



# Time-Driven Activity-Based Costing: A Better Way to Understand the Cost of Caring for Hip Fractures

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## Abstract

Geriatric hip fractures are a common and costly injury. They are expected to surge in incidence and economic burden as the population ages. With an increasing financial strain on the healthcare system, payors and providers are looking toward alternative, value-based models to contain costs. Value in healthcare is the ratio of outcomes achieved over costs incurred, and can be improved by reducing cost while maintaining or improving outcomes, or by improving outcomes while maintaining or reducing costs. Therefore, an understanding of cost, the denominator of the value equation, is essential to value-based healthcare. Because traditional hospital accounting methods do not link costs to conditions, there has been little research to date on the costs of treating geriatric hip fractures over the entire cycle of care. The aim of this article is to summarize existing costing methodologies, and in particular, to review the strengths and limitations of Time-Driven Activity-Based Costing (TDABC) in orthopaedic trauma, especially as it pertains to the needs and challenges unique to hip fracture care. TDABC determines costs at the patient-level over the entire care cycle, allowing for population variability, while simultaneously identifying cost drivers that might inform risk-stratification for future alternative payment models. Through process mapping, TDABC also reveals areas of variation or inefficiency that can be targeted for optimization, and empowers physicians by focusing on costs in the control of the provider. Although barriers remain, TDABC is well-positioned to provide transparent costing and targets to improve the value of hip fracture care

## Keywords

TDABC, time-driven activity-based costing, bundled payment, alternative payment model, value, cost, hip fracture, geriatric, orthopaedic trauma

Submitted January 29, 2020. Revised August 8, 2020. Accepted August 20, 2020.

## Background

Healthcare expenditure in the United States has risen drastically over the past several decades; it constituted 17.8% of the gross domestic product (GDP) in 2015, and is projected to reach 20% by 2021, far outpacing the rate of inflation.<sup>1</sup> Hip fractures alone cost \$17 billion annually,<sup>2</sup> and are expected to rapidly increase in incidence in the coming decades as the population ages.<sup>3</sup> In response to rising expenses there has been a movement by payers toward alternative payment models (APMs) such as bundled payments to contain costs. Bundled payments have already been implemented in orthopaedic care in total joint replacement<sup>4-7</sup> and are on the horizon for orthopaedic trauma.<sup>4,5,8,9</sup> These models shift risk to physicians or hospitals depending on the convener and replace traditional fee-for-service models, which reward high volumes with a new

focus on value. Value in healthcare is defined as outcome over cost for a specific condition; an equation wherein patient outcomes achieved serve as the numerator and the cost of care serves as the denominator.<sup>10</sup>

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Patient-reported outcomes (PROs) are increasingly collected for both research and clinical practice as a gold standard of outcomes measurement<sup>11,12</sup>: The American Board of Orthopaedic Surgery (ABOS) now collects PROs for Part II board certification, and The Centers for Medicare & Medicaid Services (CMS) encourage reporting of PRO data for joint replacement.<sup>13</sup> PRO data will continue to be central to improving outcomes as we shift toward a value-based healthcare system. However, identifying the cost of care delivery across healthcare organizations has proved a significant challenge. Idiosyncratic costing policies and accounting systems among hospitals and health systems prevent fair comparisons of costing between systems, and traditional hospital accounting methods are not linked to conditions or outcomes. Nor are they measured over a complete cycle of care for a particular condition. In the complex field of orthopaedic trauma, there has been little inquiry into the actual costs of hip fracture care. In contrast to arthroplasty, the patient population of hip fractures is heterogeneous and difficult to model; creating challenges around policy making and development of optimized value based care. Furthermore, there is little transparency that might guide efforts to improve processes or reduce costs without sacrificing patient outcomes, making traditional costing methods untenable for value-based payment models, which require knowledge of the cost of treating a condition at the patient level.<sup>14</sup>

Time-driven activity-based costing (TDABC) has been presented as a costing solution well suited to the value-based healthcare movement. TDABC estimates costs of care based on the rate of consumption of each resource in a care cycle by a patient. Using process mapping and time equations, TDABC is able to capture the true complexity of activities at the patient level, while also accounting for the many care pathways among heterogeneous populations like hip fracture patients.<sup>15,16</sup> As a methodology that combines accurate costing with opportunities to optimize care delivery, TDABC meets the need for value-based costing that will be required before APMs can be feasible for hip fracture care.

## Costing Methodologies

Traditional hospital cost accounting methodology uses a “top-down” approach, in which all direct and indirect costs are accounted for by summing total costs and then allocating costs to patients using arbitrary cost-to-charge ratios (CCRs). This approach allows for larger-scale financial evaluations and ensures solvency, but is not accurate at the patient-level because it assumes that each type of service utilizes indirect costs in the same proportion and from a single shared well without regard to differences in time or personnel required on an individual basis.<sup>16-19</sup> Relative value units (RVUs) are, in theory, more refined than CCRs because they estimate the time and complexity of services before allocating costs to specific procedures. However, they are imprecise, leading to “unintended cost distortions” in practice.<sup>18</sup> Neither CCRs nor RVU account for time-based differences among individual instances of the same

procedure and current billing and reimbursement practices further foster obfuscation in costing data.<sup>18</sup>

Activity-based costing (ABC), developed in 1988 by Cooper et al,<sup>20</sup> assigns activity costs to all services according to their consumption. Using a “bottom-up” approach, ABC determines the unit cost for each resource by using employee estimates of time devoted to each activity, as well as the costs of the materials and equipment used in the activity. By sorting indirect and overhead costs into distinct pools that can be allocated on an individual basis according to actual utilization. ABC accounts for indirect costs more precisely than traditional hospital costing. However, relying on self-reported time estimates introduces bias, particularly because productivity is often reported at 100% theoretical capacity, when in reality productivity levels tend to be closer to 80-85% of theoretical capacity.<sup>19</sup> This bias puts cost driver rates too high. Furthermore, the implementation of ABC is an enormous burden in terms of data collection and analysis. Whenever there is a change the entire model requires updating, including re-interviewing staff to update the cost drivers of activities.<sup>19</sup>

Time-driven activity-based costing (TDABC) was developed as a response to the accuracy issues and burdens of employing ABC. It requires just 2 parameters: (1) cost per unit time of an activity at practical capacity, and (2) unit times of consumption of the resource or, in simpler terms, time required to perform the activity.<sup>15</sup> Applying these parameters to the healthcare setting can be accomplished through a series of 7 steps laid out by Kaplan and Porter,<sup>21</sup> in which (1) a medical condition is selected, (2) the care delivery value chain identified and (3) process maps generated for each step of a patient’s care delivery chain. (4) Time estimates are obtained for each process step and (5) the cost of supplying all patient care resources is calculated, including direct and indirect costs. (6) Capacity cost rates are then calculated for each resource, typically by estimating 80% of theoretical cost rates, and finally, (7) total costs are calculated by multiplying capacity cost rates for each resource used in each step by the time spent by the patient with each resource.

Indirect costs accounted for by TDABC include informational technology (IT), administration, maintenance, and billing. Other overhead costs not directly related to patient care, such as construction and legal services, are excluded. By performing a practical capacity rate adjustment, TDABC also captures indirect personnel costs such as benefits, vacation time, sick days, etc. Notably, the indirect costs included in TDABC methodology are generally those considered as overhead to the healthcare institution, and do not account for wider nonmedical and societal costs, such as patients’ travel expenses or time lost from work. With a stronger focus on costs that are more under the control of the provider, there is more opportunity to increase value.

The granular level of analysis derived through TDABC essentially creates “apples” for comparison where fair comparison is otherwise impossible. Its process maps lend the model the visibility necessary to reveal high cost-drivers, non-value-added steps and unused resource capacity; which can then inform decisions about how to optimize value over the care cycle.

## Comparing TDABC to Traditional Accounting

Direct comparisons of TDABC to traditional hospital accounting methods have revealed substantial differences in cost estimates, with traditional costing methods estimating significantly higher total costs than those derived by TDABC. A 2016 study, which compared costs of total hip arthroplasty (THA) and total knee arthroplasty (TKA) between TDABC and traditional hospital accounting, found TDABC estimates to be 49%-55% of the traditional accounting costs for THA (\$12,982 versus \$23,915), and 53%-55% of traditional accounting costs for TKA (\$13,661 versus \$24,796).<sup>16</sup> In 2018 TDABC was found to comprise 59% of the traditional accounting costs for THA (\$12,957 versus \$22,076), and 58% of traditional accounting costs for TKA (\$16,981 versus \$29,488).<sup>22</sup> Another study found TDABC to account for 48% of the total cost derived through traditional accounting methods (\$2,792 vs \$5,782) for the treatment of ankle fractures, with traditional accounting producing significantly greater costs in every category aside from implants.<sup>23</sup> It should be noted that large academic medical centers and trauma centers, provide a larger proportion of indigent care, and in some cases charge higher rates for elective procedures to offset the losses from the provision of indigent care.

These disparities are typically attributed to differences in how indirect cost is accounted for. While traditional methods account for all equipment, personnel expenses, unused capacity, and operating costs by estimating costs as portions of the total sum; TDABC allocates cost only for direct and indirect resources utilized by the patient. Therefore some infrastructural costs not dedicated to patient care activities but required to provide patient care, such as hallway space, research, sterile processing, legal services, janitorial personnel, construction costs, etc. are not accounted for in the TDABC model. This allows TDABC to provide precise and transparent cost analyses only of the resources required in treating individuals.<sup>16,22-24</sup>

## TDABC Allows Cross-System Comparisons

The derivation of a patient-centric "micro-cost" by TDABC allows for workflow and costing comparisons between organizations that are not possible using traditional costing methods, which are often based on differing reimbursement systems. One study comparing costing details for fast-track THA and TKA between 2 Danish orthopaedic departments identified process variations in the perioperative settings between departments, but found total costing between them to be similar, confirming the advantages of fast-tracks for THA and TKA.<sup>25</sup> Another compared outpatient THA and TKA costs between a hospital and an ambulatory surgery department and found outpatient costs to be similar between settings when hospital length of stay was 11 hours, and outpatient costs to be approximately two-thirds cheaper than 2-day inpatient stays without accounting for complications or readmissions.<sup>26</sup> A costing comparison between a hospital and an ambulatory surgery department would not be reasonable using traditional

accounting, where the hospital's immense overhead costs would distort the true expenses incurred at the individual level.

## TDABC Provides Actionable Data

One of the greatest strengths of TDABC is its ability to illuminate areas of variation or inefficiency in the care pathway through process mapping. The granular measurement of each process step can then inform strategic reallocation of resources and restructuring of care pathways to increase value. For example, after comparing TDABC to traditional costing in the inpatient setting, one study leveraged TDABC to identify inefficiencies of care and redundancies in their THA and TKA pathways that had been previously obscured by the hospital accounting system.<sup>22</sup>

TDABC can also expose cost drivers and predictors of high cost in the care pathway. A TDABC analysis of the TKR pathway at a teaching hospital in the UK identified operating room consumables, corporate overheads, overall ward costs, and operating room staffing as major cost drivers. Specifically, a \$621 difference between implants was found, representing an 11.5% increase in the overall cost of treatment; in contrast, each additional day of a hospital stay (\$249.23) comprised only a 4.6% increase in total cost. In this case TDABC revealed that one of the highest cost drivers in TKR (implant cost) is actually under the control of the provider.<sup>27</sup> A US study applied TDABC to identify the primary cost drivers for THA and TKA as consumables (specifically the implant, which alone comprised 53% of the overall cost of THA, and 44% the overall cost of TKA), and personnel, which accounted for 44% and 50% of the total cost for THA and TKA, respectively.<sup>24</sup> Similarly, implant price (57%) and personnel costs (20%) proved to be the primary cost drivers for total shoulder arthroplasty (TSA) following TDABC analysis.<sup>28</sup> Further examination of TSA identified female sex, an ASA score  $\geq 3$ , and a lower ASES score as preoperative characteristics of higher cost patients.<sup>28</sup>

Each finding of TDABC provides actionable data that clarifies how and where costs are being incurred, where resources are being under-utilized, and where waste can be reduced, as well as highlighting which steps add the highest value.<sup>29</sup> Immediately, non-value-adding steps can be eliminated and resource substitution can be implemented for high-cost steps so that all people are working at their highest levels of licensure. Ultimately, resource demands can be better matched to clinical and administrative capacities, with opportunities for capacity planning to match payer reimbursement schemes and provide performance-based incentives for providers and administrators.<sup>29</sup>

## Employing TDABC in the Care of Hip Fractures

Thus far within orthopaedics, TDABC has primarily been applied to arthroplasty, a field with high volumes and low variation. In these cases process mapping is straightforward, and is often used to streamline care by reducing variances in the care pathway.<sup>1,18,28</sup> Costing in orthopaedic trauma is more

difficult, especially for hip fracture patients, whose hospital courses are complex, varied, and unpredictable. Compared to arthroplasty patients, hip fracture patients tend to be a more frail and geriatric population with more comorbidities, and because cases come in emergently, hip fracture patients cannot be optimized before surgery.<sup>30-32</sup> Although there have been minimal analyses of costing in hip fracture care, determining true patient-level costs and identifying cost drivers will be imperative before alternative payments can be as successful in orthopaedic trauma as they have been in arthroplasty. Time-driven activity-based costing has all the characteristics needed to bridge the current gap in trauma costing and to prepare the field for alternative payment models. It should be noted that a disproportionate number of hip fracture patients will utilize transitional care settings and that cost is unaccounted for using TDABC in the inpatient setting.

TDABC shifts the focus away from fixed overhead costs to those costs more in the control of the provider. This repositioning better aligns payers, providers and administrators, and empowers clinicians to make choices to increase the value of care provided (for example, by choosing less expensive implants).<sup>27,28</sup> Process mapping allows for the identification of unnecessary variances in the care delivery chain that can be standardized, as well as alternative patient pathways—this was the case for a group at Boston Children’s Hospital, who used TDABC to examine practice pattern and cost variations in the treatment of torus (buckle) fractures and found opportunities to reduce cost and streamline care while simultaneously decreasing unnecessary radiation exposure.<sup>18</sup>

The identification of alternative pathways and of characteristics that predict higher cost in patients, is particularly beneficial for such a heterogeneous patient population because it can inform risk stratification for APMs. The Surgical Hip and Femur Fracture Treatment Model (SHFFT) is a bundled payment program extending from the framework of the Comprehensive Care for Joint Replacement (CJR) model, and nearly became mandatory in 2018. It encourages providers to deliver higher-quality hip fracture care while controlling costs by paying a fixed target price to hospitals for an episode of care, incentivizing positively through gainsharing, and negatively through reconciliation payments and larger required Medicare discounts. Without appropriate risk adjustments, expenses can quickly exceed the reimbursements provided by value-based payment models, rendering them untenable. Although participation in SHFFT is currently voluntary, mandatory APMs are likely on the horizon for hip fracture care.<sup>9</sup> Ultimately, by providing a granular measurement of actual resource use during the care cycle, TDABC meets the need for value-based costing in the complex setting while simultaneously providing targets in the care pathway for value improvement and risk stratification.

## Barriers and Limitations

TDABC is not without its limitations. Lower costing results from TDABC have frequently been attributed to greater

accuracy than traditional methods, when in fact these results can only truly be called different.<sup>29</sup> Because TDABC excludes substantial indirect overhead costs, it can neither guarantee solvency nor replace traditional methodology for capturing total costs.<sup>33</sup> Furthermore, direct and indirect costs, while calculated at the patient level, are considered from the institution’s perspective, and cannot account for wider indirect costs to patients and society that are typically accounted for in traditional cost-effectiveness analyses, for example: transportation, childcare expenses, lost time, and reduced productivity.

Assuming a uniform capacity cost rate for all departments’ activities may also be problematic, particularly in the health-care field where some providers have no unused capacity costs. For example, while a practical capacity adjustment is logical for some salaried positions such as nurses, for whom benefits and lost productivity due to vacation and sick time contribute to indirect cost, other providers such as surgeons utilize costing structures that allocate pay by the unit of service provided regardless of time spent, making capacity adjustments in these cases inappropriate. Ultimately, TDABC is a new methodology with much still to prove, yet its strength lies in its combination of meticulous costing and process mapping, which produce not only micro-costing results, but opportunities to improve efficiency and value.

Challenges remain in the application of TDABC. Initial implementation is expensive and resource heavy, especially the creation of process maps. Existing software is not well integrated with institutional financial processes. Current information systems are not set up to calculate costs or determine the exact amount of time each resource used,<sup>34</sup> and it is difficult to determine the amount of time spent on patient care outside of direct patient interactions.<sup>16</sup> At the systemic level, fee-for-service payments tend to penalize lower-cost higher-quality care, which will impede TDABC-driven improvements until alternative payments are more widely implemented.<sup>14,17</sup> Furthermore, there seems to be little agreement on how to implement TDABC in the healthcare system, with huge variations in the application of TDABC methodology.

Among these variations the prime example is in the inclusion of indirect costs. Some include indirect costs as a flat rate portion. One study assumed indirect costs to be 60% of direct costs,<sup>16</sup> while another assumed indirect costs to be 16.5% of total costs.<sup>22</sup> Still another assumed indirect costs to be 43.8% of the difference between revenue and cost.<sup>27</sup> Others include some indirect costs, such as medical testing and cleaning, but not building, equipment utilities, or administration.<sup>25</sup> Many studies exclude indirect costs completely.<sup>26,28</sup> It should be noted here that, perhaps anticipating this issue, Kaplan rejects the “myth” that indirect costs cannot be accounted for, and denounces the “peanut butter” approach of estimating costs as a flat-rate portion of direct costs in his article, “How to Solve the Cost Crisis in Health Care,” though he does not offer an alternative method to calculate indirect costs. One systematic review recommends that a set of principles be standardized to guide TDABC implementation, especially in regard to indirect costing, proposing that, at a minimum, maintenance,

informational technology (IT), hospital administration, and billing costs be included as standard in TDABC costing since these are most commonly recorded and constitute the largest sources of indirect cost.<sup>19</sup>

These and other considerations regarding the development of process maps, adjustments from theoretical to practical capacity, and the determination of what constitutes a full care pathway would benefit from a set consensus, and from carefully following all steps outlined by Kaplan and Porter.<sup>21</sup> This would allow for better comparison across systems and prepare providers for the implementation of alternative payment models.

## Conclusion

Employing TDABC in hip fracture care will require support and sponsorship from executives and hospital administration, engagement from providers and dedicated project management, particularly at the beginning.<sup>29</sup> However, once a curriculum for TDABC is standardized, the benefits will be sundry: a transparent and shared understanding of costs among surgeons, clinicians, administrators, and finance professionals within and across organizations. This can inform decisions regarding resource allocation and process improvement, align incentives to optimize treatment across care delivery chains, and mitigate risk in future value-based payment initiatives—this is the denominator of value-based healthcare.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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