Estimating Total Healthcare Costs of Occupational Injuries and Diseases Using Activity-Based Costing and Care Pathway Modeling

A Multi-Facility Health System Study

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Abstract

Accurate cost information is essential for healthcare financing, reimbursement design, and resource allocation. However, many health systems lack standardized methodologies to estimate the true cost of care for occupational injuries and professional diseases. This study developed and implemented an activity-based costing (ABC) framework combined with patient care pathway modeling to estimate direct and indirect healthcare costs across multiple accredited health facilities.

Twenty-five high-priority occupational risk events were analyzed through 37 validated clinical care pathways. Unit costs for human resources, medications, diagnostics, supplies, and disability subsidies were collected and allocated using standardized costing modules. The model produced cost estimates per case and annually, identifying major cost drivers and variation across clinical scenarios.

Results demonstrated significant cost differences between medical and surgical pathways and highlighted opportunities for standardization and efficiency improvements. The methodology proved scalable, transparent, and replicable, providing decision-makers with actionable financial intelligence for contracting, reimbursement, and planning.

Keywords

Healthcare analytics · Activity-Based Costing · Health economics · Care pathways · Cost modeling · Occupational health · Healthcare operations

1. Introduction

Healthcare payers and providers frequently make budgeting and reimbursement decisions with incomplete or inconsistent cost information. This challenge is particularly acute in occupational health services, where diverse clinical presentations and variable care processes complicate cost estimation.

Without reliable costing methods, payment models such as fee-for-service, per-event reimbursement, or capitated contracts may misalign incentives and lead to inefficiencies or financial risk for both providers and insurers.

This study addresses this gap by developing a structured, data-driven approach to estimate the total cost of care for occupational injuries and professional diseases using:

- Activity-Based Costing (ABC)
- Care pathway modeling
- Standardized cost allocation methods

The objective was to generate actionable cost intelligence to support financing and contracting decisions across accredited healthcare facilities.

2. Objectives

Primary Objective

Estimate total healthcare costs (direct and indirect) for selected occupational injuries and diseases across accredited health units.

Secondary Objectives

- Develop a replicable costing methodology
- Identify major cost drivers and variability
- Support reimbursement and contracting strategies
- Strengthen institutional capacity in healthcare cost analytics

3. Methods

3.1 Study Design

Descriptive, mixed-methods cost analysis combining qualitative process mapping and quantitative cost modeling.

3.2 Scope

- 25 occupational risk events
- 37 validated care pathways
- Multiple accredited health facilities
- Multi-specialty coverage (orthopedics, internal medicine, surgery, ENT)

3.3 Costing Framework

An Activity-Based Costing approach was used to allocate resources based on actual clinical workflow rather than aggregated accounting averages.

Each event was decomposed into:

1. Clinical stages
2. Activities per stage
3. Resources consumed

3.4 Direct Costs Included

- Human resources (clinical and administrative time)
- Medications
- Diagnostic tests
- Consumable supplies
- Medical materials
- Disability subsidy days

3.5 Indirect Costs

Indirect costs were allocated proportionally using standardized overhead ratios derived from facility financial data.

3.6 Data Collection

Data sources included:

- Provider financial records
- Unit cost databases
- Interviews with finance officers
- Clinical workshops with specialists

- Resource utilization estimates validated by multidisciplinary teams

3.7 Analytical Tools

- Structured Excel calculation modules
- Pathway cost tables
- Scenario comparisons
- Sensitivity checks

4. Care Pathway Modeling

For each occupational event, simplified care pathways were developed to represent typical patient journeys, including:

- Initial evaluation
- Diagnostics
- Treatment
- Procedures or surgery
- Follow-up
- Rehabilitation
- Subsidy/incapacity periods

These pathways enabled:

- Resource attribution per step
- Scenario comparison (medical vs surgical)
- Standardization across facilities
- Simulation of alternative treatment options

5. Results

5.1 Coverage

- 25 occupational conditions analyzed
- 37 care flows validated
- Multiple specialties involved

5.2 Cost Patterns Observed

Key findings included:

- Direct costs accounted for up to 75% of total costs in many cases
- Surgical pathways were 2–3x more expensive than conservative management
- High-cost drivers included:
    - Hospital days
    - Specialized procedures
    - Diagnostic imaging
    - Subsidy/incapacity payments
- Significant variability existed between facilities, suggesting opportunities for standardization

5.3 Operational Insights

- Care process mapping revealed inefficiencies and duplication
- Standard treatment bundles could reduce variation
- Data transparency improved budgeting discussions between providers and payers

6. Discussion

This study demonstrates that Activity-Based Costing combined with pathway modeling is a practical and scalable solution for healthcare systems that lack reliable cost intelligence.

Compared with retrospective chart costing, this approach:

- Requires fewer resources
- Is easier to replicate
- Enables forward planning and simulations
- Produces standardized outputs for policy decisions

The methodology is especially useful for:

- Insurance systems
- Occupational health programs
- Value-based care initiatives
- Contract negotiations
- Population health budgeting

7. Practical Applications

The results supported:

- Reimbursement negotiations
- Contract design (per capita vs per event)
- Budget forecasting
- Resource planning
- Cost-effectiveness assessments
- Capacity building in healthcare analytics

8. Limitations

- Convenience sampling of facilities
- Some unit costs based on medians rather than full accounting
- Estimates represent standardized scenarios rather than individual patient variability

9. Conclusion

Activity-Based Costing and care pathway modeling provide an effective framework to estimate the true cost of healthcare delivery. The methodology is transparent, replicable, and decision-oriented, enabling policymakers and administrators to align financing with actual resource consumption.

This approach strengthens financial sustainability while supporting evidence-based planning and operational efficiency.

10. Author Contribution

Luis Bolaños Prado served as Principal Investigator, leading study design, methodology development, data integration, cost modeling, stakeholder coordination, and reporting.