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Methodological Review

Time motion studies in healthcare: What are we talking about?

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ABSTRACT

Time motion studies were first described in the early 20th century in industrial engineering, referring to a quantitative data collection method where an external observer captured detailed data on the duration and movements required to accomplish a specific task, coupled with an analysis focused on improving efficiency. Since then, they have been broadly adopted by biomedical researchers and have become a focus of attention due to the current interest in clinical workflow related factors. However, attempts to aggregate results from these studies have been difficult, resulting from a significant variability in the implementation and reporting of methods. While efforts have been made to standardize the reporting of such data and findings, a lack of common understanding on what "time motion studies" are remains, which not only hinders reviews, but could also partially explain the methodological variability in the domain literature (duration of the observations, number of tasks, multitasking, training rigor and reliability assessments) caused by an attempt to cluster dissimilar sub-techniques. A crucial milestone towards the standardization and validation of time motion studies corresponds to a common understanding, accompanied by a proper recognition of the distinct techniques it encompasses. Towards this goal, we conducted a review of the literature aiming at identifying what is being referred to as "time motion studies". We provide a detailed description of the distinct methods used in articles referenced or classified as "time motion studies", and conclude that currently it is used not only to define the original technique, but also to describe a broad spectrum of studies whose only common factor is the capture and/or analysis of the duration of one or more events. To maintain alignment with the existing broad scope of the term, we propose a disambiguation approach by preserving the expanded conception, while recommending the use of a specific qualifier "continuous observation time motion studies" to refer to variations of the original method (the use of an external observer recording data continuously). In addition, we present a more granular naming for sub-techniques within continuous observation time motion studies, expecting to reduce the methodological variability within each sub-technique and facilitate future results aggregation.

1. Introduction

In the early 20th century, special interest was devoted to the study of industrial processes driven by the global concern related to inefficiencies and waste on material resources [1]. Frederick Taylor (1856–1915) devoted his research to this issue, proposing that the biggest loss due to inefficiencies was not material, but indeed a waste of human effort. He contributed to the emerging "scientific management" field with his Time Study method aiming at reducing processes' times. At a very basic level, time studies were described as detailed observations of workers using a stop-watch to determine the time required to accomplish specific tasks (e.g. time required to swing the shovel backward and then throw the load for a given horizontal distance, accompanied by a given height [1]). This method was later expanded by Taylor's disciples, Frank and Lilian Gilbreth, who focused on motion [2]. The Motion Study method sought to make processes more efficient by reducing the motions involved. These two techniques, time studies and motion studies, became integrated into a widely accepted method in scientific management referred to as Time Motion Studies (TMS).

Taylor's time study method was originally presented to the American Society of Mechanical Engineers and emphasized that the same principles could be applied to all kinds of human activities. In 1914, the Gilbreths began the application of their motion study techniques to healthcare and life sciences by assessing inefficiencies in the healthcare industry [3]. Since this time, TMS have been adopted by hospital managers and researchers, who initially

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applied these methods to study costs and inefficiencies in healthcare delivery and then rapidly expanded the focus of their studies towards patient safety and quality. More recently, an increase in adoption of informatics and information technology systems in healthcare and life sciences, associated with the inherent potential to cause a major impact on quality, efficiency and costs of healthcare [4,5], has triggered the need to study and evaluate the adoption of such systems. Since the observation that increased time for documentation is one of the most commonly stated barriers to successful implementation of electronic health records [6], the evaluation of time efficiency in documentation and other workflow related factors have become a common research aim, positioning time motion studies in a protagonist role.

A century after the introduction of scientific management methods to the healthcare arena, there is genuine interest in aggregating results from these TMS to generate knowledge in healthcare workflow, inefficiencies, patient safety and quality, and lately, to support decision making on the acquisition and implementation of health information technologies. Regrettably, attempts to aggregate results conclude that the design, conduct, and data reporting of existing TMS varied considerably, making study comparison impossible [7]. Efforts to summarize findings across TMS are frustrated due to dissimilar activity categorizations and a lack of methodological standardization [8].

A first step towards standardizing the method was published by Zheng et al. who, after analyzing a sub set of twenty-four "time and motion studies" specifically assessing health IT implementations, proposed a checklist aiming at standardizing the reporting of such studies' methods. [7]. Although this is an important first contribution, it did not address the persistent lack of common understanding concerning the definition of what are (or are not) "time motion studies", persisting two major gaps in knowledge and practice as follows:

(A) The lack of common understanding hinders reviews and any further methodological standardization efforts. In order to apply and take advantage of Zheng's reporting checklist for "time motion studies", authors must first correctly identify what a time motion study encompasses, which does not seem to be the case: in the previously mentioned review, 40% of the exclusion was due to articles failing to conform to a working definition presented by the authors ("independent and continuous observation of clinician's' work to record the time required to perform a series of clinical or non-clinical activities") [7].
(B) Also, the inability to identify and distinguish distinct variations of the original technique could partially explain the methodological variability described (duration of the observations, number of tasks, multitasking, training rigor and reliability assessments) caused by an attempt to cluster dissimilar sub-techniques.

As such, a crucial step towards the standardization and validation of time motion studies in the biomedical domain corresponds to establishing a common understanding, accompanied by a proper identification of the distinct techniques it encompasses.

1.1. Objective

In response to the aforementioned gaps in knowledge and challenges surrounding TMS methodologies, our objective in this report is to contribute to the standardization of time motion studies by providing a disambiguation based on a broad understanding on what the concept "Time Motion Studies" currently embraces in the biomedical literature. Specifically, we aim to:

a. Review a broad sample of the biomedical literature being referenced or classified as pertaining to "time motion studies" in order to identify the current scope of the method.
b. Provide a detailed description of the distinct methods used in those articles.
c. Present a disambiguation schema for the term "time motion studies".

2. Methods

Our goal was not to conduct a survey on every quantitative data collection method used in workflow research (thoroughly discussed by Unertl et al. [9]), but to identify what the term "Time Motion Studies" currently refers to in the biomedical literature, particularly in healthcare. Thus we selected PubMed/MEDLINE as the bibliographic database, and searched for empirical studies published in English that contained the strings "time motion study" or "time and motion study" in the title/abstract. The PubMed search engine treats dashes as spaces [10], thus the results did not change when adding "time-motion studies" to the query. With this search strategy, we expected to retrieve those articles where the author actively, either in the title and/or in the abstract, declared having conducted a time motion study. Moreover, in addition to assessing and classifying what researchers consider to be focused upon "time motion studies," we also evaluated what MeSH classifies as time motion studies. To maintain efficiency while expanding the scope of the review, we selected the "Time and Motion Studies" MeSH major topic. This allowed us to assess a convenience sample spanning 10 years of studies where either "Time and Motion Studies [MeSH]" was one of the main topics discussed in the article or "time motion study" was declared in the title/abstract. We restricted the search to journal articles only, and as we were interested in time motion study methods in empirical studies, we excluded editorial, comments and review publication types from the query. The final search strategy resulted in: ("Time and Motion Studies"[Majr] OR "time and motion study"[Title/Abstract] OR "time motion study"[Title/Abstract]) AND "Health Care Category"[Mesh] AND English[lang] AND "2003/01/01"[PDAT]: "2013/01/01"[PDAT] AND Journal Article[ptyp] NOT Editorial[ptyp] NOT Review[ptyp] NOT Comment[ptyp].

The query was run in May 2013, and retrieved 285 citations. No extra exclusion criteria were used: we aimed to assess every empirical study either classified by MeSH or by the authors as TMS. Twenty-two articles corresponding to article types that were missed by our query exclusion criteria (reviews, comments or editorials) were discarded, leaving 263 articles for full assessment. With very few exceptions and only if no doubt existed on the method being reported, the assessment was performed on the full article.

An initial assessment of the sample revealed that our query, besides encountering the original method or variations of the original method (i.e. the use of independent external observers recording time data continuously), also returned a broad spectrum of distinct quantitative data capture methodologies referred to as "time motion studies". Since the only common theme corresponded to the capture and/or analysis of the time required to complete one or more events, and supported by literature reporting differences on data quality depending on the data collection method [11–13], we grouped the distinct methods encountered by major data capture procedures. Once we identified the method(s) in an article, we clustered them by similarities regarding how, by whom and when the time motion data was collected, provided a detailed description, and finally reported a relative prevalence of each method (see Table 1). In addition, we analyzed changes in the relative prevalence of methods over time. Last, we assessed discrepancies in the scope of "time motion studies" between "time motion studies'

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