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Original Research

Direct Cost of Surgically Treated Adult Traumatic Brachial Plexus Injuries



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Purpose: The economic implications of brachial plexus injuries (BPI) in the United States are not well understood. The purpose of our study was to quantify the direct costs associated with surgical treatment of BPI after traumatic injury in adults, which would enable future study of the societal value of surgical reconstruction.

Methods: Using an administrative database of patients with commercial insurance, a cohort of patients aged 18 to 64 years with BPI treated surgically from 2007 to 2015 was assembled and assessed for index admission associated with BPI surgery and all payments toward claims (including medical, surgical, therapy, and pharmacy claims) for 1 year after surgery.

Results: Among 189 patients undergoing surgery for BPI, median direct payments were \$38,816 (interquartile range: \$18,209 to \$72,411; minimum: \$3,512; maximum: \$732,641).

Conclusions: Relative to recently published data for the indirect cost of traumatic BPI (median: \$801,723), direct payments for 1 year after surgical treatment represent 4.6% of the total long-term cost of BPI. In the context of existing literature demonstrating cost-effectiveness in models of BPI surgical care, our data suggest that surgery and other interventions to maximize return to work after traumatic BPI in adults may be beneficial to society.

Type of study/level of evidence: Economic and Decision Analyses IV.

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Brachial plexus injuries (BPI) often have a debilitating and profound effect on patients because of the devastating and sudden loss of function of the shoulder, arm, and hand. This sudden change drastically affects patients' ability to complete the most basic daily activities and challenges their self-image.^{1,2} Surgical treatment is generally effective at improving upper-extremity function,³ but awareness of its effectiveness is lacking among referring physicians.^{1,2} During the recovery process, many patients are away from

work for a year or longer while they recuperate; most patients change occupations to account for the alteration in their physical abilities.^{4–6} The extensive nature of surgical reconstruction and the prolonged time off work have the potential to garner substantial direct and indirect costs, respectively, to the individual and society. Understanding the fiscal impact of BPI is especially necessary because it primarily affects young working-age patients whose most productive years are disrupted by the injury.

Despite these direct and indirect costs incurred during treatment of BPI and the tremendous investment of resources toward this treatment, little has been published on the economic impact of BPI. A single study tallied hospitalization charges associated with BPI surgery in 1 year (2006) using the Nationwide Inpatient Sample, reporting \$34,733 in mean hospital charges for BPI cases.⁷ Recent work estimated the indirect cost of traumatic BPI

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(per-patient mean: \$1,113,962; median: \$801,723),⁸ capturing the cost of lost productivity and disability payments from a societal perspective. The purpose of the current report was to use payment data to estimate direct costs associated with surgical treatment of BPI to demonstrate the utility of surgery in treating BPI and enable future study of the societal value of surgical reconstruction.

Materials and Methods

Using the Truven Health MarketScan Commercial Claims database (IBM Watson Health, Armonk, NY), we assembled a cohort of adult privately insured patients aged 18 to 64 years with BPI who were treated surgically from 2007 to 2015 in the United States ($n = 189$). We identified the index admission coded specifically for BPI surgery (Current Procedural Terminology code 64861 or 64713) or with a diagnosis of BPI (International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis 953.4) plus a related surgical procedure (any of Current Procedural Terminology codes 64708, 64856, 64857, 64859, 64872–64876, 64892, 64893, or 64897–64902). To restrict the population to patients most likely to have true BPI without other associated injuries, patients were excluded if they were coded for any of the following conditions without a BPI diagnosis (953.4) within 7 days of BPI surgery: ulnar nerve (354.2), radial nerve (354.3), brachial plexus lesion (353.0), or carpal tunnel syndrome (354.0). We excluded patients if they were coded for complications of a surgical device on the day of surgery, or chronic pain (338.29) on the day of surgery without a BPI diagnosis, or if they were coded for acute postoperative pain (338.18) on the day of surgery, other than on claims for a nerve block. In addition, patients were excluded if they were coded within 7 days of surgery for brachial neuritis, dislocation of the shoulder or upper arm, rib or scapula excision, shoulder arthroscopy with claviclelectomy, or decompression of the subacromial space. Patients were also excluded if they were coded for cervical spine or rotator cuff disorders or a history of cancer in the prior year, if they had coordination of benefits indicating another source of health insurance or lacked medical and pharmacy insurance coverage for a full year after surgery. Payments (composed of those made by insurers and individual beneficiaries) were tabulated for all paid claims, including medical, surgical, therapy, and pharmacy, for 1 year after surgery. Payments were adjusted for inflation to 2017 US dollars using the consumer price index medical care cost component.⁹ All data management and analysis was performed using SAS (version 9.3, SAS Institute, Inc, Cary, NC).

Results

Among the 189 patients undergoing surgery for BPI, median payments were \$38,816 (interquartile range [IQR]: \$18,209 to \$72,411). Minimum and maximum payments were \$3,512 and \$732,641, respectively. Median payment for medical, surgical, and therapy claims for 1 year after surgery was \$34,544 (IQR: \$16,396 to \$66,928) (Table 1). Median payment for drug claims for 1 year after surgery was \$835 (IQR: \$132 to \$2,752) (Table 1). Median age of patients was 36 years (range, 18–64 years; IQR: 24–50 years). The cohort was 70% male and 30% female. The geographic distribution of patients was 12% Northeast, 28% North Central, 44% South, 15% West, and 2% unknown.

Table 1
Payments Associated With Care for BPI Patients Treated With Surgery ($n = 189$)

Minimum	Quarter 1	Median	Quarter 3	Maximum	Mean
Total payments from all medical, surgical, and therapy claims per patient					
\$3,365	\$16,396	\$34,544	\$66,928	\$724,832	\$59,437
Total payments from all drug claims per patient					
\$0	\$132	\$835	\$2,752	\$81,451	\$3,391

Most index BPI surgery cases involved nerve grafting and/or nerve transfer (91%), whereas 7% incorporated free muscle transfer.

Discussion

Median direct payments for 1 year after BPI surgery were \$38,816. When this was added to the previously estimated per-person indirect lifetime cost of BPI (median: \$801,723),⁸ the estimated median total (direct plus indirect) economic burden of adult traumatic BPI was \$840,539/person. Using the payments reported here as a surrogate for direct cost, we estimate that direct costs for 1 year after surgical treatment represent 4.6% of the total cost of BPI. This suggests that surgery and other interventions to maximize return to work are likely cost-effective and perhaps cost-saving from a societal perspective, given that they represent a fraction of overall cost. However, the cost-effectiveness of surgical interventions hinges on return to some level of employment, which can be inconsistent among BPI patients. Variations in injury severity, functional recovery after surgery, and other patient characteristics likely contribute to the variable return to work among BPI patients. Our findings were limited to privately insured BPI patients in the United States, which limits generalizability to publicly insured patients (such as those covered by Medicaid or Medicare) or in other countries. In addition, because of the nature of administrative data, we are unable to determine the severity of BPI and the complexity or extent of reconstructive strategies used. We acknowledge that the associated cost for surgical reconstruction is likely much greater for a complete BPI compared with an upper-trunk injury. We are also unable to detect revision surgery reliably, nor can we report length of stay or clinical data using these administrative data. Finally, owing to concerns regarding the lack of reliability in diagnosis coding with administrative data, we are unable to report payments associated with nonsurgical treatment of BPI.

A prior economic analysis from Italy demonstrated the savings in long-term disability payments from surgical reconstruction of BPI,¹⁰ but further investigation in the United States is necessary given the unique nature of its health care system. Economic models based on the US health care system showed the potential cost-effectiveness of surgical reconstruction after BPI^{8,11} but do not provide actual payment data to contextualize their findings. Like all economic simulations, the models of Wali¹² and Khalifeh et al¹¹ rely on assumptions about the use of procedures, the projected occurrence of postoperative events, and estimated surgical charges. Our findings add to this body of work by providing actual payment data from patient encounters, which can help in advocating for BPI care and research among stakeholders such as health care payers and funding sources.

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