Title Page

**Using Time-Driven Activity Based Costing (TDABC) to Assess Total Hip Arthroplasty (THA) Bundles: A Case Study**

by

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**Abstract**

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University of Pittsburgh, 2020

**Abstract**

US healthcare spending is high and getting higher, yet despite this trend, US healthcare outcomes are similar or worse than other highly developed countries. Spending increases can be attributed to a number of issues, the most relevant being pricing failures and system complexity which cause chaos and opacity in the healthcare system at large. Finding a solution to these extreme costs is of public health importance as rising costs deter many from seeking care or result in those who receive care being negatively affected by such exorbitant costs. This essay considers Time-Driven Activity-Based Costing (TDABC) as a portion of the solution to better measure—and ultimately decrease—healthcare costs. TDABC is a methodology developed by Robert S. Kaplan and Michael Porter that identifies the true cost of care by developing care flow process maps and identifying the types of resources utilized in each step. Here, TDABC is applied to a case study of Total Hip Arthroplasty(THA) bundling and demonstrates that THA is a good setting to apply TDABC; that outpatient procedures are far more cost-efficient than inpatient procedure; and the two most costly resources were consumables and personnel. Although TDABC is a useful tool, a drawback is that it is work-intensive and thus, not truly easily scalable.

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Preface

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# Introduction

## What is the Problem?

Addressing disproportionately high healthcare spending is a long-standing challenge in the United States (US). In 2011, healthcare costs exceeded 17% of Gross Domestic Product (GDP) and although that number has remained stable, raising only to 17.9% of GDP in 2018, it is expected to continue to rise. ([Porter, 2011](#_ENREF_13)) ([CMS, 2017](#_ENREF_2)) In a Centers for Medicare and Medicaid Services (CMS) expenditure projection report, US national health spending is projected to grow at a rate of 5.5% and nearly reach $6.0 trillion by 2027. ([CMS, 2018](#_ENREF_3)) It has also been shown that the US spends more on healthcare than any other country, incurring costs approaching 18% of GDP. ([Shrank, Rogstad, & Parekh, 2019](#_ENREF_15)) A 2018 study also showed that despite the fact that the US spends roughly twice as much as other high income countries, utilization rates were similar; thus, utilization is not the main driving factor in overspending. ([Papanicolas, Woskie, & Jha, 2018](#_ENREF_12)) The costs are high, and if the outcomes were improving at a similar pace, perhaps this spending could be justified. However, the US lags other comparable countries in overall mortality rate, premature death, life expectancy at birth, mortality amenable to healthcare and others. ([Gary Claxton, 2015](#_ENREF_7))

To dive deeper into spending habits, other countries’ spending trends will be addressed and compared to those of the US. The US ordered more imaging tests and had slightly higher levels of some common surgical procedures ranging from coronary artery bypasses to knee replacements. ([Papanicolas et al., 2018](#_ENREF_12)) Other high income countries show similar trends, but a differentiating characteristic of US spending is the amount of administrative costs. The US spent 8% of GDP on administrative healthcare costs, more than twice as high as the mean 3% of GDP spent by the other countries studied. ([Papanicolas et al., 2018](#_ENREF_12)) The US also spent the highest amount on pharmaceuticals: $1,443 per capita as compared to the mean of $749 per capita for the other countries. ([Papanicolas et al., 2018](#_ENREF_12))

Another issue to consider regarding higher costs is waste. For the purposes of this paper “waste” will be defined by Dr. Don Berwick’s view on the issue. In 2012, Dr. Berwick released a special communication entitled, “Eliminating Waste in US Health Care” in which waste was specifically broken down into six categories: overtreatment, failures of care coordination, failures in execution of care processes, administrative complexity, pricing failures, and fraud and abuse. ([Berwick & Hackbarth, 2012](#_ENREF_1)) These categories have been used by many to break down and account for waste across the industry. Studies have estimated that roughly 30% of healthcare spending can be attributed to waste. ([Shrank et al., 2019](#_ENREF_15)) The estimated cost of all this waste ranged from approximately $760 billion to $935 billion. ([Shrank et al., 2019](#_ENREF_15)) Although all six of the sources of waste are important, the two most costly types are pricing failure and administrative complexity. The causes of the observed pricing failures were boiled down to variability and inflation in pricing of medications, testing, procedures, devices and durable medical equipment (DME). ([Shrank et al., 2019](#_ENREF_15)) Pricing failures have accounted for a range of $230.7-$240.5 billion in waste. ([Shrank et al., 2019](#_ENREF_15)) An example of pricing failure can be seen in the exorbitant prices for simple diagnostic procedures such as MRI and CT scans, which, due to the lack of cost transparency, result in the US prices being several times higher than those in comparable countries for identical procedures. ([Berwick & Hackbarth, 2012](#_ENREF_1)) A number of interventions have been identified, but the most relevant suggestion is the creation of patient-facing cost-transparency initiatives. ([Shrank et al., 2019](#_ENREF_15))

Another important consideration is the abundance of administrative complexity. This is attributed to billing and coding costs, physician administrative burden, insurance administrative burden and inefficiencies. ([Shrank et al., 2019](#_ENREF_15)) Administrative complexity resulted in a waste of roughly $265.5 billion. ([Shrank et al., 2019](#_ENREF_15)) This data supports the claim that the US spent more than twice on administrative costs as compared to amounts spent by other high income countries. The recommendations for this issue boil down to interventions to facilitate simpler billing and coding, elimination of processes that do not improve quality and access to care and do not reduce costs and finally streamlining administrative personnel and processes. ([Shrank et al., 2019](#_ENREF_15))

Building off of this information, it is important to not only consider that spending is increasing, but also that specific types of spending that are increasing and that all of these spending types are contributing to the issue. In 2017, hospital care spending (room and board, ancillary charges, services of resident physicians, etc.) reached $1.1 trillion, or 33% of total healthcare spending. ([Martin, Hartman, Washington, & Catlin, 2019](#_ENREF_11)) Similarly, physician and clinical services spending increased 4.3% over a period of one year, accounting for 20% ($694.3 billion) of total healthcare spending in 2017. ([Martin et al., 2019](#_ENREF_11)) Interestingly, total retail prescription drug spending only grew 0.4% in 2017. This rate was actually a deceleration in spending, as in 2016 the spending rate was 2.3%. ([Martin et al., 2019](#_ENREF_11)) Medicare and Medicaid spending accounted for 20% and 17% of national healthcare spending, respectively. ([Martin et al., 2019](#_ENREF_11)) Lastly, private health insurance spending reached $1.2 trillion, accounting for 34% of total healthcare spending. ([Martin et al., 2019](#_ENREF_11))

Another possible explanation for excessive spending is the fact that Americans pay higher prices for the same care. ([Martin et al., 2019](#_ENREF_11)) An important pricing issue is the extremely variable nature of prices across the US, which contributes to increased healthcare costs. ([Reinhardt, 2019](#_ENREF_14)) Essentially, there is no true set price, rather the amount the hospital “charges” depends on the payer. ([Reinhardt, 2019](#_ENREF_14)) This contributes to increased healthcare costs because providers cannot attempt to decrease costs if there is no set price to judge against. The opaque and confusing nature of these “arbitrary” costs is indicated by the wide range of different prices unique payers are charged. These prices can be divided into three types: charges, negotiated prices and Medicare prices. ([Reinhardt, 2019](#_ENREF_14)) “Charges” are those prices determined by hospitals’ “charge masters”. Hospitals create their own charge masters, through processes that are not clear and are typically not explained. ([Reinhardt, 2019](#_ENREF_14)) Negotiated prices are those that are negotiated by private health insurers. Finally, Medicare prices are the prices paid by Medicare, which can vary, but not excessively. ([Reinhardt, 2019](#_ENREF_14)) The point of these definitions is not to do a deep dive on payers, but rather to showcase that the world of healthcare costing is a vast and confusing place. Few can understand it because the system is chaotic and opaque. The vague nature of the system discourages measurement and reform efforts, in short, it is near impossible to improve a system that cannot be assessed. Thus, such an opaque system for accounting for prices and costs lies at the heart of exorbitant US spending.

Another question to address is what exactly constitutes “excessive” healthcare spending? If “normal” could be defined as spending the average amount on healthcare and receiving average quality care seen in Papanicolas’ study in JAMA, then “excessive” could be explained as spending a higher than average amount and seeing no related increase in quality.

 The opaque nature of the costing system, and the resultant lack of understanding of what it costs to deliver care to patients is perhaps the most important item to address regarding excessive healthcare spending. ([Porter, 2011](#_ENREF_13)) The current costing systems, or lack thereof, make it incredibly difficult to determine accurate prices and to attempt to reduce costs and make improvements. ([Porter, 2011](#_ENREF_13)) In short, it is not possible to improve what cannot be systematically measured. The solution lies in the ability to effectively account for the costs of the resources needed to care for the patient over the entire episode of care. By accurately accounting for the true cost of care, the opaque nature of the system could be broken down and clarified.

## How to Address this Problem?

This essay considers Time-Driven Activity-Based Costing (TDABC) as a portion of the solution to better measure—and ultimately decrease—healthcare costs. Costing in healthcare is difficult due to the complexity of care delivery, the fragmented nature of the healthcare system, the lack of consistency in pricing and a number of other factors. What is needed is a system that seeks to track the resources, personnel and other costs associated with providing care for a patient throughout their care experience, and TDABC is one possible option.

# TDABC

## What is it?

TDABC is a methodology developed by Robert S. Kaplan and Michael Porter that identifies the true cost of care by developing care flow process maps and identifying the types of resources utilized in each step. This model assigns costs directly to the cost objects (e.g. equipment, clinicians, operating rooms), and uses time as its primary cost-driver. ([Kaplan & Anderson, 2007](#_ENREF_9)) Table 1 walks through the steps of TDABC. These time measurements are captured in multiple ways: direct observation (e.g., shadowing); logging the time needed to complete roughly 50 to 100 instances of a task and then using that number to determine the average time per action; interviewing employees; utilizing existing process maps; recycling time estimates from other places within the company. ([Kaplan & Anderson, 2007](#_ENREF_9)) As Kaplan and Porter explain, any quality costing system must account for the total cost of resources used as a patient passes through the process. ([Porter, 2011](#_ENREF_13)) TDABC accomplishes this by categorizing resources into four buckets: personnel, consumables (supplies), space and equipment.

Stratifying resources used in a process into four buckets allows the observer to more easily and accurately assign costs to a process, to understand what aspects are driving the total costs of that process and thus guide potential efficiency initiatives. Personnel can be defined as any staff involved in the care of a patient in the selected medical condition’s care process, for example nurses, patient care technicians, residents, care coordinators, transport services, etc. The cost of personnel was based on annual salaries or hourly wages of those staff involved in the care process, with the exception of physician cost calculation. ([Keel, Savage, Rafiq, & Mazzocato, 2017](#_ENREF_10)) Physicians can be costed using the following items: physician fees, negotiated additional compensation, incentive compensation, administrative stipends, outside income, malpractice insurance, and average base salary. ([Keel et al., 2017](#_ENREF_10)) Supplies or consumables are typically described as the cost of consumable resources used in the process of patient care. This category would consist of items such as gloves, surgical towels, sutures, etc. Space is considered the cost of using the space within the hospital, or outpatient clinic: the cost of the operating rooms (ORs), the clinic room, etc. Finally, equipment costing considers the use of long-lasting equipment such as hospital beds, CT machines, surgical tables, X-ray machines, etc. Aside from the consumables, the costing of these resources is heavily dependent on the time spent using them.

Table 1 Stepwise description of TDABC

|  |  |
| --- | --- |
| **Step** | **Description** |
| 1. | Select the medical condition |
| 2. | Define the care delivery value chain * Chart all key activities performed within the care cycle
 |
| 3. | Develop process maps of each activity in patient care delivery* Incorporate all direct and indirect capacity-supplying resources
 |
| 4. | Obtain time estimates for each process |
| 5. | Estimate the cost of supplying patient care resources* The cost of all direct and indirect resources involved in care delivery
 |
| 6. | Estimate the capacity of each resource and calculate the capacity cost rate |
| 7. | Calculate the total cost of patient care  |

## Origins of TDABC

TDABC began as Activity Based Costing (ABC). ABC, created in the 1980s, provided a methodology for managers to determine how costs were being allocated across a business, and quantify the amount of effort being expended on a customer-by-customer basis. ([Kaplan & Anderson, 2007](#_ENREF_9)) It taught managers to prioritize high value, high efficiency customers and products. ([Kaplan & Anderson, 2007](#_ENREF_9)) Despite the role ABC has played in developing improved methodologies for costing, it is often found to be too time-consuming and not an effective method for making real-time decisions. ([Kaplan & Anderson, 2007](#_ENREF_9)) This section will address the makeup, benefits and drawbacks of the ABC system.

ABC begins with the creation of a project team, who would then go about interviewing supervisors and department heads to determine the activities and items needed to complete the main process. Next, the team interviews employees, asking for the percentage of time they estimate is spent on the activities identified by the department heads. This part of the process is rather time-consuming and difficult for the employees to accurately assess. The project team then takes the total costs of the department and assigns them to the activities based on the assumptions given by the employees. ([Kaplan & Anderson, 2007](#_ENREF_9)) This information is utilized to calculate “cost-driver rates” or, in the example of a manufacturing plant, the cost per unit of product. ([Kaplan & Anderson, 2007](#_ENREF_9)) ABC is most often used in manufacturing due to the regimented and clearly defined nature of the industry.

ABC was first applied to healthcare in the 1990s to succeed where traditional cost-accounting methods had failed. ([Keel et al., 2017](#_ENREF_10)) The benefit of ABC is that it found a way to assign costs from activities that are somewhat difficult to quantify in a less arbitrary way than previous methods. Using ABC helped companies to improve the costing process in three specific ways: by expanding the number of cost objects to spread overhead costs across; by allowing costs to be allocated based on cost-generating activities rather than volume; and by making some indirect costs directly traceable to specific activities. ([Kaplan & Anderson, 2007](#_ENREF_9)) Although it achieved more accurate costing, its usage declined shortly after its introduction because it demanded large resource investments, which many users did not want to expend, leading to incomplete applications of the methodology. ([Keel et al., 2017](#_ENREF_10))

 The drawbacks of ABC are precisely the motivation for the creation of TDABC. In TDABC, there is no need for the stage of activity definition, and so there is also no need to allocate costs to department activities – one of the more time-consuming aspects of ABC. ([Kaplan & Anderson, 2007](#_ENREF_9)) In contrast, TDABC requires only two estimations: capacity cost rate of the department and the capacity usage per transaction. ([Kaplan & Anderson, 2007](#_ENREF_9)) TDABC is a smaller, more scalable model; it has greater accuracy, is easier to build and maintain, and it identifies many process improvement opportunities. ([Kaplan & Anderson, 2007](#_ENREF_9))

## TDABC Application in Healthcare

What began as a business methodology has shifted towards healthcare in recent years in light of the focus on maintaining costs and the advent of bundling programs. Despite its applicability to the healthcare world, not much research has been done on the subject, although it is gaining in popularity. In a January 2020 PubMed search using keyword “TDABC” and “Time-Driven Activity-Based Costing”, 77 and 156 articles were found respectively. In contrast, searching a popular term such as “accountable care organizations” returns a total of 2,163 results. This speaks to the relative novelty of the TDABC as a tool in healthcare.

 Created in 2004, the basis of this methodology has actually been in existence since the 1980s. The first healthcare-focused paper on the subject of TDABC was published in September 2013. It described the use of TDABC in a clinical setting with the hope of quantifying the effects of process-improvement initiatives. ([French et al., 2013](#_ENREF_6)) The next paper published on the subject was written by its creator, Robert Kaplan. This paper is simply titled “Improving Value with TDABC” and was published in June 2014. After this paper, TDABC has been used to assess many aspects of healthcare: neurosurgery; provider engagement initiatives; total knee arthroplasty; prostate cancer; pediatric appendectomy; colonoscopies; total hip arthroplasty; blood transfusion programs; and emergency medicine, among others. In an April 2017 literature review of TDABC usage in healthcare, it was determined that to date, TDABC has been most often applied to surgical procedures like Coronary Artery Bypass Graft (CABG) or Total Knee Replacement (TKR). ([Keel et al., 2017](#_ENREF_10))

Table 2 Overview of Healthcare Settings Where TDABC is Used

|  |  |
| --- | --- |
| **Inpatient Surgery** | Hip Arthroplasty |
| Head and Neck Surgery |
| General Surgery |
| Total Knee Replacement |
| Heart-Valve Surgery |
| Neurosurgery |
| Abdominal Surgery |
| Coronary Artery Bypass Surgery |
| Urology |
| **Outpatient Surgery** | Orthopedic Surgery |
| Pediatric Plastic and Oral Surgery |
| **Outpatient Services** | Psychiatry |
| Urology |
| Ear, Nose and Throat |
| Dermatology |
| Pre-surgery Anesthesia |
| Radiotherapy Settings |
| **Non-hospital Services** | Primary Care |
| Cytometry |

# Case Study: Total Hip Arthroplasty Bundling: An Application of TDABC

To demonstrate an application of TDABC, a case study of total hip arthroplasty (THA) was considered. As shown above in Table 2, THA is a typical setting to apply TDABC. The hip is one of the largest joints in the body and is essentially a “ball and socket” joint. The acetabulum, which is part of the pelvis, forms the socket and the “ball” is the femoral head or the upper part of the femur. Both surfaces are covered in articular cartilage, which is a tissue that cushions the joint and allows it to move smoothly and easily. ([Foran, 2015](#_ENREF_5)) The most common causes of hip pain are osetheoarthritis, rheumatoid arthritis, and traumatic arthritis. Each of these ailments damages the cartilage and bone in the joint and compromises hip function. ([Foran, 2015](#_ENREF_5)) When the pain or lack of functionality becomes untenable, patients will turn to THA, or total hip replacement. This is a procedure where a patient’s damaged bone and cartilage is replaced with prosthetics. ([Foran, 2015](#_ENREF_5)) THA is an ideal setting to apply TDABC because it is a relatively common procedure that is repeatable, stepwise and easily quantified in terms of personnel, resources, space and equipment.

## Case Study Introduction

Three distinct bundles at three different high-volume hospital settings delivering THA were studied. (Table 3) Bundle A was provided in an urban non-teaching setting. Bundle B was provided in a community-based teaching setting. Bundle C was provided in an urban non-teaching setting that performs THA as an outpatient procedure in a specialty orthopedic nursing unit. Bundles A and C were developed using the theory of a “focused care center” or otherwise known as a “hospital within a hospital”. ([Herzlinger, Schleicher, & Mullangi, 2016](#_ENREF_8)) In terms of the operating room and pain management, Bundles B and C used a consultant pain management team and peripheral nerve blocks, while Bundle A did not. The goals of this cost study were as follows: first to show how TDABC, supported by shadowing, is a valid approach to measure and compare costs; second, to compare three bundles when delivered in inpatient versus outpatient settings; third, to show how the resultant information can be used to tightly couple clinical and financial performance in order to focus operational and clinical improvements.

Table 3 Description of Bundles

|  |  |  |  |
| --- | --- | --- | --- |
| **Bundle** | **A** | **B** | **C** |
| **Setting** | Urban | Community | Urban |
| **Teaching** | Non-Teaching | Teaching | Non-Teaching |
| **Procedure Type** | Inpatient Stay – 1 day | Inpatient Stay – 2 days | Outpatient |

## Case Study Methods

The first step in TDABC is to define the span of the clinical condition being addressed. For all three bundles, the episode of care began 30 days prior to surgery and concluded 90 days post-operatively. The next steps were to identify the segments of care for the chosen clinical condition, and then develop a process map for each segment of care. The care experience was first divided into the following segments: pre-hospital, hospital, and post-hospital. (Figure 1) The pre-hospital segment consists of all patient interactions spanning from 30 days prior to surgery up until the actual day of surgery. Within this segment is new patient scheduling, the pre-surgical office visit, patient education, billing, pre-operative testing and consultation, and pre-operative administrative support (such as chart preparation, central sterile processing activities, etc.). The sub-segments involved are pre-op office and pre-op testing/consulting. The hospital segment spans from check-in on the day of surgery through the inpatient stay (where applicable). The sub-segments are pre-operative prep on the day of surgery, OR time, post-anesthesia care unit (PACU) stay, and an inpatient stay for Bundles A and B. The post-hospital segment begins when the patient leaves the hospital and ends 90 days post-operation. This segment is made up of home and outpatient physical therapy, follow-up office visits and post-operative administrative support. The sub-segments are therapy and follow-up visits. The therapy sub-segment encompasses home and outpatient physical therapy. The follow-up visit sub-segment includes any follow up visits 90 days post-surgery.



Figure 1. Segments and Sub-segments Determined Through Shadowing

TDABC classifies resources used in the process of patient care into four categories: personnel, consumables, space and equipment. This process allows clinicians and administrators to understand the full cost of a procedure and thus guide potential efficiency initiatives. ([Keel et al., 2017](#_ENREF_10)) The personnel category references all of the caregivers involved in the experience. Such personnel include surgeons, nurses, patient care technicians, office staff, and others that interacted with the patient over the cycle of care. Personnel time was calculated as 365 days minus weekends, holidays, sick days, meal/break time, meetings, mandatory annual competencies, and continuing education. Research, education, and administrative time was additionally subtracted from the 365 days in calculating physician capacity, as per TDABC guidelines. Salary costs per minute for the 47 different staff types that were identified through shadowing were also calculated using the same system. Malpractice insurance rates were included where applicable.

The consumable category encompasses all items that were utilized once during patient care and then discarded. Such items include surgical towels, gauze, sutures, etc.

Equipment was categorized as the large-scale items utilized during patient care that could be re-used for other patients. Equipment was calculated by recording the amount of time each piece of equipment was used through shadowing and then calculating the cost-per-minute of use for these items. This could include the surgical table in the OR, the saws and drills used during the surgery and other re-usable items.

Lastly, space was calculated based on time spent in consultation rooms, ORs, PACU bays, etc. Cost data for space, equipment, and consumables were gathered from a variety of hospital departments (pharmacy, construction, supply chain management, and others). The following indirect costs were not included: overhead costs for marketing activities; legal services; insurance; debt services; general human resources activities; on-call pay; shift-differential; staff orientation time tied to personnel ([DiGioia, Greenhouse, Giarrusso, & Kress, 2016](#_ENREF_4)).

## Case Study Results

### Total Costs

The total costs for Bundles A, B and C were calculated by summing the cost of personnel, consumables, space and equipment for each. As shown in Figure 2, Bundle B (the community teaching hospital) was the most costly ($10,993) and Bundle C, the outpatient approach, was the least expensive ($7,407). The cost for the implant was identical for all three bundles--however, the cost of the implant accounted for 39%, 34% and 50% of total costs of Bundles A, B and C, respectively.

Figure 2 Segments and Sub-Segments Determined Through Shadowing

### Costs per Category

Personnel, consumable, space and equipment costs were broken down and detailed with the cost of the implant included (Figure 3) and excluded from consumables (Figure 4). The most expensive item within the consumable category was the implant. When the cost of the implant was included, Bundle C had the lowest cost for consumables ($4,389) and Bundle B, the highest ($5,535). The cost of the implant accounted for 76%, 67% and 84% of consumable costs for Bundles A, B and C, respectively. Personnel was the second most expensive resource used by each Bundle. Bundle B’s personnel costs were the highest ($5,011) and Bundle C’s personnel costs were the lowest ($2,860). If the cost of the implant is excluded, personnel becomes the most expensive category. An important observation is the relatively negligible cost of space and equipment. Although these two categories may have been expected to be major drivers of cost, they only accounted for 5%, 6% and 4% of costs for Bundles A, B and C respectively. (Figure 4)

Figure 3 Cost per Resource per Bundle Including Cost of Implant

Figure 4 Cost per Resource per Bundle Excluding the Cost of the Implant

### Costs by Segment and Sub-Segment

Next, the costs were broken down by segment (pre-hospital, hospital and post-hospital; Figure 5) and include the cost of the implant. Bundle A (provided in the urban non-teaching center) was the most costly in only one segment (pre-hospital), Bundle B (provided in the community teaching setting) was the most expensive in two of the three segments (hospital and post-hospital), and Bundle C (the community non-teaching outpatient facility) was the least costly across all three categories. In the pre-hospital segment, Bundle A provided the most costly care at $774 while Bundle C provided the least costly care at $465. Pre-hospital is the only segment where Bundle A had the highest cost. This is due to its use of a comprehensive pre-testing and patient education center (Bundle A incurs staff and consumable costs for these centers). The hospital and post-hospital segments similarly reflect the trends: Bundle A has the second-highest costs, Bundle B has the highest costs, and Bundle C provides care for both segments at the lowest cost. This is due to the fact that Bundle C provides an outpatient procedure, which significantly lowers the post-day of surgery costs because the patient is not staying for multiple days in the hospital and thus is not using up staff time or consumables. Further, Bundle B has the highest costs due to the fact that it provides an inpatient procedure at a teaching hospital.

Figure 5 Cost per Segment

Next, the bundles were broken down into sub-segments (Figure 6). Bundle C provided the least costly care across nearly all of the seven sub-segments (Figure 1), and Bundle B was the most costly in every segment except pre-operative testing and therapy. Aside from the OR, the second highest costs occurred during the inpatient stay. As this was a major cost driver for all three bundles, a further breakdown of inpatient costs is shown in Table 4. Bundle C provided an outpatient THA, only incurring costs on the actual day of surgery. By contrast, Bundles A and B both provided inpatient THAs. Patients in Bundle A stayed for an average of two days, while patients in Bundle B stayed for an average of three days. This difference in inpatient stay resulted in Bundles A and B incurring costs of more than twice the total of Bundle C’s inpatient care. The third highest cost-driver was cost of inpatient and outpatient therapy. Figure 5 shows a distinct difference between the therapy costs for Bundles A and B and those for C: $1,371 and $1,306 for A and B compared to $371 for C.

Figure 6 Cost per Sub-Segment

Table 4 Breakdown of Inpatient Costs

|  |
| --- |
| **Inpatient Stay Costs per Bundle** |
|  | Day 0 | Day 1 | Day 2 | Day 3 | Total Cost |
| **Hospital A** | $ 437 | $ 610 | $ 452 | $ 0 | $ 1499 |
| **Hospital B** | $ 365 | $ 540 | $ 539 | $ 399 | $ 1844 |
| **Hospital C** | $ 537 | $ 0 | $ 0 | $ 0 | $ 537 |

### Costs of Day of Surgery

The costs during the day of surgery made up a majority of the total costs of the bundle. The day of surgery expenses are composed of time in pre-op, the OR, the costs of the implant and the PACU. The day of surgery costs for each bundle are as follows: Bundle A cost $5,498; Bundle B cost $6,935; Bundle C cost $5,842. Bundle B, as a teaching hospital had more personnel in the OR as well as longer OR times which significantly added to the day of surgery costs.

The day of surgery took up the majority of the total costs, making up 59%, 63% and 79% of costs for Bundles A, B and C, respectively.

# Discussion

US healthcare spending is high and getting higher, yet despite this extra spending, US healthcare outcomes are similar or worse to other highly developed countries. Spending increases can be attributed to a number of issues including growing administrative costs, waste, pricing failure, and administrative complexity. The most relevant to this case study are the pricing failures and system complexity. The key issue for both of these items is the chaotic and opaque nature of the healthcare system at large. It is near impossible to determine the actual costs of providing care to patients and without a way to gauge these costs, the prices will only continue to rise.

 The opaque nature of healthcare is where the use of TDABC becomes attractive. As shown in the literature review of the use of TDABC in healthcare, this costing methodology is on its way to becoming a well-utilized tool to cost certain procedures. This case study and the literature review overlapped in a number of ways. Both explain the high level steps of TDABC, and address TDABC’s possible role in determining bundled payments. Further, the literature review identifies systematic and repeatable orthopedic procedures as an ideal place to apply the costing methodology – a determination echoed in this paper and case study. The Keel et al. literature review and this essay have a number of differences as well, namely the literature review spends a fair amount of time showcasing the other situations to which TDABC has been applied, notes the places that TDABC has not been applied (to directly inform bundled payments, etc.), and stops at a cursory explanation of TDABCs use in these situations. With these differences in mind, this paper addresses the following gaps: it specifically explains how to account for each resource, gives an in-depth look at how to apply TDABC to the hip replacement process at three hospitals and compares and contrasts approaches.

 The case study was an excellent way to showcase the benefits of utilizing TDABC in easily repeatable and quantifiable settings. By applying TDABC to THA cases in three unique hospitals, a few items of note were identified. First, it was shown that THA is a good setting to apply TDABC. Second, it was determined that outpatient procedures are far more cost-efficient than inpatient procedures, supporting the industry-wide trend toward outpatient procedures. Third, it was determined that the two most costly resources were consumables and personnel. Relating to this, the costs of space and equipment were determined to be relatively small, indicating that the true cost drivers are the cost of staffing procedures and the supplies needed to complete them.

 TDABC is a great way to easily quantify resources and compare cost performance on procedures between hospitals and doctors. Breaking down resources into the four buckets allows interested parties to determine what the biggest cost drivers are. By concretely determining costs per each bucket, it is then easy to compare costs between hospitals or among doctors, as seen in the case study. Lastly, this system is relatively simple to explain, particularly compared to ABC, and could be used as a tool by administrators in any hospital.

If enough procedures could be costed, and an average created, these numbers could be used to determine true costs of procedures and be utilized to determine reimbursement amounts. This would allow hospitals and administrators to facilitate cost transparency, specifically for easily repeatable and quantifiable procedures.

Although TDABC is a useful tool, after assessing its use in the case study, some weaknesses of the methodology were found, namely that it is work-intensive and thus, not truly easily scalable. Calculating the resources used in each segment is time-consuming, particularly when calculating clinician cost per minute. Timing the actual procedures also takes manpower and time. With these two issues in mind, scalability is called into question. It is not feasible to expect a large healthcare organization to spent the necessary time and money to detail each and every procedure that occurs within the hospital. That does not mean that each and every setting is a poor application, rather it shows that organizations must be strategic in using the methodology. For example, a repeatable and systematic procedure such as a hip or knee replacement is an ideal application. In contrast, an unpredictable and complicated service such as orthopedic trauma may have a harder time finding a procedure in which to apply TDABC.

# Conclusion

TDABC is a methodology developed by Robert S. Kaplan and Michael Porter that identifies the true cost of the full cycle of care by developing care flow process maps and identifying the types of resources utilized in each step of the process. To test this methodology, we conducted a case study using TDABC to assess total hip arthroplasty bundles at three distinct hospitals. We found that personnel is the most costly resource, followed by consumables and that space and equipment incur relatively negligible costs. After completing and assessing the case study, we found that TDABC was a good methodology to apply to systematic and repeatable processes like THA, however that it is also too time and resource-intensive to scale up to every procedure in a hospital. However, as a costing methodology to determine bundling payments for somewhat simple and repeatable processes, it can provide invaluable and incredibly detailed information. In conclusion, quantifying resources may seem like an obvious and simple task, but by taking the time to complete the “obvious”, true cost can be identified.

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