

## ORIGINAL ARTICLE

# Traumatic Brain Injury in Patients With Traumatic Spinal Cord Injury: Clinical and Economic Consequences

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**ABSTRACT.** Bradbury CL, Wodchis WP, Mikulis DJ, Pano EG, Hitzig SL, McGillivray CF, Ahmad FN, Craven BC, Green RE. Traumatic brain injury in patients with traumatic spinal cord injury: clinical and economic consequences. *Arch Phys Med Rehabil* 2008;89(12 Suppl 2):S77-84.

**Objective:** To evaluate the clinical and economic burden of traumatic brain injury (TBI) in people with traumatic spinal cord injury (SCI).

**Design:** Prospective, case-matched control study.

**Setting:** Inpatient spinal cord rehabilitation program.

**Participants:** Patients (n = 10) diagnosed with traumatic SCI and concomitant TBI matched to an SCI-only control group.

**Interventions:** Not applicable.

**Main Outcome Measures:** Inpatient rehabilitation length of stay, health care costs (patient care hours), clinician resource allocation, behavioral and critical incidents, FIM, Personality Assessment Inventory, and neuropsychological assessment findings.

**Results:** Prolonged loss of consciousness, increased rehabilitation costs, and greater demands on clinician resources (trend) were found in the SCI with TBI group relative to the SCI-only group. Neuropsychological test performance was significantly worse in the SCI with TBI group, while the FIM cognition score did not discriminate because of ceiling effects. Greater evidence of psychopathology was observed in the SCI with TBI group.

**Conclusions:** The presence of TBI in SCI has a range of clinical and economic consequences. This dual diagnosis has the potential to affect SCI rehabilitation negatively, as well as quality of life and reintegration in the community. Specialized care appears to be needed to improve outcomes and to minimize clinical and economic burden, but further research is required.

**Key Words:** Brain injuries; Rehabilitation; Spinal cord injuries.

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**T**HE CO-OCCURRENCE OF TBI with traumatic SCI represents a comorbidity with debilitating consequences. This dual diagnosis can pose clinical challenges that are more complex than either of these traumas on its own.<sup>1</sup> At present, there is a paucity of specialized dual diagnosis care, although it has been suggested that specialized care is critically needed to improve rehabilitation outcomes.<sup>1-3</sup> Aside from the complexity and expense, we suggest that the lack of specialized care may be a result of a dearth of information regarding the clinical and economic impact of TBI on patients with SCI. Thus, a fuller understanding of the impact of TBI on SCI may well be of significant clinical import.

In most cases of traumatic SCI and TBI, the causes of injury are the same, with motor vehicle collisions and falls accounting for approximately 70% of all TBI and traumatic SCI.<sup>3-5</sup> Co-occurrence is common, with estimates of dual diagnosis ranging from approximating 25% of all traumatic SCIs to over 70%.<sup>3-14</sup> Methodologic differences across studies likely explain this disparity.<sup>15</sup> For example, incidence studies have differed in experimental design (eg, prospective vs retrospective),<sup>10,12-14</sup> inclusion criteria,<sup>16</sup> time postinjury,<sup>7,11,17</sup> sampling techniques,<sup>18</sup> and diagnostic criteria for TBI.<sup>1,13</sup>

While even the most conservative estimates of dual diagnosis are of scientific interest and clinical concern, there is little research to date on its clinical and economic consequences. Conventional SCI rehabilitation involves the acquisition of new knowledge and skills in order to regain functional independence and facilitate recovery.<sup>18-20</sup> Cognitive sequelae would logically hamper or prolong this relearning.<sup>21</sup> Moreover, behavioral sequelae might impede progress by causing patients to be branded as "difficult."<sup>22</sup> Rehabilitation costs should also be higher if rehabilitation takes longer and/or is less effective. Arraga et al<sup>2</sup> speculated that the post-SCI medical and adjustment difficulties would be compounded by the presence of concurrent TBI; however, to our knowledge, only 2 studies have empirically examined this speculation. Richards et al<sup>23</sup> conducted a prospective evaluation of the long-term consequences of TBI on SCI. Here, patients with dual diagnosis were compared with a matched SCI-only group on measures of

## List of Abbreviations

GCS	Glasgow Coma Scale
LOC	loss of consciousness
LOS	length of stay
MRI	magnetic resonance imaging
PAI	Personality Assessment Inventory
PTA	posttraumatic amnesia
SCI	spinal cord injury
TBI	traumatic brain injury
WAIS-III	Wechsler Adult Intelligence Scale- Third Edition
WMS-III	Wechsler Memory Scale- Third Edition
WTAR	Wechsler Test of Adult Reading

From the Toronto Rehabilitation Institute (Bradbury, Wodchis, Pano, Hitzig, McGillivray, Craven, Green); Department of Health Policy, Management and Evaluation (Wodchis); Graduate Department of Rehabilitation Sciences (Pano, Green), and the Department of Medicine (Craven, Mikulis, McGillivray), University of Toronto; Department of Psychology, York University (Hitzig); Toronto Western Hospital (Mikulis), Toronto, ON, Canada.

Supported by the Ontario Neurotrauma Foundation (grant no 2005-AB1-392).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

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0003-9993/08/8912S-0026\$5.00/0

doi:10.1016/j.apmr.2008.07.008

# Economic Consequences Of Traumatic Spinal Cord Injury

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## **Economic Consequences Of Traumatic Spinal Cord Injury:**

**The Economic Consequences of Traumatic Spinal Cord Injury** Monroe Berkowitz, 1992-01 This is a unique contribution to our understanding of the demographics economics of living with spinal cord injury SCI It is a comprehensive analysis of who becomes spinal cord injured occupational data before after SCI the impact of SCI on life style career goals The book discusses the direct costs of SCI including hospitalizations medical care expenditures on home modifications equipment medications as well as indirect costs lost wages changes in family life These costs are aggregated over the entire SCI population an estimate made of lifetime costs for the present future SCI population The book will be of interest to physicians involved in the care of SCI patients to lawyers economists sociologists survey researchers involved in disability long term care

**Multiple Sclerosis** June Halper, Nancy Holland, 2005-06-01 Education about multiple sclerosis has traditionally been medically oriented and related to disease and dysfunction In contrast this brand new second edition of the Guide continues to focus on staying well in the presence of MS a disease that while incurable can be managed The book covers a broad spectrum of topics related to MS and its effects focusing especially on the needs of those who have been living with the disease for some time Practical tips on self care are designed to promote maximum independence well being and productivity The theme of the book wellness can be described by the acronym Weighing options Eating well Living to your fullest Learning new skills Needing others Evaluating situations realistically Surviving stress and Staying responsible Contributors to the book are professionals who have a specialty or a special interest in MS Their suggestions advice and strategies come from years of experience in the field It is their hope that readers will come away with fresh ideas on how to cope with the ever changing challenges of MS

*Journal of Rehabilitation Research and Development* ,2002

**Spinal Cord Medicine, Second Edition** Christopher M. Bono, Diana Cardenas, Frederick S. Frost, Margaret C. Hammond, Laurie B. Lindblom, Inder Parkash, Steven A. Stiens, Robert M. Woolsey, 2010-03-19 A Doody's Core Title 2012 The thoroughly revised Second Edition of this authoritative reference continues to define the standard of care for the field of spinal cord medicine Encompassing all of the diseases and disorders that may affect the proper functioning of the spinal cord or spinal nerves this comprehensive volume provides a state of the art review of the principles of care and best practices for restoring function and quality of life to patients with spinal cord injuries Expert contributors from multiple disciplines cover topics ranging from acute medical and surgical management of specific problems to cutting edge research bladder bowel and sexual dysfunction neurologic and musculoskeletal issues advanced rehabilitation techniques and technologies functional outcomes and psychosocial care While comprehensive in scope Spinal Cord Medicine offers practical guidance for physicians and other health care professionals involved in the management of individuals with SCI multiple sclerosis and other spinal cord disorders The Second Edition has been completely updated to fully reflect current science and practice Each section has been re ordered to better present information and the Second Edition brings in many new authors and topics more diagrams

illustrations and tables to solidify concepts and contains 18 entirely new chapters Spinal Cord Medicine Principles and Practice Second Edition reflects the breadth and depth of this multi faceted specialty Involving over 150 authors from more than 20 fields of medicine it is a trusted reference for anyone who works with spinal cord patients and strives to deliver superior clinical care and improve outcomes      **National Highway System Designation Act of 1995** United States.

Congress. Senate. Committee on Environment and Public Works. Subcommittee on Transportation and Infrastructure,1995

**Aging with Spinal Cord Injury** Gale G. Whiteneck, PhD, Maan H. Jawad,1993 This is the first book to integrate the theory design and stability analysis of plates and shells in one comprehensive volume With authoritative accounts of diverse aspects of plates and shells this volume facilitates the study and design of structures that incorporate both plate and shell components      **Restorative Neurology of Spinal Cord Injury** Milan R. Dimitrijevic,2012-01-12 Following injury or disease

neural circuitry can be altered to varying degrees leading to highly individualized characteristics that may or may not resemble original function In addition lost or partially damaged circuits and the effects of biological recovery processes coupled with learned compensatory strategies create a new neuroanatomy with capabilities that are often not functional or may interfere with daily life To date the majority of approaches used to treat neurological dysfunction have focused on the replacement of lost or damaged function usually through the suppression of surviving neural activity and the application of mechanical assistive devices Restorative Neurology of Spinal Cord Injury offers a different and novel approach Focusing on the spinal cord and its role in motor control the book details the clinical and neurophysiological assessment process and methods developed throughout the past half century by basic and clinical scientists Then through the use of specialized clinical and neurophysiological testing methods conduction and processing performed within the surviving neural circuitry is examined and characterized in detail Based on the results of such assessment treatment strategies also described in this book are applied to augment rather than replace the performance of surviving neural circuitry and improve the functional capacity of people who have experienced injury to their spinal cords      *Trauma* Eric Legome, Lee W. Shockley,2011-06-16

*Trauma A Comprehensive Emergency Medicine Approach* is a fully illustrated interdisciplinary overview of trauma Using both evidence based approaches and a practical understanding of the emergency department it gives a broad and in depth review of trauma care The entire spectrum of trauma presentations is reviewed from minor soft tissue injuries through to major life threatening conditions Written by over 50 expert contributors it gives concrete and practical recommendations for evaluation treatment consultation and disposition decisions on both common and unusual conditions Extensive use of photographs illustrations and key information boxes is used to make the material accessible Additional sections provide an overview of multiple other issues relating to emergency management of trauma including administrative nursing research and legal matters This book provides an essential reference for anyone who is called upon to provide acute trauma care in the emergency department      Journal of Rehabilitation Research & Development ,2002      **American Rehabilitation**

,2004 *Spinal Cord Injury* Monroe Berkowitz,1998-10 Explores in detail elements that make up both the medical and nonmedical direct costs of spinal cord injury focusing on the costs of home modifications vehicle adaptations and wheelchairs and on the determinants of employment for people with spinal cord injury Contains sections on basic demographics and injury characteristics direct and indirect costs lifetime costs and employment and income Includes appendices of statistics and a survey instrument Annotation copyrighted by Book News Inc Portland OR Vocational Rehabilitation Program United States. Congress. House. Committee on Veterans' Affairs. Subcommittee on Education, Training, and Employment,1993 *Veterans Small Business Loans* United States. Congress. House. Committee on Veterans' Affairs. Subcommittee on Housing and Memorial Affairs,1993 **The Future of Social Security for this Generation and the Next** United States. Congress. House. Committee on Ways and Means. Subcommittee on Social Security,1998 **National Library of Medicine Current Catalog** National Library of Medicine (U.S.),1993 *Tracheostomy and Ventilator Dependence in Adults and Children* Roxann Diez Gross,Kristin A. King,2023-04-27 The first of its kind *Tracheostomy and Ventilator Dependence in Adults and Children Learning Through Case Studies* provides clinicians educators and students in the fields of speech pathology otolaryngology nursing and respiratory care with detailed descriptions of real world interventions and treatment strategies A wide variety of tracheostomy and ventilator dependency cases are presented including congenital acquired and progressive illnesses surgical cases and COVID 19 pandemic case studies The case studies also address both pediatrics and adults in many settings such as outpatient inpatient acute care and rehabilitation ICU and home care Written in an engaging tone that focuses on the humans behind the diagnoses the case studies offer a holistic approach that integrates what is known about physiology and treatment methods into the context of actual patients and their lives Heterogeneous ever changing and highly complex this patient population requires skillful and innovative approaches across disciplines Readers may use this inspiring and educational text as a resource selecting a case that is similar to one they are facing or may face in the future which may ultimately help them navigate speech phonation vent weaning and swallowing objectives for their own patients Each case has a title indicating the primary diagnosis so that readers may easily choose cases that are relevant to their clinical practice or educational objectives Sourced from speech pathologists respiratory therapists nurses and physicians from around the world the well rounded clinical perspectives in these challenging and thought provoking case studies will facilitate learning and enhance the knowledge of health care professionals thus helping to improve the care and outcomes of pediatric and adult patients with tracheostomy or ventilator dependence The book may also be used to supplement academic coursework for health care professionals in fields such as medical speech language pathology by providing real world examples of patient care for problem based learning Key Features Full color clinical photographs featuring patients and interventions Background information related to the specific issue and physiologic underpinnings Case history of the patient including the environment where treated The problem to be

solved or goal to be achieved The decisions that led to the plan treatment or intervention The logic physiologic basis or research behind the treatment intervention strategies Peer reviewed references     Disability Studies Quarterly ,1994

**Pain Management** Gabor Racz,Carl E. Noe,2012-01-18 Pain Management Current Issues and Opinions is written by international experts who cover a number of topics about current pain management problems and gives the reader a glimpse into the future of pain treatment Several chapters report original research while others summarize clinical information with specific treatment options The international mix of authors reflects the casting of a broad net to recruit authors on the cutting edge of their area of interest Pain Management Current Issues and Opinions is a must read for the up to date pain clinician     **Morbidity and Mortality Weekly Report** ,1994-12     *National Highway System Designation Act of 1995: February 23 and March 23, 1995* United States. Congress. Senate. Committee on Environment and Public Works. Subcommittee on Transportation and Infrastructure,1995

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