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Review

Time-driven activity-based costing in health care: A systematic review of the literature

George Keel, Carl Savage, Muhammad Rafiq, Pamela Mazzocato*

Medical Management Centre, Department of Learning, Informatics, Management and Ethics, Karolinska Institutet, Stockholm, Sweden

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ABSTRACT

Health care organizations around the world are investing heavily in value-based health care (VBHC), and time-driven activity-based costing (TDABC) has been suggested as the cost-component of VBHC capable of addressing costing challenges. The aim of this study is to explore why TDABC has been applied in health care, how its application reflects a seven-step method developed specifically for VBHC, and implications for the future use of TDABC.

This is a systematic review following the PRISMA statement. Qualitative methods were employed to analyze data through content analyses.

TDABC is applicable in health care and can help to efficiently cost processes, and thereby overcome a key challenge associated with current cost-accounting methods The method's ability to inform bundled payment reimbursement systems and to coordinate delivery across the care continuum remains to be demonstrated in the published literature, and the role of TDABC in this cost-accounting landscape is still developing. TDABC should be gradually incorporated into functional systems, while following and building upon the recommendations outlined in this review. In this way, TDABC will be better positioned to accurately capture the cost of care delivery for conditions and to control cost in the effort to create value in health care.

1. Introduction

Value-based health care (VBHC) has been proposed as a strategy to address the challenges facing health care today [1]. Value is defined in terms of the value equation – health outcomes achieved per unit cost expended over the entire care delivery value chain (CDVC) [2]. The CDVC disregards boundaries between departments and organizations, and captures all processes in the care continuum for a medical condition. Fixed bundled payments to reimburse each CDVC hold providers accountable for the full cycle of care. The ability for providers to compare health outcomes and costs is expected to foster improvement through competition on value. There is currently great interest in VBHC, mostly directed at identifying which health outcomes are appropriate to measure for a particular medical condition [3]. Less attention has been paid to developing a standard for cost calculations [4]. The problem addressed in this paper is that valid value-based comparisons are not possible without consensus around how to calculate costs for medical conditions, and if solved, health care providers will be able to understand the cost of care delivery for conditions and control cost.

This paper reviews the empirical application of the cost-accounting tool, Time-driven activity-based costing (TDABC), presented as the solution to the cost-crisis in health care [5]. In modern competitive reimbursement environments, providers and policy makers are looking for cost-accounting solutions capable of informing process improvement and meeting the expectations of cost-control policies [5–7]. However, previous attempts to develop process-oriented cost-accounting methods in health care, such as Activity-based costing (ABC), have proven challenging. One reason is that it is too resource intensive in large or complex organizations [6,8]. ABC was first applied in health care in the early 1990s [9]. It proved more useful than traditional cost-accounting methods [10,11], but demanded large resource investments, which led to partial or incomplete applications [12]. This was exacerbated by the complexity inherent to health care organizations [13–16]. After peaking in the mid-1990s [12], the subsequent demise of ABC [11] exemplifies the need to find balance between validity in costing and the resources expended to achieve that validity [15,17].

TDABC was presented by Kaplan and Anderson [8] as a modified version of ABC that sought to find this balance. TDABC has

* Corresponding author at: Medical Management Centre, Dept. of Learning, Informatics, Management and Ethics, Karolinska Institutet, Tomtebodavägen 18A, 171 77 Stockholm, Sweden.
E-mail address: pamela.mazzocato@ki.se (P. Mazzocato).

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demonstrated some success in the production and service industries [18]. It prioritizes accuracy over precision, i.e. "approximately right rather than precisely wrong" [6]. Accuracy is how close your cost estimate is to actual cost, and precision is the number of decimal places you include in your estimation. TDABC demands fewer resources by requiring only two key parameters: the capacity cost rate (CCR), and the time required to perform activities in service delivery [8] – thus the name "time-driven" ABC. The CCR is the cost of capacity-supplying resources divided by the practical capacity of those resources. TDABC has been described as a micro-costing approach well-suited to accommodate the complexity of cost accounting in health care organizations [5,19]. In 2011, Robert Kaplan and Michael Porter presented a seven-step approach to the application of TDABC in health care settings (Table 1) as the solution to the cost crisis, and linked it to the VBHC agenda [5] (hereafter, all references to TDABC will be to this approach).

Given the increasing interest in VBHC and the need to understand the cost of care delivery for medical conditions, the current empirical evidence of TDABC applications in health care should be investigated. Therefore, the aim is to explore why TDABC has been applied, how its application reflects the seven-step model, and what recommendations can be drawn for future applications in health care.

2. Materials and methods

This systematic literature review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [20]. We aimed to investigate how TDABC has been applied, not the quantitative effects of its application. Therefore, we chose a qualitative approach using content analysis [21,22] to analyze how different applications of TDABC compared to one another and their adherence to the theoretical model. This allowed us to analyze in-depth descriptions in the text.

2.1. Search

A comprehensive search strategy was developed in order to capture the maximum number of relevant articles in each database. All possible formulations of the phrase "time-driven activity-based costing" were identified through an iterative discussion among the authors informed by the literature. Seven major databases were searched based on their relevance to health care: PubMed/MEDLINE, EMBASE, WebOfScience, OvidSP, Scopus, CINAHL and Science Direct with search strategies tailored for each. (See Appendix A: Search strategies for each database). All searches were run on June 5th, 2015, and updated on January 21st, 2016.

Table 1
The seven steps of TDABC for health care organizations.

Step 1	Select the medical condition
Step 2	Define the care delivery value chain, i.e. chart all key activities performed within the entire care cycle
Step 3	Develop process maps that include each activity in patient care delivery, and incorporate all direct and indirect capacity-supplying resources
Step 4	Obtain time estimates for each process, i.e. obtain time estimates for activities and resources used
Step 5	Estimate the cost of supplying patient care resources, i.e. the cost of all direct and indirect resources involved in care delivery
Step 6	Estimate the capacity of each resource and calculate the capacity cost rate
Step 7	Calculate the total cost of patient care

2.2. Eligibility criteria and study selection

Identified records were subjected to three rounds of screening. The first sought to include only those records which explicitly discussed TDABC as a key topic. The titles and abstracts were made visible in the browser and two word searches were run: 1) "driven", and 2) "abc". This comprehensively captured any formulation or abbreviation of TDABC. Any record that did not mention TDABC in the title or abstract was thereby excluded.

In the second round, records outside the context of health care were excluded, e.g. automobile, engineering, or accounting fields. Records not written in English, only available as abstracts, as well as letters, editorials, and commentaries were excluded.

The third round involved a full-text reading to exclude articles that did not explicitly describe empirical applications, i.e. theoretical articles and systematic reviews. Before exclusion, these articles were snowballed to find additional studies.

2.3. Data extraction and analysis

Three separate data extraction and analysis processes were employed. These processes were conducted by GK and MR together to improve trustworthiness. Throughout data extraction and analysis, when uncertain about aspects of the analysis, they discussed with PM and CS until consensus was reached.

First, we extracted data on general study characteristics, i.e. publication year, country, medical specialty, and type of organization. Data was stored in Microsoft© Excel 2010.

In the second analysis, we conducted a conventional inductive content analysis [23,24], because it is suitable for exploring rationales, strengths, and weaknesses [22]. Meaning units were extracted and coded based on their manifest meaning. The analysis was conducted in NVivo qualitative data analysis software; QSR International Pty Ltd. Version 10, 2012.

Third, we used a directed content analysis approach [24], because we wanted to compare empirical applications with an existing theoretical framework [22], i.e. the seven-step model [5]. A coding template was created in Nvivo for each step, and information was extracted from the articles. This provided an overview which we then exported to Microsoft© Excel 2010 and developed further by populating the analysis with examples from each article.

2.4. Methodological limitations

We did not appraise the scientific quality of the articles, because we wanted to explore how TDABC has been applied, and not the effects of an intervention. However, the exclusion of quality appraisals may have led to the inclusion of articles with methodological weaknesses or incorrectly reported findings. Yet, the thorough content analysis we performed allowed us to identify questionable applications and make recommendations [22] for future applications of TDABC based on these and other insights drawn from the review.

3. Analysis of the articles

3.1. Study selection and PRISMA flow diagram

A total of 774 records were obtained after executing the search strategies, and six records from subsequent snowballing (Fig. 1). After duplicates were removed, 525 records remained. Of these, 374 were excluded because they did not mention TDABC in the title or abstract. After reviewing the abstracts of the remaining 151 records, 117 were excluded because they were not conducted in a health care setting or did not meet other inclusion criteria of the second screening, leaving 34 articles for the final screening. Nine articles