Factors Associated with Cost of 30-day and 90-day Readmissions Following Anterior Cervical Discectomy and Fusion: Insights from the Nationwide Readmissions Database

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Background

- Annual healthcare spending in US: $3.3 trillion ($10,348/person)
- %GDP spent on Healthcare in US: 17% - More than any country

CMS: US health care spending to reach nearly 20% of GDP by 2025

https://data.worldbank.org/indicator/SH.XPD.TOTL.ZS
Background

- Spine surgery has attracted the attention of policymakers, due to high costs
- Dramatic rise in rates of cervical spine surgery: 29 cases in 1990 to 61 cases in 2009 per 100,000 people
- While frequency of cervical spine surgery performed for degenerative disease may be stabilizing in recent years, costs have continued to rise at a rate almost double that of inflation with a 64% increase in mean inflation adjusted cost from 2001 to 2013
- ACDF: most commonly performed cervical spine procedure, ideal focus for healthcare reform efforts

Chotai et al Neurosurgery 2018
Marquez-Lara et al Spine 2014
Oglesby et al Spine 2013
Patil et al Neurosurgery 2005
Liu et al Spine 2017
Bundled Payments & ACOs
Providers Bear Financial Responsibility

**Bundled Payment**
- Selected patient admissions
- Self-determined budget
- Costs of selected conditions
- Specialist-focused
- Up and downside risk
- Keep all savings
- BP org pays providers

**ACO**
- Entire population
- CMS-determined budget
- All costs
- PCP-focused
- Upside risk
- Shared savings with CMS
- CMS pays providers

Background

The cost of readmission episodes after ACDF can contribute as high as 35% to the direct 90-day costs of ACDF in some patients.
Knowledge gap

• However, what determines cost of readmissions is not known
Objective

• To determine patient, clinical and hospital factors determining cost of 30 and 90-day readmissions following elective ACDF for degenerative cervical spine disease

• To determine the diagnoses associated with costly readmission episodes
Methods


- NRD:
  - All-payer national readmissions data
  - Constructed using 27 state inpatient databases
  - 17 million hospitalizations every year, accounting for 56.6% of all US hospitalizations
  - Sampling weights
  - Hospital charges and cost-to-charge ratios
Methods

• Study sample:
  • Inclusion criteria
    • Elective ACDF for degenerative cervical spine disease (ICD-9 procedure and diagnosis codes)
    • Readmitted within 30 or 90-days of index admission for ACDF
    • For 30-day readmission episodes: observation period was 11 months for 2012-2014 and 8 months for 2015Q1-Q3
    • For 90-day readmission episodes: observation period was 9 months for 2012-2014 and 6 months for 2015Q1-Q3
Methods

• Study sample:
  • **Exclusion criteria**
    • Died in hospital
    • Missing charge data
    • Same day event/transfer
    • Diagnostic exclusions: Spinal trauma, tumors and infections
    • Procedural exclusions: Another concurrent major surgical procedure at index admission (manual review of all ICD-9 codes in the cohort)
Methods

• Outcome of interest: Total hospital costs (cost-to-charge ratio X hospital charge)

• Variables
  • Demographics: Age, Sex, Elixhauser comorbidity score, insurance status, median household income
  • Length of stay
  • Weekend vs Weekday admission
  • Days from index admission to readmission
  • Hospital factors: Ownership, bed size, teaching status, urban/rural designation
  • Type of primary diagnosis at readmission, Procedure-related (e.g. infection, hematoma, dysphagia etc) vs medical (manual review of primary ICD-9 code at readmission)
Methods

- **Analysis**
  - Descriptive analysis was performed using standard t-test and Chi-squared tests.
  - Two multivariable linear models were fitted with the cost of 30/90-day readmission episodes serving as the continuous outcome variable.
  - Cost is a skewed outcome, normalized as log cost.
  - Multiple imputation for missing data.
  - Statistical significance: p<=0.001.
  - Relative predictor importance determined using type III F statistics.
Methods

- **Analysis**
  - Annualized national estimate of cost:
    - *For 30-day readmission episode*
      - Multiply NRD estimate by 12/11 (12/8 in the 2015 dataset)
    - *For 90-day readmission episode*
      - Multiply NRD estimate by 12/9 (12/6 in the 2015 dataset)
210,740 patients who underwent an elective ACDF at index admission with primary diagnosis (DX1) on the inclusion list between 2012 – 2015Q3

- 171,232 patients after excluding index admissions that occurred outside the observation window for a 30-day readmission analysis
- 165,005 patients after excluding index admissions with a diagnosis DXn on the exclusion list
- 139,960 patients after excluding index admissions where a major procedure other than ACDF was performed
- 139,894 patients after excluding patients who died within 30 days of index admission
- 139,877 patients after excluding patients who had same day events at index admission
- 4,161 patients after excluding patients who did not have readmission within 30 days of index

30-day readmission rate = 4,161 / 139,877 = 2.97%

- 4,104 patients after excluding patients with missing total charge values

Total 30-day readmissions = 4,365 readmissions

- 138,582 patients after excluding index admissions that occurred outside the observation window for a 90-day readmission analysis
- 133,855 patients after excluding index admissions with a diagnosis DXn on the exclusion list
- 113,520 patients after excluding index admissions where a major procedure other than ACDF was performed
- 113,433 patients after excluding patients who died within 90 days of index admission
- 113,418 patients after excluding patients who had same day events at index admission
- 6,677 patients after excluding patients who did not have readmissions within 90 days of index

90-day readmission rate = 6,677 / 113,418 = 5.89%

- 6,581 patients after excluding patients with missing total charge values

Total 90-day readmissions = 7,431 readmissions
Factors associated with cost of 30-day readmissions

Linear Model of Thirty Day Readmission Episode Cost

- Number of Procedures Performed at Readmission
- Length of Stay of Readmission
- Days Readmission was from Index Admission
- Private/non-private Ownership of Hospital
- Total Number of Discharges from Hospital
- Elixhauser Score at Readmission
- Number of Diagnoses
- Hospital Urban/Rural Designation
- Patient Age
- Type of Primary Diagnosis at Readmission (Medical/Procedure-Related)
- Hospital Bedsize
- Patient Household Income
- Patient Gender
- Diagnosis at Index Admission
- Payer Type
- Number of Chronic Diseases
- Weekend Readmission
- Hospital Teaching Status
- In-state Patient
Factors associated with cost of 90-day readmissions
Top diagnoses associated with cost of 30-day readmission episode

Top 20 Diagnoses at Readmission Contributing to National 30 Day Readmission Costs

- Cervical spondylosis with myelopathy (7211)
- Other mechanical complication of other internal orthopedic device, implant, and graft (99849)
- Other postoperative infection (99859)
- Hematoma complicating a procedure (99812)
- Unspecified sepsis (6089)
- Spinal stenosis in cervical region (7230)
- Pneumonitis due to inhalation of food or vomitus (5070)
- Acute respiratory failure (51881)
- Pneumonia, organism unspecified (488)
- Intervertebral disc disorder with myelopathy, cervical region (72271)
- Other pulmonary embolism and infarction (41919)
- Seroma complicating a procedure (99813)
- Other specified complications of procedure not elsewhere classified (99889)
- Acquired spondylolisthesis (7380)
- Degeneration of lumbar or lumbosacral intervertebral disc (72529)
- Cervical spondylosis without myelopathy (7210)
- Displacement of lumbar intervertebral disc without myelopathy (72210)
- Dysplasia, unspecified (88720)
- Kyphosis (acquired) (postural) (73710)
- Other nervous system complications (99700)
- Spinal stenosis, lumbar region, without neurogenic claudication (72412)

Mean National Total Hospital Cost Per Year (Millions)

Cost | Readmit
--- | ---
8% | 3.6%
5.6% | 2.2%
5.5% | 5.7%
5% | 6%
2.8% | 2.7%
2.4% | 1.5%
2% | 2%
2% | 0.9%
1.6% | 2.9%
2.6% | 1.1%
1.5% | 2.5%
1.3% | 2.6%
1.2% | 0.3%
1.2% | 0.5%
1.2% | 0.8%
1.3% | 0.7%
1.1% | 2.8%
1% | 0.2%
1% | 0.8%
1% | 0.5%
Top diagnoses associated with cost of 90-day readmission episode

Top 20 Diagnoses at Readmission Contributing to National 90 Day Readmission Costs

- Other mechanical complication of other internal orthopedic device, implant, and graft (99645)
- Cervical spondylosis with myelopathy (7211)
- Degeneration of lumber or lumbosacral intervertebral disc (72252)
- Spinal stenosis, lumbar region, without neurogenic claudication (72402)
- Displacement of lumber intervertebral disc without myelopathy (72249)
- Other postoperative infection (99859)
- Unspecified sepsis (1918)
- Lumbosacral spondylosis without myelopathy (7213)
- Spinal stenosis in cervical region (7230)
- Spinal stenosis, lumbar region, with neurogenic claudication (72403)
- Hematoma complicating a procedure (99812)
- Acquired spondylolisthesis (7304)
- Cervical spondylosis without myelopathy (7210)
- Pneumonia due to inhalation of food or vomitus (50750)
- Intervertebral disc disorder with myelopathy, cervical region (72271)
- Acute respiratory failure (51001)
- Subendocardial infarction, initial episode of care (41071)
- Osteoarthritis, localized, not specified whether primary or secondary, lower leg (71436)
- Pneumonia, organism unspecified (485)
- Coronary atherosclerosis of native coronary artery (41401)
- Accidental puncture or laceration during a procedure, not elsewhere classified (9982)

Mean National Total Hospital Cost Per Year (Millions)
Summary

• In addition to patient related factors, several hospital related factors contribute to readmission costs

• Other important factors
  • Weekend readmission
  • Days from index admission to readmission
    • Late intervention required? (e.g. provider phone calls/other quality improvement efforts at late intervals following discharge)

• Readmitted patients with cervical myelopathy contribute the highest to annual national cost associated with readmissions following elective ACDF
  • Need for adequate risk adjustment for myelopathic patients in current value-based reimbursement models?

• While procedure-related diagnoses were associated with higher costs, a significant readmission cost burden was attributable to medical diagnoses that were unrelated to surgery
  • May point to need for optimization of medical comorbidities prior to discharge in an otherwise surgical population
Limitations

- Standardized cost, not internal cost accounting data
- Only inpatient ACDF costs included, could not assess any outpatient costs
Thank you

Questions & Discussion