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Peer Review File

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Reviewer A

In brief this was a multicenter cost analysis comparing the costs to execute a cholecystectomy at 5 public hospitals in Brazil. TDABC was applied to the pre-operative, intra-operative and post-operative environments. The major opportunity for cost savings identified through the application of TDABC was physician time required to perform the surgery.

The analysis was thorough and clearly identified labor and non-labor cost contributors. The end result is somewhat underwhelming as surgeon speed is not easily changed at the institutional level. Did you have a time of surgical incision and dressing application? In the room and out of room time? Were there other variables that affected operating room time? None the less I think the concept that TDABC can be applied to surgical care processes to identify opportunities to increase value is a strong point of the manuscript. I think the biggest drawback to the manuscript as written is the writing itself. Significant editing needs to be undertaken before this is worthy of publication.

Answer: We thank the reviewer for the comments, and we elaborated below a point-by-point answer letter. Regarding the questions introduced in the first general commentary, we do not have the physician time stratified by dressing before and post-surgical. We considered the total length of time since the physicians start to be prepared for the surgery until they finish it.

Recommendation: potential acceptance with significant rewriting.

Line by line items follow: Bolded items are edits

Title: processes: a cholecystectomy case series
Answer: we've incorporated the suggestion.
78 – migrate from fee for service to value based reimbursement requires
Answer: we've incorporated the suggestion.
79 – 80 opportunities to make care pathways more efficient
Answer: we've incorporated the suggestion.
81 – performing patient care activities
Answer: we've incorporated the suggestion.
82 – define value
Answer: we've incorporated the suggestion in the first paragraph of the manuscript.

90 – departments generate the greatest hospital expenditure
Answer: we've incorporated the suggestion.
93 -94 resource used to provide care
Answer: we've incorporated the suggestion.
97 - The application of TDABC
Answer: we've incorporated the suggestion.
99 – procedures more efficient, competitive
Answer: we've incorporated the suggestion.
102 – The application of TDABC to surgical episodes of care has
Answer: we've incorporated the suggestion.
107-108 -method across multiple
Answer: we've incorporated the suggestion.
134 – Approval was granted by all ethical committees of participating hospitals.
Answer: we've incorporated the suggestion.
159 – Units of time were collected from patient's medical
Answer: we've incorporated the suggestion.
162 – the quantity and price of materials
Answer: we've incorporated the suggestion.
164-165 – omit "given the public nature of the participating centers".
Answer: we've incorporated the suggestion.
175 – hours, salaries and benefits were
Answer: we've incorporated the suggestion.
198-199-200- graphically, specifically surgical times and CCRs with in each hospital. Delete the next sentence and reference the graph.
Answer: we've incorporated the suggestion.
213- pick another adjective instead of "representative"
Answer: we've incorporated the suggestion.
216-218 please rewrite this sentence
Answer: we've incorporated the suggestion.

263-266 rewrite these sentences
Answer: we've incorporated the suggestion.
280 – ensure reimbursement is aligned with the quality of services provided.

283-284 – because consumption changes depending on patient risk profiles
Answer: we've incorporated the suggestion.
284 -286 - I don't understand this sentence
Answer: Thank you, we opted by removing this last part of the paragraph.
308 – this methodology to
Answer: we've incorporated the suggestion.

Reviewer B

The reviewer thanks the Editors for the opportunity to review this manuscript. In

general, the manuscript is of an interesting topic, TDABC is certainly gaining more and more interest and importance in the last time. Especially the multicenter approach of this study is honourable compared to existing literature. Therefore, this manuscript should be considered for publication, but major revision should be conducted first considering the points raised below:

Title

- Title does not reflect the study. Consider rephrasing to "Identifying cost-saving opportunities for surgical care via multicenter time-driven activity-based costing (TDABC) analysis as exemplarily shown for cholecystectomy" or similar.

Answer: We thank the reviewer for this great suggestion for the Title.

Introduction

- Line 77. Since it is important for the reader to understand that costing approaches do not want to reduce costs by all means but only if medical outcome remains equal or even better, pleas rephrase to [..to minimize healthcare costs without worsening medical outcome is one of the main..]

Answer: We thank the reviewer for this suggestion. We requote the sentence.

- For the common reader, please define the term value in health care management in one sentence (achieved outcome per costs or dollar spent).

Answer: Yes, we've included the value definition.

- Please consider, that saving costs may not only help the "competitive providers" but also the patients themselves given the fact that in most health care systems resources are limited. Hence, by saving wasted expenses these resources can be attributed to improve value somewhere else.

Answer: Thank you for the commentary, we've rewrote this sentence.

- Line 86-89. Rephrase to two sentences, too complicated sentence.

Answer: Thank you for the suggestion, we've rewrote this sentence.

- Line 90: Reference 9 does not really support this statement. Moreover, regarding recent technical developments raises expenditures of interventional disciplines (cardiology, radiology etc.) as well as of intensive care units even beyond those of common surgical procedures. Rephrase statement.

Answer: Thank you for the suggestion, we've rewrote this sentence.

- Throughout the manuscript. Please clarify/ensure that assessing costs (for e.g. by TDABC) does not equal assessing value. Value is the equation of outcome over costs, with only the denominator assessed by TDABC. A definition of value (see above) may help to clarify this point.

Answer: We thank the reviewer for this commentary. We reviewed the full manuscript to avoid any confusion in the interpretation of these two concepts.

- Please erase first person verbiage like “we believe” from the manuscript. Rather set up a hypothesis which you aim to test within this study
Answer: We removed the first person from the manuscript.

- Please clarify why it is important or a sufficient role model to analyze cholecystectomy with TDABC and not for e.g. appendectomy or any other surgical procedure.
Answer: We included the justificative at the beginning of the methods.

- “Estimate”: As you state, TDABC is designed as a precise tool for cost assessment. On this basis, one should not need to “estimate” using this data. Please rephrase.
Answer: We understand the issue pointed out by the reviewer. However, in our study, we are applying the TDABC to assess the costs of a surgical procedure with high data accuracy and we are using the results to estimate potential cost savings if we redesign the surgical process to get closer to the benchmark identified. We did not redesign the process yet to assess the cost-savings. This is the reason for we use the term 'estimate'. To avoid the interpretation that the term ‘estimate’ could be associated to the cohort cost assessment, we review the full manuscript to make clear that we are: (i) assessing the cost per patient of a cohort of patients, and (ii) using the results to estimate potential cost-savings.

- Define a clear aim of this study at the end of the introduction.
Answer: based on the question above, we redefined our objective at the end of the introduction.

Methods:
- Line 138: Rephrase “the procedure” to “cholecystectomy”.
Answer: we’ve incorporated the suggestion.

- Why was a maximum of 20 patients per center defined? Where patients included consecutively or selected? If the latter, how where observed procedures selected?
Answer: Respecting the period between March and October 2018, the centers selected 20 consecutively patients submitted to the video-assisted cholecystectomy. We included the information that patients were consecutively selected. The volume of 20 patients was defined to confirm that all centers could include 20 patients in a length of 8 months and that the research teams in each center capacity to collect patients individual data.

- Line 161: Correct typo “,”
Answer: we’ve incorporated the suggestion.
- Please elaborate on which basis overhead costs were estimated.
-Please discuss your methodical approach of estimating overhead costs rather than performing TDABC of overhead costs. Although Robert Kaplan et al., the inventors of TDABC, strongly recommend TDABC analysis of overhead costs (Kaplan RS,

Anderson SR. Time-driven activity-based costing. Harv Bus Rev 2004; 82:131–138, 150; Kaplan RS, Porter ME. How to solve the cost crisis in health care. Harv Bus Rev 2011; 89:46–52, 54, 56–61.), assessing overhead costs in practical studies, like this one, is a major difficulty in applying TDABC (doi: 10.1016/j.healthpol.2009.05.003, 10.1016/j.jvir.2020.09.017, 10.1097/SAP.0000000000000002). How may these disadvantages be overcome in the future applications of TDABC?

Answer: We thank the reviewer for this commentary and provocation. Our study focused on direct costs and did not include overhead costs because of the high variability in the financial information able to be accessed in each center. We managed a lot of challenges to collect the direct costs with the same standard on the data collection, and the inclusion of overhead costs is pointed out as a future study recommended. We also added the no consideration of overhead costs as a limitation.
We also included a paragraph exploring how the poor quality of financial data accessibility is challenging to perform multicenter cost analysis, including overhead costs.

- Were time estimates of each activity as well as involved personnel also assessed by the "observing researcher"? Please clarify. In this context, how was it ensured that activities performed long before the surgical procedure (like material ordering /storage etc.) were correctly included in this analysis?
Answer: We complemented the explanation for time data collection, as is detailed below:
"For the time data, units of time were collected from patient's medical records and by the procedure observation by a researcher. In each center, all the patients included have their time registers obtained by a researcher that was observing the activities that each patient was being submitted. Then, the length of time that patients spent in each activity and the respective labor and structural resources consumed in each activity was registered in the database for each patient. In addition, the professionals were asked to report the additional time dedicated to surgical prepare activities, and their answers were computed together with the observed time per patient."

- In general: The methods section has to be heavily revised. Currently, the reader is left with a "black box" of which and how costing data for the different resources spent was calculated and included in the analysis. Please study current TDABC literature to re-work your methods section.
Answer: We added more explanations and imitations to our methods section, in special to explain the time and CCR data. We can affirm that we strictly followed the recommendations from these two methodological articles:
da Silva Etges, A.P.B., Cruz, L.N., Notti, R.K., Neyeloff, J.L., Schlatter, R.P., Astigarraga, C.C., Falavigna, M. and Polanczyk, C.A., 2019. An 8-step framework for implementing time-driven activity-based costing in healthcare studies. *The European Journal of Health Economics*, *20*(8), pp.1133-1145.

da Silva Etges, A.P.B., Polanczyk, C.A. and Urman, R.D., 2020. A standardized framework to evaluate the quality of studies using TDABC in healthcare: the TDABC in Healthcare Consortium Consensus Statement. *BMC health services research*, *20*(1), pp.1-15.

This last reference mentioned suggests the use of a checklist to report results from a TDABC study in healthcare. We introduced the checklist with our answers ad a supplementary material, and it also can be consulted below. As is described, we have included all the mandatory elements.

TDABC Elements	Classification	Paper section	Article Checklist
1.1 It is defined if the results are being explored for general health service management or redesign and value or only to assess costs?	**Strongly Suggested, but not mandatory**	**Introduction**	**Yes, redesign and value**
1.2 Is the clinical pathway, technology or procedure studied justified because of an interest from government, hospital, society or a Health Technology Assessment Analysis?	**Mandatory**	**Introduction**	**No, but in this case the clinical pathway was used an example to demonstrate how the method can be used to sustain cost-saving estimates. However, the selection of the conditions for that was justified in the methods.**
1.3 Are study limitations being presented?	**Mandatory**	**Discussion**	**Yes**
1.4 Is the TDABC method selection being justified?	**Mandatory**	**Introduction**	**Yes, it is the aim of the study to demonstrate how the method can be used to guide redesign initiatives that can result in cost-savings.**
2.1 Are authors using specific methodologies to design	**Mandatory**	**Methods**	**Yes, explained in**

the care pathway?			**the methods.**
2.2 Are authors using a multidisciplinary team to apply the TDABC? (Design the process, correctly consider clinical characteristics, correctly evaluate costs)	**Mandatory**	**Methods**	**Yes**
2.3 Are authors reporting activities in the process map on a macro level?	**Mandatory**	**Methods**	**Yes, supplementary material 3**
2.4 Are authors reporting activities in the process map on a micro level?	**Strongly Suggested, but not mandatory**	**Methods**	**No.**
2.5 Is the full process map (or a part of) being presented in a picture or graphic display?	**Strongly Suggested, but not mandatory**	**Results**	**No**
3.1 Is a table or a map being presented to illustrate the association between activities and resources?	**Strongly Suggested, but not mandatory**	**Results**	**No**
3.2 Are the resources that are included in the analysis being defined and justified?	**Mandatory**	**Methods**	**Yes, all structural and labor.**
3.3 Are authors reporting observation in-situ approach to better identify resources used in each activity?	**Mandatory**	**Results**	**Yes.**
3.4 Are the authors interviewing the professionals to better identify resources used in each activity?	**Mandatory**	**Results**	**Yes.**
4.1 When using hospital financial database, it is being stated how those data were collected and analyzed?	**Mandatory**	**Methods**	**Yes.**
4.2 Are authors defining the currency and applying discount taxes when it is necessary?	**Strongly Suggested, but not mandatory**	**Methods**	**Yes, collected in Reais (R$) and reported in I$.**
4.3 When using external financial databases, is there a description of the database and how those data were accessed?	**Mandatory**	**Methods**	**NA**
4.4 When mixed financial databases are being used (for example, salaries from external reference and structural costs from the hospital) is the origin of each data variable being stated?	**Mandatory**	**Methods**	**NA**
4.5 Did the authors explaining how the overhead costs are being considered?	**Mandatory**	**Methods**	**Yes, it was not included.**
5.1 Are authors defining if the capacity data used represents the total capacity per resource or it is being considered an expected idleness?	**Mandatory**	**Methods**	**Yes, it was not being considered an expected idleness.**
5.2 When authors are considering an expected idleness, it is explained how actual performance data were collected	**Mandatory**	**Methods**	**NA**

and analyzed?			
6.1 Are authors explaining how time data were collected?	**Mandatory**	**Methods**	**Yes, observer followed by professionals interviews.**
6.2 Are authors using interviews with professionals crossed with medical record review to estimate time data?	**Strongly Suggested, but not mandatory**	**Methods**	**Yes**
6.3 When using chronanalysis, it is being explained how the sample of data was defined?	**Mandatory**	**Methods**	**No, it is not being used.**
6.4 Is it being explained if the chronanalysis used a digital technology to collect real time data, such as mobile app, wearable, drone, etc.?	**Strongly Suggested, but not mandatory**	**Methods**	**NA**
7.1 Is the median or average cost per patient (or per technology) being calculated?	**Mandatory**	**Result and Discussion**	**Yes**
7.2 Are authors presenting the cost per each patient included in the sample? (Chart bar, table, etc.)?	**Mandatory**	**Result and Discussion**	**Yes**
7.3 Is the median or average cost per activity on a macro level being presented?	**Mandatory**	**Result and Discussion**	**Yes**
7.4 Is the median or average cost per activity on a micro level being presented?	**Mandatory**	**Result and Discussion**	**No**
7.5 Is the median or average cost per resource being presented?	**Mandatory**	**Result and Discussion**	**Yes**
7.6 Are authors performing capacity idleness analysis?	**Strongly Suggested, but not mandatory**	**Result and Discussion**	**No**
7.7 Are authors exploring statistical analyses to better understand costs along the process of care?	**Strongly Suggested, but not mandatory**	**Result and Discussion**	**No**
7.8 If the objective was to use the study to support management and value decisions, are authors reporting how value increasing was achieved or if they are planning to achieve it?	**Strongly Suggested, but not mandatory**	**Result and Discussion**	**Yes, possible cost savings.**

Results:

- Total treatment costs are useless to report, since it depends on the number of patients. Please only report per patient data.

Answer: we've incorporated the suggestion.

- Line 213: please rephrase "representative", the term is delusive in this case.

Answer: we've incorporated the suggestion.

- Line 217: please rephrase "better", the term implies better health care/value which is not analysed here.

Answer: we've incorporated the suggestion.

- Please add a Figure with a process map so the reader can follow the activities and data analyzed in this study.
Answer: we understand the importance of this detailed figure in TDABC studies, and it is the unique mandatory element from the TDABC checklist (supplementary 4) that we did not include in the article. The main reason for that is to maintain the level of the analysis at a macro-activity level. All our analyses are considering the pre, surgical and post-surgical phases. Because of that, in supplementary file 3, we illustrate each resource consumed in each macro phase in each center. However, this flow in a micro-level of activities requires adding five different figures (one per hospital) to detail. Later in the paper, we are not exploring a micro-level of activity in our analysis. Therefore, we choose to demonstrate a macro process and the differences in time per resource in each phase percenter.

- Please report, what and how activities were redesigned in "optimal pathway". How was the time of the surgeon during cholecystectomy reduced in the respective centers?
- Material costs are totally neglected within these results. Considering a difference of 26% vs 45% of non-labor costs within hospital A compared to E, it seems there are plenty of options for improvement for the materials resources spent without "hurrying" the personnel to operate "faster".
Answer: This study did not redesign the pathways, only estimated the potential cost savings that can be achieved if each hospital works in the parameters of time of the most effective hospital in each step of the care pathway. We rewrote the paragraph below to make clearer that we did not implement the redesigned suggestions.
"To explore the most efficient process, the minimum mean time for each labor resource in the surgical pathway was identified among the hospitals, which resulted in the minimum mean time per labor resource. An optimal surgical-process reference was suggested for each hospital (A', B', C', D', and E'), which multiplied the minimum time for each labor resource by the specific CCR resource. The current labor cost was compared to the optimal potential labor cost, and differences between hospitals represent labor cost-saving opportunities that could be achieved by improving the surgical pathway in each hospital."
In addition, we included in our limitations that we are not assessing the results achieved by a surgical redesign initiative, we are only estimating the potential labor cost-savings that can be achieved. We do believe that it is strongly recommended in future studies to apply the TDABC to evaluate the results achieved in a surgical redesign project, following the recommendations available in the literature (1) and including the impact of materials and medications.

1 - Etges APBS, Stefani LPC, Vrochides D, Nabi J, Polanczyk CA, Urman RD. A Standardized Framework for Evaluating Surgical Enhanced Recovery Pathways: A Recommendations Statement from the TDABC in Health-care Consortium. *JHEOR*. 2021;8(1):116-124. doi:10.36469/001c.24590

- Please concrete your results on how TDABC analysis helped to re-design and improve surgical treatment cycle. “Work faster” is not a result that may work in many settings.
Answer: We thank the reviewer for the suggestion. In addition to the explanations provided in the other answers and the incorporation of a list of suggestions listed by the reviewers, we reviewed a few sentences in the discussion and conclusions sessions to make clear the main contributions of this research.

Tables:
- Table 1: Please specify if reported $ are per minute or hour etc. since numbers to not add up to total costs.
Answer: we’ve incorporated the suggestion.
- Table 2: It is obvious that CCR for personnel does not change per phase, so there is no need to report it individually per phase. In this context: Why is the CCR for e.g. for a physician higher in the surgery phase than in other phases? The physician should cost the same rate per minute prior to, within or after surgery. If the time needed with the resource spent is already included than the heading of the table is wrong, since it would not be a CCR in this case. Please clarify.
Answer: We agreed that the name of the table is not correct and causing doubts in the reading. The idea behind this table is to make the readers able to calculate the cost by multiplying the CCR and time per resource and phase. This is the reason we have detailed each resource per phase. Based on that, we renamed the table for: “TDABC cost equation structure”
We reviewed the table and there is not different CCR for a same resource, i.e, physicians in the same center have the same CCR in the surgery or post surgery phases.

Discussion:
- Please discuss advantages and disadvantages of the used methodical approach to observe all activities by a present researcher (“stopwatch approach”), for e.g. bias due to staff working different when being observed; problems with compliance of observed staff when implementing TDABC data based changes to process flow) in comparison to other methods (interview-based approach of time-need or chip-based time assessment (doi: 10.1016/j.jvir.2020.09.017). In this context, discuss TDABC as “bottom up” approach compared to other “top down” costing methods.

Answer: We thank the reviewer for this commentary. However, this article is not aiming to discuss top-down or bottom-up microcosting techniques or methods. The study aims to demonstrate how the cost and time information generated by the application of the TDABC can be valuable. Because of that, we did not drive our discussion to compare microcosting methods. We already did it in previous articles (listed below) and focused on the potential use of the TDABC method to additional contributions that are not limited to assess costs.

da Silva Etges, A.P.B., Cruz, L.N., Notti, R.K., Neyeloff, J.L., Schlatter, R.P., Astigarraga, C.C., Falavigna, M. and Polanczyk, C.A., 2019. An 8-step framework for implementing time-driven activity-based costing in healthcare studies. *The European Journal of Health Economics*, *20*(8), pp.1133-1145.

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- Line 289: please add reference for the recommendations
Answer: we included the reference.

- Line 310: There were 100 cholecystectomy performed and no complication observed, not even minor adverse events?
Answer: We thank the reviewer for this question. As is posted in our limitations, this research focused only on the costs measures, did not included clinical outcomes, which is recommended in future analysis. Then, we did not receive any report of adverse events or complications that required ICU hospitalizations, for example.

References:
- There are some typos regarding the numbering of references.
Answer: we reviewed the reference list.