ORIGINAL ARTICLE HEALTH SERVICES RESEARCH AND POLICY

Utilizing Time-Driven Activity-Based Costing to Increase Efficiency in Ultrasound-Guided Breast Biopsy Practice

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Abstract

Purpose: In this study, we used time-driven activity-based costing to increase efficiency in our ultrasound-guided breast biopsy practice by understanding costs associated with this procedure.

Methods: We assembled a multidisciplinary team of all relevant stakeholders involved in ultrasound-guided breast biopsies, including a radiologist, a lead technologist, a clinical assistant, a licensed practical nurse, and a procedural support assistant. The team mapped each step in an ultrasound-guided breast biopsy from the time of scheduling a biopsy to patient checkout. We completed on average 20 time observations of each step involved in these biopsies from a provider's perspective. Using capacity cost rate, we calculated the cost of all resources including personnel, supply, room, and equipment costs. Several costly steps were identified in the process, which led to the intervention of changing our overlapping biopsy times to staggered biopsy times. Time observations for each step and cost calculations were repeated postintervention.

Results: Our postintervention data showed that the total time spent by the radiologist in an ultrasound breast biopsy decreased by 28%, accounting for 56% of the total cost in comparison with 63% pre-intervention. The radiologist's wait time decreased by 38%, accounting for 28% of the total cost in comparison with 35% pre-intervention. Our total cost of the procedure decreased by 20%, and the personnel cost decreased by 25%.

Conclusions: Time-driven activity-based costing is a practical way to calculate costs and identify non-value-added steps, which can foster strategies to improve efficiency and minimize waste.

Key Words: Breast biopsy, cost, TDABC, time

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INTRODUCTION

With increasing health care costs and evolving payment models, it is more critical than ever that medical providers maximize value by increasing efficiency and decreasing costs. Although value is difficult to define in health care, Porter's widely cited definition of value is outcomes achieved relative to costs (outcomes/cost) [1]. To enhance value, one must improve outcomes or decrease cost. Although there has been a significant focus on improving patient outcomes in the recent past through regulatory and financial incentive models, there has been scant emphasis on decreasing cost. To decrease cost, one must be able to evaluate the true cost of a medical process or procedure.

Calculating the cost of a medical process or procedure is challenging because various shareholders in the health care arena often define costs differently. Health care policy makers may refer to cost as the money paid to providers for medical services, and providers may define their costs by their reimbursement, but these are not necessarily the costs incurred by the health care system for a medical process or procedure [2,3]. Not knowing true costs prevents one from truly decreasing

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costs, which can have substantial negative downstream consequences such as the inability to adequately negotiate reimbursement in a bundled payment model.

Calculating true costs is challenging in health care due to the complexities of resources involved in the care cycle of a patient. Time-driven activity-based costing (TDABC) has been proposed as a practical approach to costing in health care. TDABC was first proposed by Kaplan and Anderson at Harvard Business School [4] and has been successful in service industries [5]. TDABC was further refined by Kaplan and Porter to be applied in the health care industry [2]. TDABC cost calculations require an estimate of the amount of time needed to perform each task in a care cycle and the capacity cost rate of each supplying capacity (eg, cost per minutes of a radiologist's time, cost per minutes of the room utilized for biopsies). The time estimates and capacity cost rate for each resource utilized are then multiplied and summed for each step in a care cycle to calculate the total cost [6].

In our breast imaging biopsy practice, we had noticed an increase in our ultrasound biopsy volumes, which was leading to long wait times for patients to schedule their biopsies. We had also subjectively noticed an increase in the time it was taking for these procedures to be performed in our division. We needed to decrease the amount of time it took us to perform ultrasound-guided biopsies so that we could increase the number of biopsy slots daily without increasing resources (staff, room, or equipment). TDABC provided an ideal solution for us to understand the time our patients were spending during each step of their biopsy care cycle and the costs associated with each of these steps. The purpose of this study was to use TDABC to understand costs associated with our ultrasound-guided breast biopsies and to increase efficiency through this process.

METHODS

Pre-Intervention

In April 2018, we assembled a team of all stakeholders involved in ultrasound-guided breast biopsies including a radiologist, a lead technologist, a clinical assistant, a licensed practical nurse, and a procedural support assistant. With the assistance of a process improvement coach, the team developed a swim lane diagram charting out the steps involved in an ultrasound-guided breast biopsy (Supplement A). Twenty time observations were made of each step and averaged for the cost calculations.

Costing

The total cost of the procedure was determined by adding together personnel, supply, equipment, and space costs at each step of the procedure (Supplement C). Personnel cost was calculated based on the role of the employee involved and the number of minutes spent by that employee in each step. The cost of each employee was determined by using average institutional salary, benefits, and supervisory overhead for that role. The personnel capacity (minutes) was calculated using the productive minutes per day (8-hour workday minus time spent for lunch and meetings) and available days per year (days per year minus weekends, holidays, and vacation). Personnel cost and capacity were used to calculate capacity cost rate (cost per minutes), which was then multiplied by minutes spent by each person in each step of the swim lane diagram.

To determine supply costs, a common list of all supplies involved in breast ultrasound biopsies (eg, needles, clips, lidocaine, gauze) was derived by the team. Working with radiology supply chain management, the total cost of all supplies used in the procedure was calculated. Equipment costs were determined by calculating annual straight line depreciation and annual maintenance cost of each piece of equipment used in an ultrasound biopsy. The equipment capacity (minutes) was calculated using the productive minutes available per day and available days per year (days per year minus weekends, holidays, and maintenance days). The capacity cost rate (cost per minutes) was then multiplied by the number of minutes each piece of equipment was used in each step of the biopsy procedure. To calculate space costs, we determined the total square footage of each space used during a breast biopsy (biopsy room, consent room, and waiting room) and calculated the space capacity cost rate in a manner similar to the equipment capacity cost rate. The space capacity cost rate was then multiplied by the number of minutes each space was utilized during the procedure to derive total space capacity cost.

Once all the personnel, supply, equipment, and space costs for each step in the biopsy procedure were determined, they were summed to determine the total cost of the procedure. Costing was performed with assistance from the radiology finance department.

Intervention

After cost analyses of the pre-intervention swim lane diagram were performed, the team met multiple times to

Table 1. Our afternoon schedule before and after our schedule change

Procedure	Pre-Intervention	Postintervention
1	1:00	1:15
2	1:00	1:30
3	2:15	2:15
4	2:30	2:45
5	2:30	3:15
6		3:45

analyze the data and determine the most costly time-consuming steps in the procedure. Detailed analysis of our procedure workflow showed that the radiologists' total time and wait time were the most costly steps for our procedures. The team determined that this was in a large part attributed to simultaneous patient flow secondary to overlapping procedure slots. Overlapping procedure times with only one procedure team and one ultrasound biopsy room meant that staff and space were not always readily available for a patient because they were being utilized by another patient at the same time. After input from all stakeholders, we staggered our procedure times so that there was a slot available every 15 to 45 min, depending on the procedure type (Table 1). We tested this change running a plan-do-study-act cycle, studying the impact it would have on the radiologist's wait time. We noticed that the schedule change allowed the radiologists to flow from room to room to complete the procedures with less wait time. The schedule staggering also allowed for an additional procedure slot to be added to the schedule. We implemented the final schedule change in October 2018.

Postintervention

In March 2019, 5 months after the implementation of the new schedule, we studied the impact on time and cost of ultrasound-guided breast biopsies. Similar to our pre-intervention data collection, we created another swim lane diagram based on average 20 observations of each step in the procedure (Supplement B). We recalculated costs for each step using the costing methods described previously and derived the total cost of the procedure.

RESULTS

Our pre-intervention data (Supplement A) showed that the radiologist spent on average 75 min (36-123 min) in the care cycle of a patient presenting for ultrasound-guided core biopsy, from planning for the biopsy to dictating the final report. Out of these 75 min, 40 min (19-66 min) was wait time, which included 27 min (13-55 min) of wait time from obtaining consent from the patient to entering the biopsy room and 13 min (6-21 min) of wait time from completing the procedure to receiving postbiopsy clip images to check. The average times spent by all personnel in a patient's care cycle of an ultrasound-guided breast biopsy are displayed in Supplement A.

Total personnel cost accounted for 81% of the total cost of the procedure in the pre-intervention period. Supply, space, and equipment costs accounted for 16%, 2%, and 1% of the total cost, respectively. The radiologist's total time was the most costly, comprising 63% of the cost of the entire procedure. Of this, the radiologist's total wait time accounted for 35% of the total procedure cost.

Our postintervention data (Supplement B), after implementation of our new schedule with staggered biopsy times, showed that the radiologist total average time decreased to 54.25 min (48-57 min) and total wait time decreased to 25 min (22-26 min), which is a 28% and 38% decrease, respectively, in comparison with pre-intervention times (Figure 1). The wait time from obtaining consent from the patient to entering the biopsy room decreased by 48% from 27 min to 14 min (12-15 min), and the wait time from completing the procedure to receiving postbiopsy clip images decreased by 15% from 13 min to 11 min (10-11 min). Changes in personnel times are displayed in Table 2.

Our total personnel cost decreased by 25% due to decreased times in the postintervention period. Table 3 outlines change in each personnel cost. Our supply, space, and equipment costs stayed the same. This led to an overall 20% decrease in the total cost of the ultrasound-guided breast biopsy procedure. In the postintervention period, personnel, supply, space, and equipment costs accounted for 77%, 20%, 2%, and 1% of the total cost, respectively. Additionally, the radiologist total time accounted for 56% of the total cost, compared with 63% pre-intervention, and the radiologist's wait time accounted for 28% of the total procedure cost after the intervention, compared with 35% pre-intervention.

DISCUSSION

In our ultrasound-guided breast biopsy practice, we utilized TDABC to improve efficiency by identifying true cost of our ultrasound procedures. By using TDABC, we were able to identify the radiologist's wait time as being the most costly non-value-added step in our biopsy practice. By modifying our overlapping

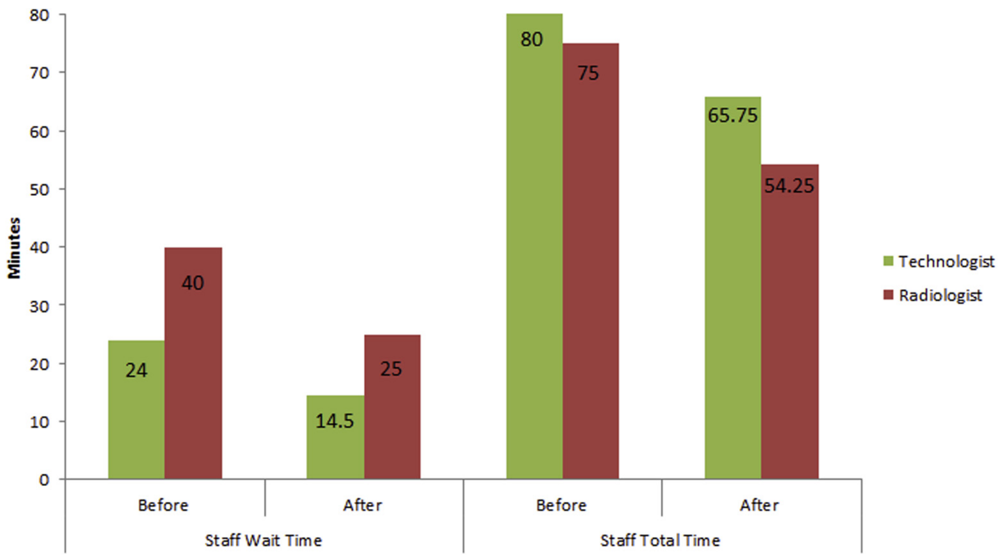

Fig 1. Technologist and radiologist average total procedure time and wait time before and after the schedule change (intervention) during ultrasound-guided breast biopsies.

biopsy schedule to a staggered schedule, we were able to reduce staff wait time and reduce cost associated with that time, resulting in a total cost decrease of our ultrasound biopsies by 20%. This increased efficiency allowed us to add a biopsy slot daily without utilizing additional resources.

With a minor change of staggering appointment slots, we were able to see significant time and cost savings in our ultrasound breast biopsy practice. As a result of TDABC, we were able to understand the most costly steps in our biopsy practice and were able to brainstorm ideas to decrease those costs. The decreased procedure time and improved efficiency observed in our practice through the implementation of TDABC allowed us to add an extra biopsy slot daily without increasing any staff, equipment, or room resources. Overall, TDABC helped us to optimize the flow of procedures and allowed radiologists to transition from one procedure to another with decreased interruptions.

In our study, we did notice a 55% increase in time and personnel cost of the schedulers during the post-intervention period. We believe this to be the result of a new institutional scheduling policy. In May 2018, the institution transitioned from divisional scheduling to a centralized scheduling system that requires a phone call to be made by the breast imaging scheduler to the centralized scheduler. The hold time associated with this phone call accounts for the increase in time and personnel cost of the schedulers. Even with this increase though, our net personnel cost decreased by 25% secondary to decreased personnel time for other providers in the patient's care cycle.

Table 2. Personnel total times before and after the schedule change (intervention)

Personnel	Total Time Before (min), Average (Range)	Total Time After (min), Average (Range)	% Average Total Time Change
Scheduler	10 (3.2-16.8)	15.5 (5-26)	+55*
Reception desk CA	1 (0.2-1.7)	1 (0.3-1.8)	-
Corridor CA	2 (1.2-2.8)	2 (1.3-2.8)	-
Subwait CA	5 (4.2-7)	3 (2.5-4.2)	−40
LPN or PSA	74 (42-94)	68.25 (42-88)	−7.8
Technologist	80 (35-103)	65.75 (28-80)	−17.8
Radiologist	75 (36-123)	54.25 (48-57)	−27.7

CA = clinical assistant; LPN = licensed practical nurse; PSA = procedural support assistant.
*Scheduling time increase noticed secondary to our institutional change of practice to centralized scheduling.

Table 3. Change in average personnel costs after the schedule change (intervention)

Personnel	% Average Personnel Cost Change
Scheduler	+55*
Reception desk CA	-
Corridor CA	-
Subwait CA	−40
LPN or PSA	−7.8
Technologist	−17.2
Radiologist	−29.2
Net change	−25

CA = clinical assistant; LPN = licensed practical nurse; PSA = procedural support assistant.
*Scheduler cost increased due to an increase in scheduling time noticed after an institutional change of practice to centralized scheduling.

Prior studies have described the utility of TDABC in radiology practices. Tibor et al described using TDABC to modify their MR enterography practice, which resulted in a 13% decrease in cost and 16% decrease in staff time [7]. Similarly, Anzai et al studied their CT abdomen and pelvis practice and discovered that the total cost of an inpatient CT abdomen and pelvis was much higher than an outpatient or emergency department CT, with personnel costs accounting for the highest proportion of that cost [8]. This allowed the authors to think of multiple strategies to minimize costs, including blocking schedules for inpatients, reducing wait times between patients, and replacing some of the roles performed by technologists and nurses with less costly staff members [8]. To our knowledge, our study is the first to describe the implementation of TDABC in a breast biopsy practice.

In the changing landscape of health care reimbursements and quality metrics, understanding true costs of a procedure or process is more important than ever before. Poor costing measurements preclude providers from truly understanding costs, which prevents them from linking costs to process improvements or outcomes [2]. Poor costing measurements also lead to arbitrary cost-cutting measures, like placing arbitrary spending limits on a procedure or process. This does not lead to true cost savings and may in fact lead to worse patient outcomes. Poor costing also puts health care providers at a disadvantage for negotiating reimbursements, such as in a bundled payment model [2]. Most importantly, though, not understanding how to calculate and reduce cost prevents one from achieving optimal value, which is defined as outcomes achieved relative to costs (outcomes/cost) [1]. TDABC provides a logical process for calculating true costs associated with each step in a patient's care cycle. By providing this insight into true costs, it allows providers an opportunity to cut costs and improve efficiency.

There are a few limitations of our study. TDABC analyses in our study required costing expertise, which may not be readily available in every practice. We only evaluated our ultrasound biopsy practice and did not study the impact of our stereotactic biopsies or needle localizations on our costs. We did not account for the variation among staff members, particularly in terms of years of practice or experience, which may affect the time spent during each step of the procedure. We did not study the productivity of radiologists performing other tasks during the wait times of ultrasound biopsies. Although our process change likely resulted in reduced patient wait times, we did not directly study the impact of our intervention on patient outcomes, such as patient wait times, success of procedures, or biopsy complications. Lastly, we could not describe our absolute costs in this study due to institutional contractual and regulatory policy.

TAKE-HOME POINTS

- We used TDABC to identify inefficiencies in our ultrasound-guided breast biopsy practice and decrease the total time and wait time of the radiologist by 28% and 38%, respectively.
- Our total cost of the procedure decreased by 20%, and the personnel cost decreased by 25%.
- TDABC allowed us to decrease personnel time and costs and increase efficiency and biopsy access without increasing any resources in our ultrasound-guided breast biopsy practice.

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ADDITIONAL RESOURCES

Additional resources can be found online at: https://doi.org/10.1016/j.jacr.2019.06.016.

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