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CALCULATING THE COSTS OF INTER-HOSPITAL PATIENT TRANSPORT SERVICE IN TD-ABC

Summary. Inter-hospital patient transport services involve transfers between hospitals for certain hospitalization needs. Despite the diversity of patients' illnesses, this type of transport is a common service utilized by the majority of patients. The aim of this study is to develop a time-driven activity-based costing (TD-ABC) model for calculating the costs of inter-hospital patient transport. This model helps to understand the real costs of hospital care services. It also helps decision-makers make smarter decisions about how to allocate and use resources. The qualitative research approach followed in this study enabled us to understand inter-hospital patient transport services and processes. The resulting model adapts flexibly to the various inter-hospital patient transport routes by Basic Life Support (BLS) ambulance. The implementation of this model in Morocco (184.56 MAD), with a well-defined round trip (from Hospital A to Hospital B and back to Hospital A), demonstrates its validity for cost calculation. However, the TD-ABC, when applied in the context of inter-hospital patient transport, encounters several limitations, notably process mapping and time estimation, which are the primary keys to allocating the resources consumed. The results show that TD-ABC provides a pricing model that considers the cost of inter-hospital transport services. It makes the value of inter-hospital transfer costs visible in the complete patient care pathway. Indeed, when the model is used for all inter-hospital journeys, it enables decision-makers to assess the distribution of costs for each patient category and the variation in costs between similar services but with different journeys.

1. INTRODUCTION

In health care, inter-hospital transport now handles all user transport activities, equipment transport, transport of the dead, transport of laboratory tests, courier services, and specimen collection services. Among these activities, patient transport is a crucial component of hospital logistics, playing a vital role in coordinating care and ensuring the continuity of medical treatment between hospitals [1]. This type of transport is also essential for transferring patients between different intensive care units for certain hospitalization services, such as surgery, radiology, and medical examination. As these are transports between healthcare establishments, they are done at the expense of the healthcare system. Today, each facility has its own transport management system, which creates diverse management practices and a lack of uniformity in the healthcare network. For example, when a patient needs to be transported (to another facility), they have to choose the mode of transport, determine whether they need an escort (and if so, what type), and then make the reservation. There are several options with different costs. Thus, unsuitable transport can result in additional costs. However,

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the inter-hospital transport service represents a considerable cost for the already overburdened healthcare system. By calculating the costs of inter-hospital patient transport in this study, we aim to provide precise information on the composition of costs, which will help decision-makers set reimbursement rates and develop hospital financing policies.

Transporting patients between hospitals places a heavy burden on an already stretched healthcare system. Healthcare establishments around the world face increasing pressure to cut costs and improve their management to meet the rising expectations of the population [2]. However, managing the logistics of these establishments represents a considerable challenge due to the complexity of the system in which they operate, which involves various stakeholders such as patients, their families, and related services. When making informed decisions, it is essential to have effective logistical means to manage the complexity of hospital services [3]. Consequently, it is imperative to further improve hospital financial management and to define new, modern costing methods aimed at better managing this complex environment of care services while respecting the requirements of quality of care and budgetary constraints [4]. Quality of care, as measured by the satisfaction of patients' needs, has become a central priority for healthcare establishments that can reduce costs and streamline turnaround times [5].

In addition, it is essential to accurately establish the real costs of healthcare services in order to develop a pricing system that meets the requirements of this field, as this would help healthcare managers make better resource allocation decisions. This field of research uses costing methods to evaluate healthcare services by comparing actual costs and reimbursement rates [6].

In response to the varying requirements of hospitals, costing methods such as time-driven activity-based costing (TD-ABC) have emerged. They are often presented as major innovations, enabling more accurate costing and reflecting the reality of hospitals [7].

Whether in Morocco or elsewhere, the provision of patient care (care and support services) is complex, as it depends on each patient's specific state of health. We have opted for inter-hospital patient transport as a model because:

- It concerns many patients requiring transfer between facilities.
- It represents most transport journeys.
- It considers the patient to be a pillar of the healthcare system.
- It provides a common ground enjoyed by the majority of patients, despite the diversity of their care pathways.
- As confirmed by the literature [8, 2], there is a real need for a model to calculate the costs of inter-hospital transport.

First, we present the theoretical background to our analysis. Second, we explain the working method we have chosen. Third, we detail our costing model for inter-hospital patient transport, using the TD-ABC method. Finally, we apply this model to a specific route: the CHU HII - HOI - CHU HII journey, located in Fez, Morocco.

2. STUDY CONTEXT

2.1. TD-ABC in healthcare

TD-ABC, a cost accounting tool used by many companies and healthcare establishments, was introduced in 2004 by Kaplan and Anderson as a derivative form of activity-based costing (ABC) [7]. ABC is a costing method that was established in the late 1980s in response to the limitations of conventional methods, which were unable to assess costs [2]. Over the years, particularly in the early 2000s [7], ABC has remained a very limited method for application in large organizations, given the complexity of their activities [9, 10].

The TD-ABC method developed by researchers to alleviate these problems [7] is considered to be more inexpensive, simpler to implement, and more flexible than ABC [7]. Its simplicity makes it easy to quickly create a precise costing model [11, 12]. It has been applied in hospitals to accurately assess

the costs of patient care activities within the complete care pathway [12, 13]. In addition, it provides several methods and forms of cost assessment in care organizations where treatment activities are complex [14, 9, 10, 15]. The main advantage of this method in hospitals is its ability to model care activities independently in the specific care pathway [2, 8], for example, for a patient receiving spinal care [16] or benefiting from pre-hospital transport services [1]. However, TD-ABC is a relatively recent concept in the healthcare sector, with a systematic literature review study revealing that around 80% of research on the application of TD-ABC was published after 2013 [8]. Similarly, this study suggests that TD-ABC should be progressively integrated into hospital cost assessment (care delivery, transport services, etc.).

The main advantage of experimenting with TD-ABC in hospitals lies in its ability to model the costs of an independent part of the care services in the complete patient pathway. The patient's care pathway may begin with care services (during transport), then move on to hospital care (emergency, radiology, surgery, etc.). Finally, this pathway may integrate inter-hospital transport services for particular services. However, the inter-hospital transport service, considered as a key stage in the care chain, is of greater interest to us in patient care services for TD-ABC cost modeling, because, on the one hand, it is considered as a specific, independent care activity in the care pathway, and comparable as the TD-ABC method allows [17]. On the other hand, a patient's complete care pathway may involve several hospital departments and related services (catering, accommodation, transport services, etc.). Inter-hospital transport is a common care service available to patients requiring transfers between hospitals, regardless of the diversity of their care pathways.

2.2. TD-ABC for inter-hospital patient transport

The TD-ABC method calculates and models service costs for inter-hospital patient transport, with the aim of estimating the resources consumed and capacities used to deliver value to patients. Inter-hospital transport services represent a significant proportion of costs in the patient care pathway, which is difficult to measure accurately. TD-ABC cost modeling specific to this service can be developed to solve the problem of pricing the service. Ultimately, the aim is to demonstrate to hospital decision-makers that this service represents a cost-consuming stage in the care process.

The application of TD-ABC to the inter-hospital patient transport service requires adherence to specific steps to ensure compliance with the theoretical architecture of the method (TD-ABC). The main steps involved in implementing the TD-ABC method are as listed in Fig. 1.

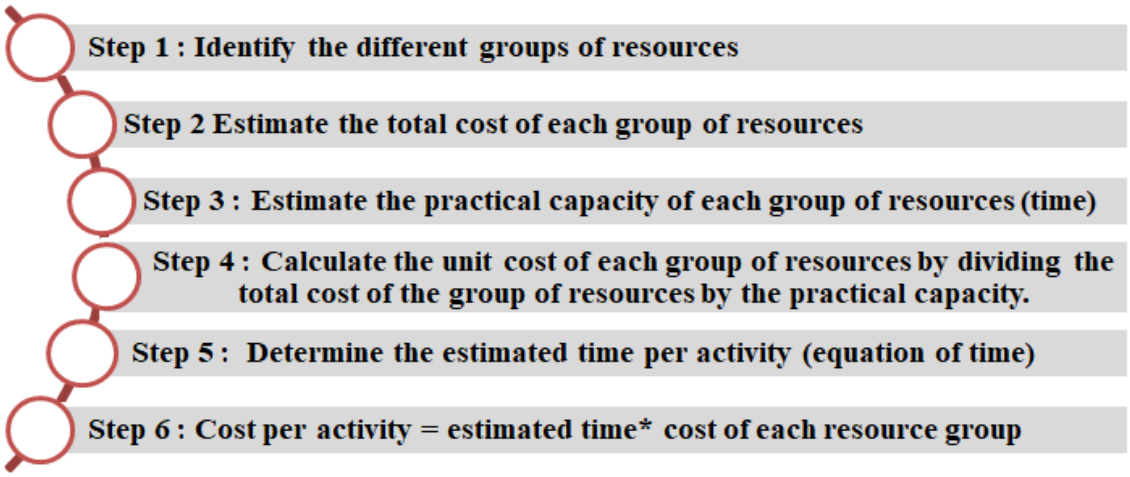

Fig. 1. TD-ABC implementation steps [11]

The complexity of patient care and the need for holistic management should enable continuous process improvement. In this respect, TD-ABC could be used to map and streamline processes, as well as to develop standardized protocols through the integration of professionals into the patient care

process. Process mapping of the inter-hospital transport service is essential to the TD-ABC approach [5]. We have taken note of existing processes for transferring patients between healthcare establishments. The TD-ABC approach (Fig. 1) is based on a developed methodology. Finally, the time equation is used to summarize the total costs incurred by the resource groups for each task in the inter-hospital transport service.

2.3. Inter-hospital transport service

The diversification of patient illnesses and increasing specialization within hospitals are accentuating the increase in inter-hospital transfers, leading to diversity and complexity in the management of inter-hospital transport services. As a result, modeling the costs of this type of transport can help standardize practices in order to improve service levels and control costs.

Of course, inter-hospital transport of patients within a healthcare facility is a major cost factor in hospital logistics. In addition, caring for patients during transport represents a major cost in their care. This involves various costs (e.g., the costs of personnel, oxygenation, monitoring, and supplies). Questions arise about hospitals' commitment to this service. In Morocco, each hospital has its own transport management system, and patient transfers between hospitals are carried out by ambulances belonging to the hospitals. Most of this service is paid for by the state. At present, inter-hospital patient transport varies across hospitals. Procedures for choosing and booking transport are neither standardized nor centralized. In some cases, this leads to a choice of transportation that is more expensive than necessary. It is essential to find ways to enhance inter-hospital patient transport. As this is a major cost center in hospital logistics, it must be done in a way that optimizes the quality of service for the patient while reducing the costs generated by their transport. The development of the TD-ABC cost calculation model for inter-hospital patient transport will enable practitioners to:

- Accurately assess the overall cost of this service as a distinct benefit in the patient's complete care pathway.
- Enhance the value of inter-hospital transport procedures in terms of activity and costs.
- Manage inter-hospital patient transport.
- Institutionalize and standardize inter-hospital transport operations.
- Master the resources allocated and the process of this activity.
- Optimize patient care times in inter-hospital transport to ensure continuity of quality care.

Inter-hospital transport is necessary when the hospital of origin lacks sufficient resources to continue treatment and is carried out by state-certified ambulance drivers. Inter-hospital transfer of non-emergency patients involves transferring patients whose medical condition does not require the intervention of medical specialists but only requires the presence of a doctor and an ambulance technician. Transporting critically ill patients requires the continuous presence of nursing staff capable of providing rapid and adequate intensive care throughout the transport chain, sometimes in complex and resource-intensive environments. The choice of transport depends on the patient's health condition, the distances to be covered, and the technical resources available. In this respect, we need to consider the types of ambulances, equipment, and personnel that can be used to transfer patients to medical care centers. Table 1 shows two types of ambulances for inter-hospital transport.

The peculiarities of the means of transport, the health processes involved in the hospital management of patients, and the requirements for building costing models in TD-ABC led us to reflect on a developed methodology. We became aware that TD-ABC models are independent, separate care services [8, 2]. Thus, we studied the framework and the current state of affairs. Meetings were held in the field to identify the various practices for choosing and booking transportation across different healthcare facilities. Additionally, these visits allowed us to identify the various types of transportation and support currently utilized within the healthcare network. During these visits, criteria for choosing transport and accompaniment were identified, and they were subsequently used to build a decision tree for the development of the methodology. To familiarize ourselves with the healthcare field and gather information, we visited various healthcare facilities throughout the city of Fez, Morocco. This gave us access to a great deal of data concerning current practices in inter-hospital trip selection, vehicle

choice, and reservation. During these visits, we realized that the choice of transport could be improved.

Table 1

Characteristics of the ambulance used for inter-hospital patient transport

Ambulance	Ambulance type	Hardware	Staff
BLS ambulance	Vehicle used to transfer non-emergency patients in a stable condition.	**Equipped vehicle:** - Source of oxygen - Stretcher - Cart	- Doctor - Technician ambulance driver
Emergency ambulance	An intensive care vehicle for patients in critical situations, equipped with all the equipment needed for intensive care and resuscitation.	**Highly equipped :** - Scanograph - DSA - Infusion device - Multiparameter monitor - Resuscitation equipment - Transport ventilator	- Technician ambulance driver - Nurse - Doctor

3. SEARCH METHOD

Based on a review of the literature on inter-hospital transfer operations, we deduced that the principles of medical ethics do not allow for patient observation or contact. In addition, it is impossible to monitor inter-hospital patient transport activities within the ambulance or to record the time actually spent on these activities. To address this issue, we adopted an experimental approach to TD-ABC in inter-hospital patient transport, using a qualitative research method. This approach is based on interviews with several providers involved in the inter-hospital transport process (an ambulance fleet manager, an ambulance technician, and a doctor). The choice of this interview method is based on the work of Alcouffe, who considers that interviews enable all activities and tasks to be mapped and identified [18]. Furthermore, Shankar P. et al. emphasized that TD-ABC is essentially based on the involvement of first-rate providers and those performing the tasks under study [19].

Overall, current TD-ABC costing techniques are often based on the treatment of costs for small units, such as an independent care activity or separate procedures [8, 2]. TD-ABC enables the treatment of inter-hospital patient transport for each type of ambulance as a distinct activity. With this in mind, we chose the basic life support (BLS) ambulance as the object of study, given its ubiquity on most inter-hospital journeys and the fact that it is the most widely used type of ambulance for the medical transfer of patients.

Inter-hospital transport by BLS ambulance is a safe, fast round trip (from Hospital A to Hospital B, then back to Hospital A) of a patient whose health status is stable and non-urgent, performed by the ambulance technician and physician.

It should be noted that our interviews with the providers of inter-hospital patient transport by BLS ambulance (doctor and paramedic) were based on their professional techniques to adjust the transport operation to the expectations associated with the development of the TD-ABC. More specifically, these interviews enabled us to map the processes of the activities carried out and record the standard time consumed. The questions were systematically mapped according to the research objectives. This provided us with access to a substantial amount of data regarding current inter-hospital transport service practices. Fig. 2 details the stages of the interviews and the nature of the questions asked. Providers in the same ambulance category (BLS) were asked the same questions in interviews.

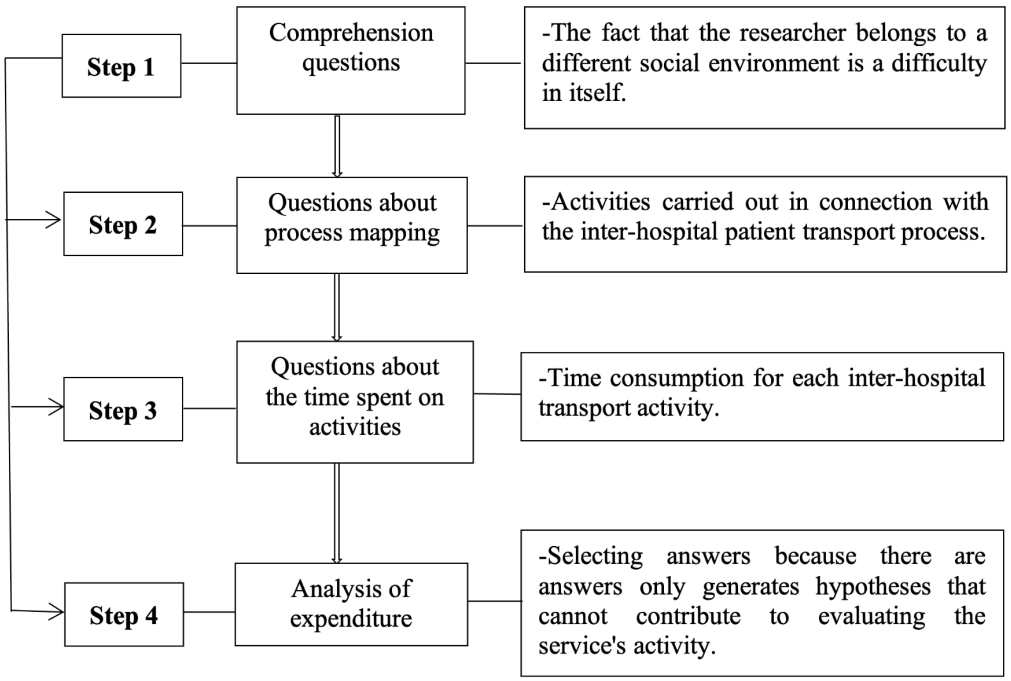

Fig. 2. The stages of the interview and the purpose of the corresponding questions

Our aim is to determine the most suitable methodology for controlling the process of inter-hospital transport of patients by BLS ambulance. The interview method enabled us to be at the heart of the inter-hospital transport operation, to examine the process in detail, and to monitor reported time consumption. This work enabled us to compare the consistency of current inter-hospital transport practices by BLS ambulance with expected results and with the findings of the few existing research studies on cost modeling of inter-hospital transport in TD-ABC.

Thus, the contributions of this work focus on the development of a theoretical and practical costing model applicable to the inter-hospital BLS ambulance patient transport service, based on a more operational costing method (the TD-ABC). This model provides managers with relevant costing tools and reliable, useful information that can be used to optimize logistics costs.

In what follows, we aim to enhance the scientific and practical understanding of the TD-ABC method's application in hospital transport services. Based on the reality of inter-hospital patient transfers, we have developed a TD-ABC cost calculation model tailored to the various inter-hospital patient transport routes using BLS ambulances. We chose a well-defined destination hospital, characterized by a more repetitive journey, in order to test the proposed model despite the difficulties encountered, notably concerning process mapping and journey time estimation, and the expectations associated with the development of the TD-ABC.

We conclude our work with a synthesis of the obtained results, taking into account the objectives defined by our research. We also highlight the practical contributions and limitations of this study. Finally, we outline the future prospects for this research.

4. CONSTRUCTION OF A MODEL FOR CALCULATING THE COSTS OF INTER-HOSPITAL TRANSPORT OF PATIENTS IN TD-ABC

4.1. TD-ABC model

Process mapping

According to the TD-ABC method, it is necessary to create a process map to identify the activities performed and the time consumed by each activity [11]. We took note of existing health standards and

protocols for inter-hospital patient transport. These standards provided a guide for process mapping. This approach was enriched by interviews with ambulance personnel (doctor and ambulance technician). The aims of identifying the practical capabilities of the material and human resource groups involved, the activities performed, and the approximate time consumed made our study complex. However, thanks to the participation of the players interviewed (ambulance technician and doctor), the inter-hospital transport process could be broken down into its main activities, meaning they could be coded and time equations could be drawn up.

Recall that the inter-hospital patient journey by BLS ambulance is made up of several stages:

1. The journey from the garage to the building of origin
2. The preparation of the patient
3. The journey to the destination (hospital B)
4. Disembarkation
5. The reinstallation of the patient in the emergency room
6. The presentation of the patient by the doctor
7. Waiting for the patient to be taken to the hospital of origin (hospital A).

We observe a multiplication of tasks throughout the journey. We have therefore succeeded in segmenting the resource. The "ambulance driver" resource for the "inter-hospital patient transport" activity has one variable linked to the journey (Hospital A - Hospital B - Hospital A) and 11 variables linked to the tasks carried out by the participants (doctor and ambulance technician). These variables were used to map all the activities of the inter-hospital patient transport service. In Fig. 3, the mapping summarizes the process of inter-hospital patient transport by BLS ambulance, along with the time variable (T) and the corresponding resource groups.

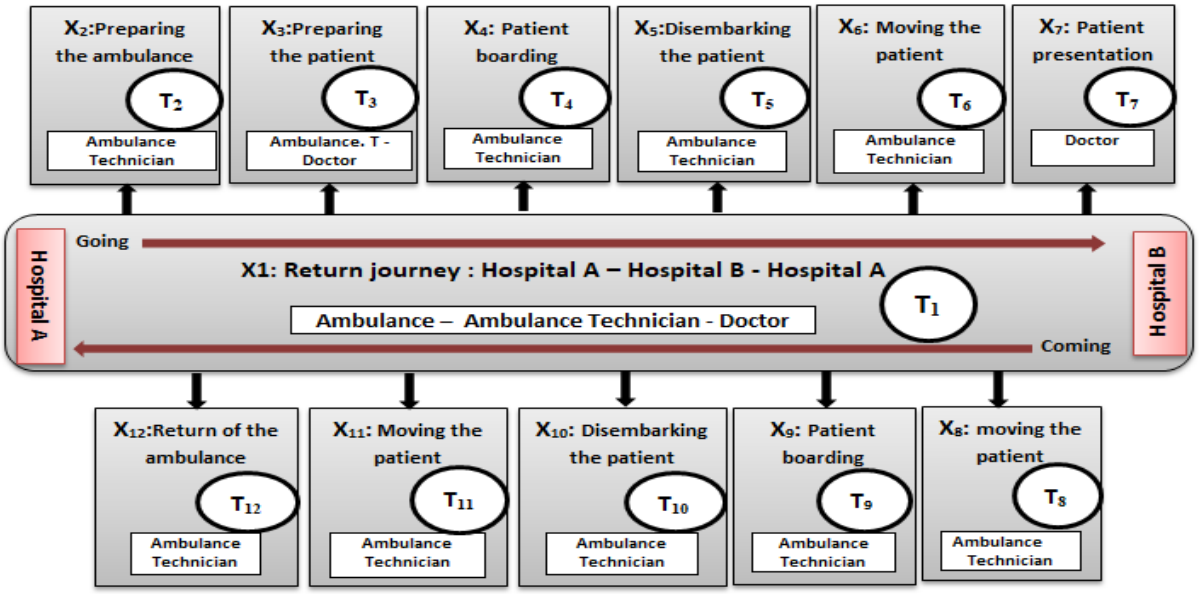

Fig. 3. The route process (Hospital A − Hospital B − Hospital A), the time variable (T), and the corresponding group of human and material resources

To develop time equations reflecting the capacity consumption of inter-hospital patient transport activity by BLS ambulance, a time (T, in minutes) is assigned to each activity variable. These times are standard averages of the various components of these activities, based on the timing of declared activities.

This process map was presented to the ambulance fleet manager for validation and to the members of the inter-hospital transport operation (doctor and ambulance technician) for enrichment. However, inter-hospital patient transport by BLS ambulance is not the hospital's only activity. In practice, the inter-hospital transport service provided user transport, equipment transport, transport of the dead, transport of laboratory tests, and intra-hospital transport services. These activities generate other

variables relating solely to departure/destination tasks, necessitating the development of new time equations to model them.

In-minute estimates of the practical capacity and unit cost of direct resource groups (human and material)

Based on the TD-ABC model, it is essential to measure the time required to complete each task and to determine the equipment and personnel responsible for carrying them out. It is also important to determine the total direct cost of the latter, as well as their practical production capacity. In this respect, it should be remembered that the resource groups include the vehicle (ambulance) and the paramedics (doctor and ambulance technician).

To calculate the cost per minute of human resources (i.e., the doctor ($\mathbf{C_2 = M_2/P_2}$) and the ambulance technician ($\mathbf{C_1 = M_1/P_1}$)), we took their annual salaries into account ($\mathbf{M_1}$ and $\mathbf{M_2}$), including all benefits and social charges borne by the hospital. Next, we assessed the time worked by these professionals and then measured their practical capabilities in minutes ($\mathbf{P_1}$ and $\mathbf{P_2}$). It should be noted that we did not take into account break times during the day, given that the ambulance technician and doctor are on standby and may be called upon to intervene at any time.

To determine the cost per minute ($\mathbf{C_3 = A/P_3}$) of the material resource group (the vehicle), we had to consider the total annual depreciation cost (**A**). In this case, we based our calculation on book depreciation by dividing the value of the ambulance over a five-year period. This enabled us to determine the cost per minute ($\mathbf{C_3}$) according to the same rule as for the doctor and ambulance technician by dividing the annual depreciation cost (**A**) by the normal practical capacity ($\mathbf{P_3}$). The latter ($\mathbf{P_3}$) was established by taking into account the vehicle's operating hours, covering every day of the year, except for days devoted to vehicle maintenance.

Calculation of activity costs attributable to direct resource groups

Establishing the cost per minute ($\mathbf{C_1}$, $\mathbf{C_2}$, and $\mathbf{C_3}$) for each resource category made it possible to calculate the direct labor cost for each task. This involved multiplying the time required to complete the task (T, in minutes) by the cost per minute of each resource category and then repeating this procedure for each resource category. Table 2 illustrates the cost of each of the activities on the inter-hospital route (Hospital A - Hospital B - Hospital A), in relation to the providers directly involved on the round trip (Hospital A - Hospital B - Hospital A).

As a reminder, we found similar activities in the inter-hospital transport process map (Fig. 3), corresponding to the same group of resources (ambulance technician), which we group together below. These activities concern (X_2 and X_{12}), (X_4 and X_9), (X_5 and X_{10}), and (X_6, X_8 and X_{11}).

Table 2

Calculation of costs for each activity involving the human resources group working directly on the round trip

Activity	Ambulance personnel	Cost per minute	Time (T, in minutes) spent by activity	Total cost
$\mathbf{X_1}$	Ambulance technician	C_1	T_1	C_1T_1
	Doctor	C_2	T_1	C_2T_1
	Total cost			$\mathbf{C_1T_1 + C_2T_1}$
$\mathbf{X_{(2,12)}}$	Ambulance technician	C_1	$T_{(2,12)}$	$C_1T_{(2,12)}$
	Doctor	C_2	0	0
	Total cost			$\mathbf{C_1\ T_{(2,12)}}$
$\mathbf{X_3}$	Ambulance technician	C_1	T_3	C_1T_3
	Doctor	C_2	T_3	C_2T_3
	Total cost			$\mathbf{C_1T_3 + C_2T_3}$

$\mathbf{X_{(4,9)}}$	Ambulance technician	C_1	$T_{(4,9)}$	$C_1T_{(4,9)}$
	Doctor	C_2	0	0
	Total cost			$\mathbf{C_1T_{(4,9)}}$
$\mathbf{X_{(5,10)}}$	Ambulance technician	C_1	$T_{(5,10)}$	$C_1T_{(5,10)}$
	Doctor	C_2	0	0
	Total cost			$\mathbf{C_1T_{(5,10)}}$
$\mathbf{X_{(6,8,11)}}$	Ambulance technician	C_1	$T_{(6,8,11)}$	$C_1T_{(6,8,11)}$
	Doctor	C_2	0	0
	Total cost			$\mathbf{C_1T_{(6,8,11)}}$
$\mathbf{X_7}$	Ambulance technician	C_1	0	0
	Doctor	C_2	T_7	C_2T_7
	Total cost			$\mathbf{C_2T_7}$

As shown in Table 2, we were able to calculate the total direct cost of all human resource groups (doctor and ambulance technician) involved in the inter-hospital transport operation. Table 3 summarizes the total cost of human resources.

Table 3

Sum of direct costs associated with human resources

Codes	Cost per activity
X_1	$\mathbf{C_1T_1 + C_2T_1}$
$\mathbf{X_{(2,12)}}$	$\mathbf{C_1T_{(2,12)}}$
X_3	$\mathbf{C_1T_3 + C_2T_3}$
$\mathbf{X_{(4,9)}}$	$\mathbf{C_1T_{(4,9)}}$
$X_{(5,10)}$	$\mathbf{C_1T_{(5,10)}}$
$\mathbf{X_{(6,8,11)}}$	$\mathbf{C_1T_{(6,8,11)}}$
$\mathbf{X_7}$	$\mathbf{C_2T_7}$
$\sum_{i=1}^{12} \mathrm{Xi}$	$\mathbf{C_1T_{(1,2,3,4,5,6,8,9,10,11,12)} + C_2T_{(1,3,7)}}$

For the material resource group (ambulance) involved in the inter-hospital trip, the vehicle must be used throughout the trip (Hospital A − Hospital B − Hospital A). Table 4 shows the cost of the ambulance for the activity (X_1: Round trip: Hospital A − Hospital B − Hospital A), which was calculated by multiplying the time required to complete the round trip ($\mathbf{T_1}$) by the cost per minute ($\mathbf{C_3}$).

Table 4

Total direct vehicle costs

Activity	Cost per Activity
X_1	C_3T_1
Total	$\mathbf{C_3T_1}$

Calculation of costs attributable to indirect resource groups

For the remaining staff working in the ambulance fleet, indirect tasks related to inter-hospital transport operations, such as disinfecting the ambulance interior or providing administrative services, generate additional variables related to the ambulance fleet and administrative activity. This implies the creation of other time equations to model these services in TD-ABC.

For the indirect costs associated with the ambulance (fuel and maintenance), we included, in addition to the total cost, the average fuel costs based on the number of kilometers traveled on the trip (α), as well as the share of vehicle maintenance costs per trip (β), such as tires, oil changes, and mechanical maintenance. To calculate this, we divided the total annual maintenance costs by the average number of annual trips.

Time equation in TD-ABC

The preceding calculation steps provided the total financed cost model for the inter-hospital transport trajectory by BLS ambulance, established using the TD-ABC method. The equation below summarizes the total cost of reconstruction (1). It is important to note that in this equation, the activity variables follow a binary distribution, meaning that they can be present or absent depending on their level of involvement in the patient's inter-hospital transport operation.

$$\mathbf{C_1T_{(1,2,3,4,5,6,8,9,10,11,12)} + C_2T_{(1,3,7)} + C_3T_1 + \alpha + \beta} \quad (1)$$

4.2. Validation of the TD-ABC costing model

The TD-ABC approach was used to model the costs of inter-hospital patient transport services. According to Equation (1), it is necessary to measure the time consumed for each activity. The aim is to determine the journey with a standardized time. We have taken into account the constraints associated with travel times to and from hospitals. Given this situation, and that hospitals differ in terms of distance to be covered, we chose the hospital (HOI) as the destination because it represents the most repetitive journey, with the majority of patients suffering from ear, nose, eye, and throat diseases. The hospital where we carried out our study (hereafter referred to as CHU HII) is a regional university hospital with a large ambulance fleet. The distance between the CHU HII hospital and the HOI hospital is 9 km.

According to annual trip statistics, the CHU HII hospital recorded the highest number of round trips (CHU HII - HOI - CHU HII), justifying our choice of this hospital.

Equation (1) summarizes the total TD-ABC cost of the inter-hospital BLS ambulance patient transport operation. Each activity in the process is assigned a duration, in minutes. These durations are averages of the times reported by the different respondents (doctor and ambulance technician), allowing for the determination of standard times.

Based on the above-mentioned time equation, the journey (CHU HII - HOI - CHU HII) takes 35 minutes. This time was based on the average journey time indicated in the ambulance drivers' statements.

The variable $X_{2,12}$ (preparation of the ambulance and return of the ambulance to the garage) corresponds to the same group of resources, constituting a time of 10 minutes. Patient preparation (X_3) takes 15 minutes. Embarkation ($X_{4,9}$: embarkation and return) takes four minutes. Disembarkation ($X_{5,10}$) takes four minutes. Other time is also associated with the "patient transport" activity: five minutes for patient movements ($X_{6,8,11}$) and 10 minutes for patient presentation by the doctor (X_7). Table 5 shows the total cost of inter-hospital patient transport in TD-ABC.

The result obtained (184.56 MAD), which corresponds to the objective of our research, represents the total TD-ABC cost for the round trip (CHU HII - HOI - CHU HII). All inter-hospital trips can be modeled according to changes in the variables of time consumed by activities. This makes it possible to generalize the model to all inter-hospital patient transport journeys.

Table 5

Total cost in TD-ABC of the trip: CHU HII - HOI - CHU HII

Route	Total cost of trip in MAD
CHU HII - HOI - CHU HII	184.56

5. DISCUSSION

5.1. TD-ABC's contribution to the inter-hospital transport service

According to the results, the TD-ABC method favors a calculation of the costs of the inter-hospital patient transport service and possible evolutions (new activities of the hospital transport service) owing to time equations, as confirmed by several researchers [20, 21, 10, 7, 22, 23]. TD-ABC also provides the means to model complex activities and carry out simulations and benchmarking [24]. Owing to the simulation option, healthcare facilities can use TD-ABC to optimize resource utilization [11]. Various possibilities and solutions are available for reorganizing and standardizing transport service activities between facilities. The benchmarking technique enables the pooling of expertise in cost modeling. Finally, this study demonstrates that the TD-ABC is applicable to the inter-hospital transport service, opening up prospects for further development for all transport services within the hospital (transport of users, transport of equipment, transport of the dead, transport of laboratory tests, intra-hospital transport, etc.). All the activities of the ambulance fleet service are modeled according to additional or modifying variables, relating to the tasks of round trips. Each activity corresponds to the approximate unit of time (T) consumed. By identifying groups of resources (human or material), we can then associate a cost with different trips based on the time consumed. However, the time equation sometimes involves more complex variables, particularly in the case of emergency ambulances and resuscitation, where the patient receives intensive care (with multiple variables).

If the proposed model were computer-programmed, it could easily be used to simulate all possible cases and calculate the costs of all inter-hospital transport activities.

When the TD-ABC method is applied to a set of inter-hospital transport services, decision-makers can observe the distribution of costs for each patient category and establish standard costs for all journeys. In addition, this method provides decision-makers with a perspective from which to consider outsourcing or subcontracting this service, aiming to optimize and rationalize the expenditure associated with hospital transport services.

From an operational point of view, practitioners are able to control patient transport between hospitals, institutionalize and standardize this operation, control the process, and optimize turnaround times to ensure continuity of quality care.

5.2. TD-ABC: limits and prospects

The inter-hospital transport service is generally poorly covered in the literature in terms of cost modeling, which presents a knowledge gap [8]. This issue deserves further investigation. Studies on contextual adaptation [25] and empirical experimentation [1] also seem important. However, cost modeling for this inter-hospital transport activity is lacking in the literature. To date, the procedure for pricing and processing the costs of outpatient transport services varies among hospitals. It would be relevant to apply the TD-ABC to the practices of other hospitals in order to define tariffs and carry out such comparisons. Moreover, the TD-ABC provides an independent breakdown of the cost of transport services within the patient's overall care pathway.

In addition to the TD-ABC, the research highlights several limitations of the TD-ABC experimentation linked to difficulties in measuring time. Given that the observation and monitoring of patient transport activities in real time has been abandoned, the elaboration of the process map (Fig. 3) and the collection of time data make up a complex phase in the TD-ABC model-building process. In

addition, Levant et al. [20] confirmed that determining the time consumed by activities is complex, as this time remains vague, variable, and unstable. The activity of transporting patients between hospitals is characterized by this variability of time, as the patient's state of health, the distance to be covered to and from the hospital, congestion, and meteorological conditions influence the time actually consumed by activities [26]. For example, the time required to transfer patients may vary according to their state of health and their location within the hospital premises. Nevertheless, the times reported in this practical case do not permit a meaningful statistical analysis of each task. It would therefore be necessary to automatically record the time spent on each activity over an extended period, such as a year. However, the repetitive nature of the routes and tasks, along with the recording of time consumed, makes it possible to establish time norms and standards, or to achieve such averages, which puts this limitation into perspective for our case.

Exploiting opportunities such as parallel intervention during inter-hospital patient transfer (lab tests, messaging, specimen collection, etc.) represents hidden performance gains. These opportunities are not planned into the time equation, especially as they are not scheduled. They can easily be integrated into the process map and Equation (1). For this, additional time intervals need to be added, notably the time interval dedicated to the activity performed in parallel with the patient transfer. As a result, the department can save journeys in order to optimize the inter-hospital transport service.

6. CONCLUSIONS

Our work shows that it is possible to rationalize and optimize the use of part of the resources used in health care provision—in particular, the inter-hospital patient transport service. Indeed, the cost calculation model, the main result of our research, has the advantage of identifying and optimizing costs while maintaining or improving patient outcomes. Consequently, optimizing the costs of healthcare services contributes to hospital improvement and performance. However, it must be stressed that controlling the costs of inter-hospital transport services requires a focus on calculating the cost of care services, which is necessary to optimize the entire patient journey. In other words, the application of the TD-ABC method to inter-hospital transport has enabled us to control the process, institutionalize and standardize this operation, and optimize turnaround times to ensure continuity of quality care. The proposed method provides the appropriate methodology for establishing reimbursement rates, controlling costs, and managing the resources allocated to this activity. As a result, decision-makers can understand how much of the costs of transport services benefit patients. Knowing the real costs of inter-hospital transport of patients by BLS ambulance makes it possible to study other inter-hospital transport processes in future research, for example, on emergency and resuscitation ambulances for patients in severe condition. The effectiveness and relevance of the TD-ABC approach open new perspectives for other hospital activities, including intra-hospital patient transport services. As is the case in other sectors, the TD-ABC method will give hospitals the means to design costing models and implement best practices for optimizing the overall patient care pathway.

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