# Kidney Transplantation Process in Brazil Represented in Business Process Modeling Notation

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## ABSTRACT

Kidney transplantation is considered to be the best treatment for people with chronic kidney failure, because it improves the patients' quality of life and increases their length of survival compared with patients undergoing dialysis. The kidney transplantation process in Brazil is defined through laws, decrees, ordinances, and resolutions, but there is no visual representation of this process. The aim of this study was to analyze official documents to construct a representation of the kidney transplantation process in Brazil with the use of business process modeling notation (BPMN). The methodology for this study was based on an exploratory observational study, document analysis, and construction of process diagrams with the use of BPMN. Two rounds of validations by specialists were conducted. The result includes the kidney transplantation process in Brazil representation with the use of BPMN. We analyzed 2 digital documents that resulted in 2 processes with 45 total of activities and events, 6 organizations involved, and 6 different stages of the process. The constructed representation makes it easier to understand the rules for the business of kidney transplantation and can be used by the health care professionals involved in the various activities within this process. Construction of a representation with language appropriate for the Brazilian lay public is underway.

THE KIDNEYS have the functions of filtering the blood to remove waste produced by the body and of producing hormones and urine [1]. However, they do not always work as they should. People with chronic kidney failure (CKF) have insufficient or even no kidney function for maintaining the organism in normal working order. There are 2 main treatments for people with CKF: dialysis, which consists of using a machine to replace specific functional features of the kidneys; or kidney transplantation [1]. Kidney transplantation is considered to be the best treatment for CKF, because it improves the patients' quality of life and increases their length of survival compared with patients undergoing dialysis [2]. Moreover, the costs of dialysis are high, even in developed countries [3]. Although kidney transplantation used to be regarded as a risky experimental procedure, it is now routinely performed in >80 countries. The countries performing the largest numbers of transplantations worldwide, in absolute numbers, are the United States, China, Brazil, and India. However, the countries in which the population has greatest access to this procedure are Austria, United States, Croatia, Norway, Portugal, and Spain [3]. Specifically for kidney transplantation, countries such as Croatia, Norway, Portugal, and the United States have transplantation rates >50 per million of population (pmp), whereas Brazil does not exceed 25 pmp [4].

The entire kidney transplantation process in Brazil is defined through laws, decrees, ordinances, and resolutions [5], but there is no defined theoretical map describing the

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kidney transplantation process in this country. Taking into consideration the growing use of process modeling [6], it is imperative to create a diagram that can represent the flow of this process. Business process modeling notation (BPMN) [7] is certainly the language most used for diagrammatically representing such processes [8]. It facilitates understanding of the process among all of the professionals involved in the process, and also helps organizations to measure their activities so as to help in administration and planning, thereby facilitating identification of points requiring changes and improvements [9].

The aim of the present study was to analyze official documents that describe the kidney transplantation process in Brazil to construct a representation of the process with the use of BPMN. This representation makes the rules of the business of kidney transplantation more easily understood and can be used by health care professionals involved in the various activities of this process, which can be taken to extend from notification of potential donors to carrying out and following transplantations performed throughout this country. There is a single kidney transplantation process in Brazil for all of the its states, even though state ordinances regulate the details of the procedures to be followed regionally.

## MATERIALS AND METHODS

The approach taken for this investigation consisted of an exploratory observational study with analysis of documents and processes, which was conducted in 5 stages. In the 1st stage, we identified and gathered official digital documents (laws, decrees, and ordinances) relating to the kidney transplantation process in Brazil.

In the 2nd stage, we analyzed the most important official document pertaining to the Brazilian process: ordinance no 2,600 of October 21, 2009 (available at http://goo.gl/KbvHpp), which recommends and specifies rules regarding how the Brazilian national transplantation system should function, from the inclusion of a new recipient to the conclusion of the transplantation and follow-up. This analysis on the process focused on the kidney transplant flow, using the methodology of analyzing and mapping out the business processes [8]. An initial representation of the kidney transplantation process was created, along with a reference table containing the nodes (activities and events) of the flow, with indications of the respective content of the official documents (article, paragraph, and/or item) that gave rise to the nodes in question. Thus, this table presented a correlation between the process that was constructed and the official documents that were analyzed. We used the Bizagi software, version 2.4.0.8 (bizagi.com), to electronically represent the kidney transplantation process based on BPMN.

From this 1st version of the process we moved to the 3rd stage, in which a professional specialist collaborated. This professional had training in the field of health care, worked within the kidney transplantation process of the state of São Paulo, and was an employee of this state's central organization for transplantations. The 1st version of the process was evaluated by this specialist, which resulted in comments about flaws in the representation and addition of activities and events to the flow of the process.

In the 4th stage of the study, we incorporated a 2nd official document (resolution SS-151 of August 13, 2010 [available at http://goo.gl/2a6HPi]) and the assessment made by the specialist to construct a 2nd version of the kidney transplantation process with the use of BPMN. This resolution recommends rules for the procedures of the organ transplantation process in the state of Paulo. This is an additional regional document which does not conflict with the national system but rather describes its flow in greater detail. The reference table was updated to take this 2nd official document into account in the analysis. In this manner, a table correlating the nodes of the flow with the content of ordinance 2,600 and resolution SS-151 was obtained.

In the 5th stage, we conducted a survey to analyze and validate the 2nd version of the process among kidney transplantation specialists. Four specialists participated in this stage by means of a survey conducted by e-mail, of whom 2 were in the state of São Paulo and 2 in the state of Pernambuco. These 4 specialists were chosen because of their wide-ranging knowledge of the field of transplantation. They were all health care professionals acting within the kidney transplantation process in different Brazilian states. The results from these analyses were incorporated into the representation of the kidney transplantation process based on BPMN.

## RESULTS

The main result from this study was construction of a representation of the kidney transplantation process with the use of BPMN (Fig 1). This representation took into account the entire kidney transplantation process in Brazil, with the addition of the particular features attributed to the state of São Paulo. A grid representing the entities involved and the different stages of the process was created. The rows represented the set of activities and events relating to each of the entities involved in the process, and the columns represented the activities and events of each stage of the process.

In this diagram, there are 3 integrated hierarchic levels. The national, state, and local levels are represented by the National Central Organization for Transplantation (CNT), the State Central Organizations for Transplantation (CETs), and hospital establishments, respectively. The CNT is responsible for organ allocation between the states. It undertakes management and distribution of organs between the different Brazilian states at the time that an organ is offered from one state to another. The CETs have the responsibility of coordinating the transplantation process in their own states. They manage activities such as enrollment and ranking of recipients, receive notifications of potential donors, and coordinate the whole donation process, which includes confirmation of the diagnosis of brain death, interviewing family members to obtain the family's consent for organ removal, and allocation of the organs. The local level (hospital establishments) is responsible for notifying the existence of a possible donor and for providing support for the whole process that is needed for the transplantation to be accomplished.

The kidney transplantation process in Brazil, from the inclusion of potential recipients in the single technical kidney registry to follow-up of patients who have received transplants, was divided into 2 subprocesses in this representation. In fact, the inclusion of new potential recipients takes place at the time when the need to perform