

# TDABC Cost Analysis of Ocular Disorders in an Ophthalmology Emergency Department versus Urgent Care: Clinical Experience at Massachusetts Eye and Ear

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## Abstract

**Purpose** To perform a cost analysis comparison for managing common ocular disorders in an eye emergency department (ED) versus an urgent care setting using a time-driven activity-based cost model (TDABC) to assist physicians and staff in appropriate allocation of resources at their own institution.

**Design** Retrospective analysis.

**Setting** Massachusetts Eye and Ear (MEE) ED and Same-Day Services (SDS), which runs as an urgent care clinic.

**Population** Patients diagnosed with corneal abrasions, dry eyes, conjunctivitis, and styes were identified between April 2014 and August 2015 ( $n = 2,408$  [ED], 26 [SDS]). We determined resources used in delivery of care, which included personnel, consumables, space capacity, and equipment. Costs were identified based on time the patient spent with each resource.

**Main Outcome** Average visit length and associated personal, space, equipment, and consumable costs.

**Results** Average visit length was 196 and 53 minutes, respectively, primarily due to longer wait times in the ED. Personnel and space costs were higher in the ED compared with SDS (\$68.92 vs. \$51.37 and \$24.44 vs. \$12.86, respectively). This led to an overall higher total resource cost for patients seen in the ED compared with SDS (\$108.41 vs. \$81.53, respectively).

**Conclusion** For common ocular disorders, total SDS costs were 25% less than ED costs at MEE primarily due to personnel and space utilization. Treating patients with nonemergent ocular problems outside the ED can lead to shorter visit times for patients as well as lower overall costs.

## Keywords

- ▶ cost analysis
- ▶ time-driven activity-based cost model
- ▶ emergency room
- ▶ urgent care clinic

The United States spends the greatest percentage (17.8%) of its gross domestic product on health care of any country worldwide, with costs exceeding \$3 trillion dollars.<sup>1</sup> Despite this expenditure, it is unclear whether the United States has quality

health care that justifies these costs. As a result, the topics of higher cost and potentially lower quality have been at the center of many financial and political discussions. One of the biggest obstacles in these conversations is the “iron triangle

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of health care,” which describes three competing health care issues: access, quality, and costs. Conventional wisdom, such as described by Kissick,<sup>2</sup> holds that changing one of the three vertices affects the other two. However, since the dynamics of each segment are constantly changing, the iron triangle may not, in reality, be that rigid. Research into methods of disrupting this iron triangle can reveal how to get better at delivering value-based health care in which patient outcomes, care, and access all improve, while costs decrease.<sup>3</sup>

Measuring medical outcomes has received growing attention, but measuring the costs required to deliver those outcomes has received far less attention. Accurate cost measurement will help sustain new treatment approaches that improve outcomes. Attempting to reduce expenses with inaccurate costing systems can be disastrous. Often times, managers attempt to reduce costs through simplistic actions such as across-the-board cuts in certain services, staff compensation, or head count. These actions lead to, at best, only marginal and short-term savings and often accompanies poorer outcomes. The more accurately we can measure costs, the better we can make informed decisions to lower costs and improve outcomes.

One option for lowering costs is to treat patients at the most appropriate level of care. Treating nonemergent problems outside of emergency departments (EDs) is a goal of many health care entities. In 2016, Friedman and coworkers assessed the epidemiology of eye-related ED visits and found that over 44% of cases (e.g., conjunctivitis, styes) were nonemergent and could easily be handled in an outpatient model.<sup>4</sup> Treating patients at the most appropriate level of care keeps costs manageable while maintaining quality.

In 2015, Massachusetts Eye and Ear (MEE) implemented a pilot project called the Same-Day Service (SDS). Staffed by optometrists with ophthalmology consults readily available, the SDS runs like a triage and an urgent care clinic where primary care physicians (PCPs) from Massachusetts General Hospital can reach an optometrist via a phone call or a page, who then determines whether the patient should go directly to the ED, be seen by the SDS, or be scheduled on a nonurgent basis. MEE also has a dedicated eye and ear ED that welcomes all patient walk-ins and referrals with ocular and ENT complaints from outside hospitals regardless of acuity. All ED patients are seen by an ophthalmology resident and staffed with an ophthalmology attending or fellow.

With a dedicated eye ED as well as a SDS, MEE could, uniquely, compare costs across different care settings and reallocate patients with nonemergent cases to the most cost-efficient location. Such a triage of nonemergent versus emergent ocular cases offers an attractive opportunity for savings.

Professor Robert Kaplan and Steven Anderson developed time-driven activity-based costing (TDABC), which uses process mapping and resource utilization per unit of time to develop highly specific and accurate measurements of costs.<sup>5</sup> TDABC attributes resource costs directly to patients and their conditions, rather than to departments, procedures, or services. Therefore, the patient’s medical condition becomes the fundamental unit of analysis for measuring costs and outcomes. The TDABC system assigns expenses

of personnel, equipment, and space resources based on the quantity of time that patients, being treated for a specific medical condition, spend with each resource. The methodology allows an institution to understand processes across its care continuum to subsequently identify opportunities for process improvement and to improve resource utilization. Rather than just capture costs incurred within a department or for a narrow treatment procedure or episode, TDABC captures all the resource costs incurred over a patient’s complete care cycle for a specific medical condition. Clinicians and staff can then consider innovative and tailored approaches to reduce costs, while sustaining and often improving patient outcomes. TDABC also better supports cost-effectiveness studies, identifies new areas for value creation, and serves as the foundation for value-based reimbursement, such as bundled payments.<sup>6</sup> TDABC has been used effectively at many health care institutions including the MD Anderson Head and Neck Cancer Center in Houston, Mayo Clinic, and the Cleft Lip and Palate Program at Children’s Hospital in Boston.<sup>7</sup> It has been applied to many medical conditions: anesthesiology, arthroplasty, interventional radiology, neurosurgery, and emergency medicine.<sup>7-14</sup> TDABC has led institutions to identify areas of process and quality improvement, such as task-shifting, so that all personnel can practice at the top of their license. Patients are seen at the appropriate site for their care for their entire care cycle, like an integrated practice unit.

A large volume of patients are seen daily in the MEE ED (~20,000 visits per year), many of them with nonemergent diagnoses that can, ideally, be managed in less than an hour. Due to the sheer traffic that goes through the ED, however, such visits can last well over several hours, delaying physicians from seeing patients with more vision-threatening problems. Many nonemergent cases that enter the MEE ED can be easily managed in an outpatient setting with shorter visit times, which would alleviate congestion, be more responsive to the patient’s needs, and, presumably, lower costs. By creating the SDS program, a PCP can refer patients with nonemergent eye problems directly to an optometrist, avoiding the need for an ED visit. In this article, we apply TDABC to measure the costs of treating common eye complaints in an ED and outpatient setting, assist in appropriate allocation of resources, and see if there are potential savings by facilitating management of nonemergent cases outside the MEE ED.

## Methods

This study was approved by the Institutional Review Board at Massachusetts Eye and Ear, Boston, MA. We retrospectively analyzed visit lengths for four common eye complaints that routinely do not need evaluation in an emergency room, but can be seen in an outpatient clinic setting (corneal abrasion, dry eye, conjunctivitis, and styes) from April 2014 to August 2015 using the following ICD-9 codes: corneal abrasion (371.81, 371.89, 371.9, 370.8, 918.1), dry eyes (370.20, 370.21, 375.15), conjunctivitis (372.00, 370.01, 370.02, 370.03, 372.05, 372.06, 372.30, 372.39), and styes (373.11, 373.12, 373.2).

The implementation of TDABC requires the following steps: (1) create process maps of the patient's care cycle; (2) measure the cost per minute of each resource used in the care cycle; (3) estimate the minutes required to perform each process in the care cycle; (4) multiply the time for each process step by the cost per minute of the resource performing that step; and (5) add up all the process step costs across the entire care cycle to obtain an estimate of total costs.

### Process Maps

We developed process maps from initial check-in to check-out at MEE for the common eye complaints listed earlier. This was performed for both the eye ED and the SDS department. Time along each step was determined through electronic medical records (when time stamps were available) and through direct observation and meetings with staff and management. We identified all resources including personnel, space capacity, and equipment costs.

### Estimation of Costs Associated with Each Specific Service

We identified the personnel, space, and equipment needed at each step of the process map and estimated the time required for each resource. We calculated the total costs over each patient's cycle of care.

Personnel costs (e.g., ophthalmologist attending/fellow/resident, optometrist, triage nurse) were calculated based on 2015 expenses and included yearly salary, fringe benefits, and liability insurance. We calculated final costs based on time dedicated to clinical duties (e.g., not administrative or research). Maintenance and billing departments provided space capacity and associated costs (e.g., cost per square feet, annual housekeeping costs per square feet). Direct costs for equipment (e.g., slit lamp), supplies, (e.g., fluorescein strip), and drugs (e.g., proparacaine) were identified.

### Calculation of Total Costs

The corresponding personnel, space, and equipment costs for each segment of the process map were identified. Final costs were calculated based on the time spent during each process map segment.

## Results

### Patient Flow

► **Fig. 1** shows the process maps for patient flow through the ED and SDS setting. Patients evaluated in the emergency room are seen by a receptionist, a triage nurse, ophthalmology resident, fellow, or attending, while patients evaluated in the SDS are seen solely by a receptionist and an optometrist. The maps showed that emergency room patients waited significantly longer to be seen by a physician.

### Total Patient Visits and Visit Lengths

Patients made a total of 2,408 ED visits for corneal abrasion, conjunctivitis, dry eye, and styes from April 2014 to August 2015. The average visit length was 196 minutes. Patients made 26 SDS visits during the same period, with

the average visit length being 53 minutes. A breakdown of the number of cases and average visit length for each diagnosis is shown in ► **Fig. 2**. The longer visit time in the ED was primarily caused by higher waiting times before seeing a physician.

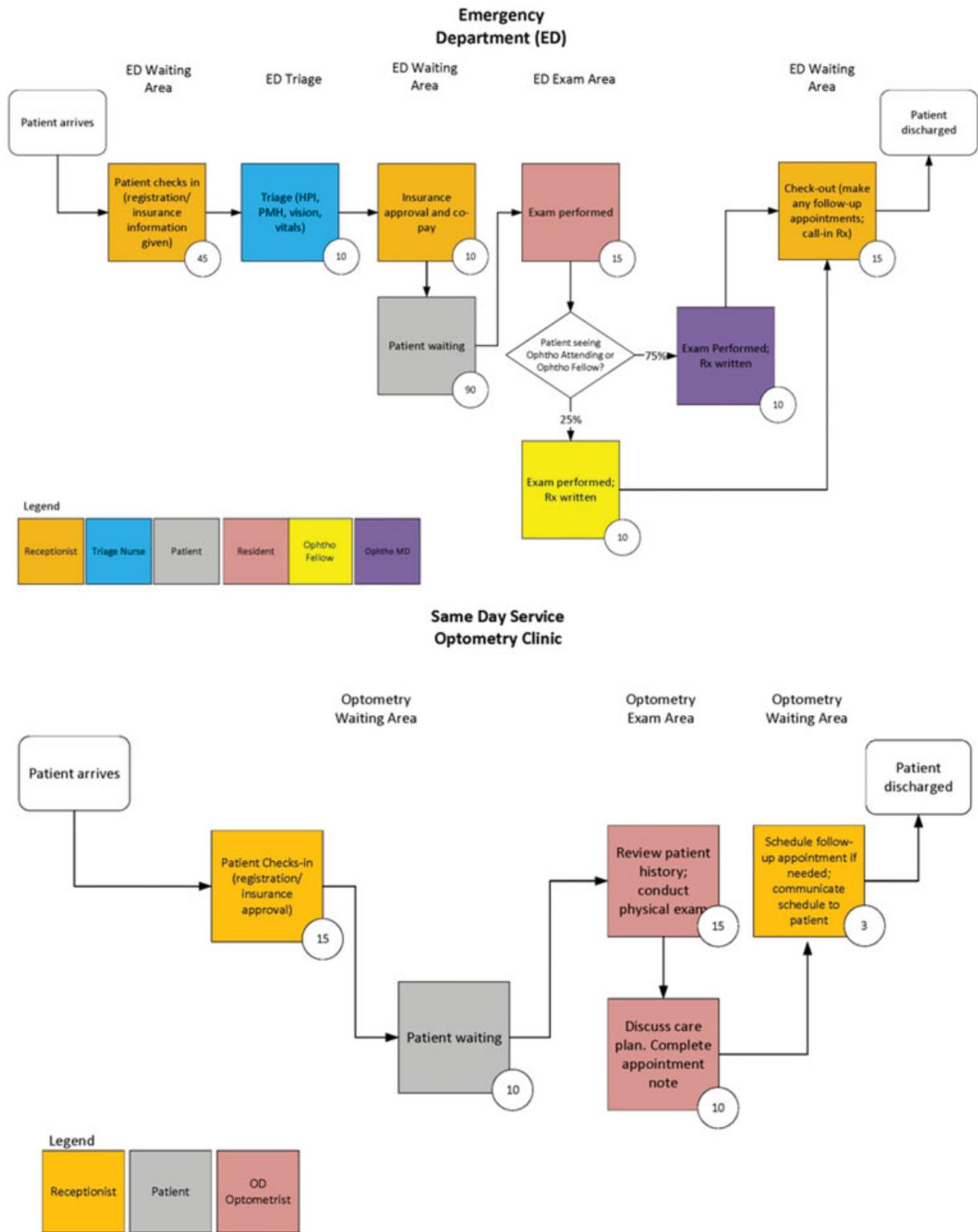
### Total Cost Comparison between ED and Same Day Service Settings

► **Table 1** lists the direct personnel cost based on the estimated time that each clinician or staff person spent interacting with the patient. Total personnel cost was \$68.92 in the ED versus \$51.37 in SDS. Physician cost was lower in the ED (\$38.01 [\$24.35 (attending) + \$11.93 (resident) + \$1.73 (fellow)]) compared with SDS (\$46.63 [optometrist]) because ED patients were seen primarily by ophthalmology residents. The cost of the receptionist was lower in SDS (\$18.43 vs. \$4.74, respectively) due to greater time spent with the patient during check-in and check-out (► **Fig. 1**). ► **Table 2** provides a breakdown of costs based on personnel, space and equipment, and consumables. The longer waiting times in the ED led to higher space and equipment costs compared with SDS (\$24.44 vs. \$12.86, respectively). Total consumables were similar in the two settings (\$15.05 vs. 17.30, respectively). As a result, total costs in the ED were higher compared with SDS for taking care of corneal abrasions, conjunctivitis, dry eye, and styes (\$108.41 vs. \$81.53, respectively; ► **Fig. 3**).

## Discussion

As health care costs continue to increase and reimbursements move more toward value-based payments, clinical leaders need to understand the actual costs for varying services. Professor Michael Porter of the Harvard Business School stated that "value is defined as outcomes relative to costs, it encompasses efficiency."<sup>15</sup> The goal of this project was to determine, using TDABC, the potential cost-savings from using the SDS department, rather than the ED, for nonemergent eye complaints. Our research shows that the SDS at MEE is grossly underutilized by almost a factor of 100 compared with the ED. There are several reasons explaining the discrepancy between the volume between the two settings. First, the SDS is limited to referrals from PCPs and does not accept walk-ins, while the ED accepts all patients. Second, and perhaps the most influential factor, is due to the ability of the optometrist to triage. After discussion with the primary care provider, the optometrist can help determine which patient needs to be seen urgently versus scheduled for a routine visit. Thus, although there were only 26 SDS visits, ~200 pages were sent during the studied timeframe, and any additional conversations via direct phone call were not recorded. As a result, it is likely that many potential visits for the evaluated ophthalmic conditions were scheduled as an outpatient nonurgent visit.

Nonemergent patients visiting the ED for treatment experienced total visit times almost four times lengthier than patients treated in the SDS, which led, in turn, to higher total costs of care, increased patient frustration and decreased satisfaction, and lowered value care. Referring patients with nonemergent conditions to the SDS will lower average

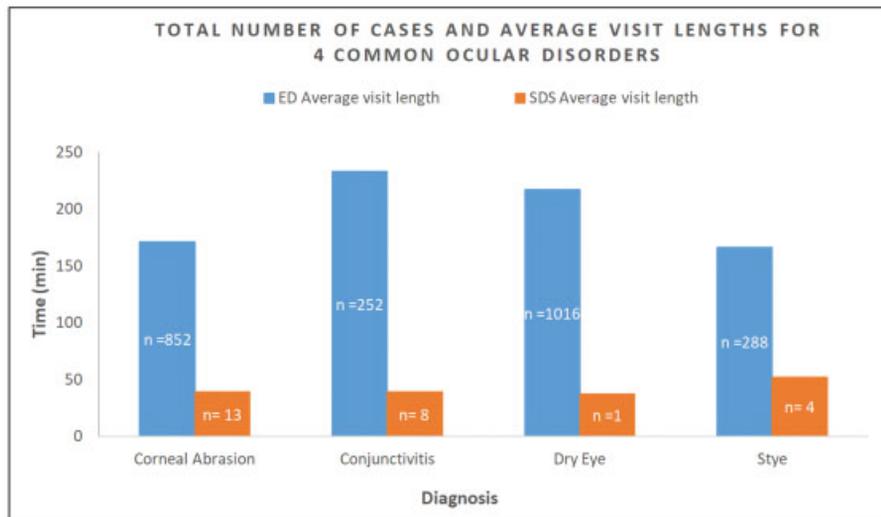


**Fig. 1** Flow map tracking patient flow through the emergency room (top) and same-day services (bottom). Time circled (bottom right hand corner) are estimates based on observations by third parties in each setting.

treatment times and also reduce the waiting times for those who do visit the ED.

In an era where “time is money,” the SDS direct costs of \$81.53 were 25% less than the ED costs of \$108.51. This difference in costs was primarily driven by personnel and space utilization. Attributed cost for physicians was actually

lower in the ED compared with SDS (\$38.01 vs. \$46.63, respectively) with cost savings of 18.5% as shown in ►Table 1. This was primarily due to a significant portion of the time that the patient spent with an ophthalmology trainee versus an attending. However, patients spent more time filling out paperwork and undergoing insurance



**Fig. 2** Average visit length measured on y-axis. Total number of visits (n) per diagnosis in each setting is noted within each bar graph.

approval with a receptionist leading to attributable costs of \$18.43 versus \$4.74 in SDS. Patients also had an additional interaction with a triage nurse leading to an extra cost of \$12.48. As a result, total personnel cost was 1.34 times more in the ED compared with SDS. Furthermore, due to the disproportionate number of patients who are seen in the ED, patient waiting times were increased leading to space costs to be 1.9 times higher compared with SDS.

In today’s society, patients expect to be seen quickly by the appropriate provider, and spend less total time in the hospital. Often, their impression of their received health care is influenced by the length of time spent in the health care setting, especially time spent waiting to be seen and treated by a clinician. Their perspective can have a significant impact on hospital reimbursements as institutions can have 1% of total Medicare reimbursements (\$850 million) withheld based on patient satisfaction.<sup>16</sup> To receive that hold-back, institutions need to score high on patient-satisfaction scores and quality performance measures, as determined by the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey. Thus, as wait time increases, patient satisfaction decreases, affecting their perception of

overall treatment provided, which ultimately can affect reimbursement.<sup>17</sup>

It is critical that when patients engage with the hospital system, we match them to the appropriate provider and location for their care.<sup>18</sup> This is especially true for non-emergent ocular cases where patients have multiple outlets to get appropriate care. For the hospital, it is important that all resources are fully utilized in an efficient and effective manner. A TDABC study is an inexpensive way to learn how all resources are currently being used, determine excess capacity, and measure the cost of unused capacity, resource by resource. In our study, we found that patients treated for non-emergent ocular diseases in an outpatient setting cost ~25% less than seeing them in the ED.

There are several limitations to this study. First, because of unavailable data, the process maps do not take into account any patient care that is conducted outside of MEE or by the providers not directly interacting with patients, such as when they coordinate care with other providers (e.g., PCP discussing with SDS service regarding patient referral). However, these conversations are typically brief, usually lasting no more than 2 to 3 minutes, and do not have a

**Table 1** Personnel cost comparison between the ED and SDS

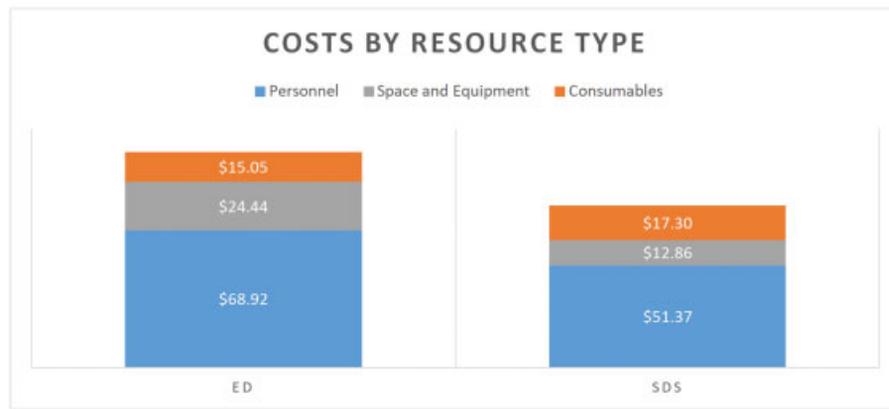
Personnel	ED		SDS	
	Prob. weighted time	Personnel cost	Prob. weighted time	Personnel cost
Ophthalmologist	8	\$24.35		
Optometrist			25	\$46.63
Nurse	10	\$12.48		
Receptionist	70	\$18.43	18	\$4.74
Resident	15	\$11.93		
Fellow	3	\$1.73		
Total personnel	106	\$68.92	43	\$51.37

Abbreviations: ED, emergency department; SDS, same-day service.

**Table 2** Total costs based on personnel, space and equipment, and consumables between the ED and SDS

Cost category	ED		SDS	
	\$	% Total cost	\$	% Total cost
Personnel	\$68.92	64%	\$51.37	63%
Space and equipment	\$24.44	23%	\$12.86	16%
Consumables	\$15.05	14%	\$17.30	21%
Total direct	\$108.41		\$81.53	

Abbreviations: ED, emergency department; SDS, same-day service.



**Fig. 3** Total costs in the emergency department were greater than same-day service for treating the four common ocular disorders described in the text (\$108.41 vs. \$81.53, respectively).

significant impact on total cost. Also, although data were available for the total amount of time a patient spent in the ED and SDS, the breakdown for each aspect of the patient flow was based on time estimates from direct observations on typical patients seen in both settings. Furthermore, there is a large disparity between the number of patients seen in the ED and SDS. It is likely that if the balance was shifted to a significantly larger number seen by the SDS, wait times could increase and thus costs. However, despite this hypothetical shift, it would likely still be cost-effective to see patients in SDS as the attributable costs due to patients in the waiting room was only ~3 to 6% of the overall calculated cost of the patient's visits. It is also important to assess value by also studying additional outcome measures, so that any increases in costs may be justified if it leads to even better outcomes for patients—higher patient satisfaction and resolution of their symptoms. Due to the retrospective nature of this study, these additional methods of identifying patient outcomes was not assessed, but future studies can assess the impact of these outcomes as the SDS expands. Nevertheless, by using TDABC, shifts in costs can be analyzed in a methodical manner to determine the optimal patient flow through either setting to save costs, while improving health care delivery.

Using TDABC, administrators and physicians can have more transparent cost analysis of patient care. As a result, specific strategies can be implemented to help reduce cost, while maintaining, if not improving, quality of care. These data provide a blueprint for Mass Eye and Ear to help reduce costs. By developing a plan to shift patients with certain eye complaints from the ED to an outpatient setting, a significant amount of the cost burden on the health care system can be decreased, while providing high-value patient care and increased patient satisfaction through decreased waiting times.

#### Funding

None.

#### Conflict of Interest

None declared.

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