Indirect Cost of Traumatic Brachial Plexus Injuries in the United States

Thomas S. Hong, MD MS1; Andrea Tian, MD1; Ryan Sachar BS1, Wilson Z. Ray, MD, David M. Brogan, MD, MSc1; Christopher J. Dy, MD, MPH1,3

1 Department of Orthopaedic Surgery, Division of Hand and Upper Extremity Surgery
2 Department of Neurosurgery
3 Department of Surgery, Division of Public Health Sciences
Washington University School of Medicine – St. Louis, MO

INTRODUCTION

• Traumatic brachial plexus injuries (BPI) pose a significant economic burden to the United States healthcare system, as they disproportionately affect young, able-bodied patients
• Beyond the direct costs associated with medical treatment, there are far-reaching indirect costs for BPI patients relating to workforce productivity that have not yet been estimated
• Objective: Estimate the per-patient indirect cost associated with traumatic BPI

METHODS

• We estimated indirect costs as the sum of (1) short-term wage losses; (2) long-term wage losses; and (3) disability payments
  - Short-term (6 month) wage losses were the product of missed work days and average earnings per day accounting for fringe benefits
  - Long-term wage losses and disability payments were estimated
    - Probability of return to work was derived from a systematic review
    - Permanent total and partial disabilities
    - Permanent total disability was estimated as being equal to lifetime earnings using the methods used in the Web-based Injury Statistics Query and Reporting System (WISQARS) Cost of Injury module
      - The equation to calculate lifetime earnings for a person of age \(a\) and sex \(b\) is as follows:
        \[
        \text{Lifetime earnings} = \sum_{k=a}^{\infty} \left( P_a,b(k) \times Y_k,b \times \left( 1 + \frac{g}{100} \right)^{k-a} \right)
        \]
        where \(P_a,b(k)\) is the probability that a person of age \(a\) and sex \(b\) will live until age \(k\), \(Y_k,b\) is the average value of annual earnings with fringe benefits for a person of age \(k\) and sex \(b\), \(g\) is the productivity growth rate which was set at 0.01 for earnings, and \(d\) is the discount rate set to 0.03
  - Probabilities of survival \(P_a,b(k)\) were calculated from the 2014 CDC’s National Vital Statistics Reports’ United States Life Tables
  - Earnings by age and sex were obtained from the Annual Social and Economic Supplement of the Current Population Survey obtained through the University of Minnesota’s IPUMS archives
  - The earnings data from 2010 to 2017 were combined and adjusted to 2018 dollars using the Employee Cost Index obtained through the US Department of Labor
  - Monte Carlo simulation was used to perform a sensitivity analysis of long-term wage losses by varying age and gender simultaneously
  - Disability benefits were estimated from the Social Security Administration. All cost estimates are in 2018 US dollars

RESULTS

• Systematic review demonstrated the following demographics for BPI patients:
  - Mean age 26.43 years, 90.5% male, most-represented occupation is manual labor
  - Our base case: 26 year-old American man working as a manual laborer prior to BPI, with an annual wage of $36,590
  - Monte Carlo simulation estimates:
    - Short-term wage losses: $22,740
    - Long-term wage losses: $813,652
    - Disability benefits: $384,606
  - Total indirect cost of traumatic BPI: $1,220,998 (per patient over the post-injury lifetime)
  - If the probability of the patient returning to the workforce in a different, lower-paying job is doubled, per-patient total indirect cost is $867,987.

CONCLUSION

• Traumatic BPI are devastating injuries that disproportionately impact young adults
• Beyond loss of physical function for the patient, there are societal implications including loss of productivity at work, absence from work, and disability.
• Indirect cost estimate per patient suggests that traumatic BPI has a far-reaching economic impact
• Continued need for allocation of resources with the goals of improving patient outcomes and restoring patient’s ability to return to employment
• With continued efforts to improve clinical outcomes, the indirect cost of BPI from both the patient and society could be dramatically decreased

Table 1: Bureau of Labor Statistics, Occupational Employment Statistics included in estimating short term wage losses, May 2017

<table>
<thead>
<tr>
<th>Occupation Code</th>
<th>Occupation Title</th>
<th>Mean Hourly Wage</th>
<th>Mean Annual Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-000</td>
<td>Food Preparation and Serving Related Occupations</td>
<td>$11.88</td>
<td>$24,730</td>
</tr>
<tr>
<td>37-000</td>
<td>Building and Grounds Cleaning and Maintenance Occupations</td>
<td>$13.91</td>
<td>$28,930</td>
</tr>
<tr>
<td>41-000</td>
<td>Farming, Fishing, and Forestry Occupations</td>
<td>$13.87</td>
<td>$28,840</td>
</tr>
<tr>
<td>47-000</td>
<td>Construction and Extraction Occupations</td>
<td>$24.01</td>
<td>$49,930</td>
</tr>
<tr>
<td>49-000</td>
<td>Installation, Maintenance, and Repair Occupations</td>
<td>$23.02</td>
<td>$47,870</td>
</tr>
<tr>
<td>53-000</td>
<td>Production Occupations</td>
<td>$18.30</td>
<td>$38,070</td>
</tr>
<tr>
<td>53-000</td>
<td>Transportation and Material Moving Occupations</td>
<td>$17.82</td>
<td>$37,070</td>
</tr>
<tr>
<td>Combined</td>
<td></td>
<td>$17.22</td>
<td>$35,837</td>
</tr>
</tbody>
</table>

Table 2: Sensitivity analysis of indirect cost with variation in return-to-work probability after brachial plexus injury

<table>
<thead>
<tr>
<th>Probability of return to work (%)</th>
<th>Short-term wage losses</th>
<th>Long-term wage losses</th>
<th>Disability benefits</th>
<th>Total indirect cost of BPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>$22,740</td>
<td>$813,652</td>
<td>$384,606</td>
<td>$1,220,998</td>
</tr>
<tr>
<td>50%</td>
<td>$33,170</td>
<td>$997,178</td>
<td>$519,000</td>
<td>$1,850,348</td>
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<tr>
<td>60%</td>
<td>$43,600</td>
<td>$1,180,692</td>
<td>$653,732</td>
<td>$2,220,438</td>
</tr>
<tr>
<td>70%</td>
<td>$54,030</td>
<td>$1,364,216</td>
<td>$788,464</td>
<td>$2,617,710</td>
</tr>
<tr>
<td>80%</td>
<td>$64,460</td>
<td>$1,547,738</td>
<td>$923,198</td>
<td>$3,019,026</td>
</tr>
<tr>
<td>90%</td>
<td>$74,890</td>
<td>$1,731,262</td>
<td>$1,057,932</td>
<td>$3,501,485</td>
</tr>
</tbody>
</table>

MARKOV model for indirect cost calculation

ACKNOWLEDGEMENTS AND FUNDING

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