ICP.		X				
Barbiturate therapy may cause reversible leucopenia, granulocytopenia and systemic hypotension.				X		
A combination of barbiturate therapy and hypothermia may result in improved clinical outcomes up to one year post injury				X		
Standard trauma craniectomy is more effective than limited craniectomy in lowering elevated ICP and leading to better GOS outcome at six months.		X				
Decompressive craniectomy reduces elevated ICP but does not significantly improve clinical outcomes post ABI in children.	X					
Resection of a larger bone flap results in greater decreases in ICP reduction after craniectomy, better patient outcome and leads to fewer post surgical complications.			X			
Hypertonic saline reduces ICP more effectively than mannitol.	X					
Hypertonic saline results in similar clinical outcome and survival when compared with treatment with Ringer's lactate solution up to six months post injury.	X					
Use of hypertonic saline in the ICU, with children, results in a lower frequency of multiple early complications and a shorter ICU stay compared with Ringers's lactate.	X					
Saline solution results in decreased rates of motrality compared with albumin.	X					
Hypertonic saline reduces elevated ICP refractory to conventional ICP management measures.				X		
Hypertonic saline may be useful as a component of a resuscitation algorithm by increasing cerebral oxygenation.				X		
Continuous rotational therapy does not worsen intracranial pressure in severe brain injury patients.				X		
Prone position may increase oxygenation and CPP in ABI patients with acute respiratory insufficiency.				X		
Hyperthermia lowers elevated ICP.	X					
There is conflicting evidence regarding hypothermia's effect on						X

mortality or clinical outcomes.						
Systemic hypothermia is associated with an increased incidence of pneumonia.	X					
Treatment with hyperbaric oxygen positively improves mortality.	X					
Treatment with hyperbaric oxygen leads to better functional outcomes 6-12 months post injury.						X
Treatment with hyperbaric oxygen temporarily lowers elevated ICP up to 6 hours most treatment.				X		
Methylprednisolone increases mortality rates in ABI patients.	X					
Triamcinolone may improve outcome in patients with a GCS <8 and a focal lesion		X				
Dexamethasone does not improve ICP levels and may worsen outcome in patients with ICP >29mmHG.	X					
Glucocorticoid administration may increase the risk of developing first last seizures.			X			
Progesterone improves GOS and modified FIM scores and it has been found to decrease mortality rates in patients with an ABI.	X					
Some bradykinin antagonists prevent acute elevations in ICP post ABI.	X					
Conclusive evidence supporting the use of bradykinin antagonists to improve functional clinical outcomes such as GOS has not yet been found.						X
Dimethyl sulfoxide transiently reduces ICP elevations.				X		
Dexanabinol does not provide acute improvements in ICP for long-term clinical benefits post ABI.	X					
Amantadine may improve levels of consciousness and cognitive function in patients in various stages of coma.	X					
Sensory stimulation, provided by family members, may help to improve consciousness of severe ABI patients with a GCS between 6 and 8.	X					
Sensory stimulation may improve clinical outcomes, physiological parameters and behaviours indicative of emergence from coma post ABI.		X				
Music therapy might be useful in promoting emergence from coma post-ABI.				X		
Median nerve electrical stimulation does not improve emergence from coma post-ABI.		X				

There is insufficient evidence to draw any conclusions regarding the ideal structure of a complete model of ABI care.						

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