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Clinical Intelligence: A study on Corneal Transplantation

Brian Carneiro, Filipe Portela[*], António Abelha, Manuel Filipe Santos

Algoritmi Research Centre, University of Minho, Braga, Portugal

Abstract

The Oporto Hospital Center (CHP) is considered a reference in the area of corneal transplantation, having performed more than 4000 transplants to date. Corneas are the most transplanted tissues worldwide and is usually the main method to recover from the blindness caused by corneal diseases. With the purpose of obtaining a better comprehension on the corneal transplantation process, a solution was required. As traditional database systems are not sufficient for proper analysis of health data, a Clinical Intelligence (CI) system was designed. CI allows organizations to acquire new insights and knowledge as well as to integrate enormous volume of health data, mostly non-structured, ambiguous and inclusive. The purpose of this study was to evaluate the process of corneal transplantation, in the context of different key performance indicators that cover not only the analysis to the affected population but also the transplant process, using a CI system. This study was conducted with a sample size of 428 eyes, throughout the period 2013-2016 and 25 business indicators were developed in order to obtain a full comprehension of the subject. With the CI system, it was possible to understand and identify the most common type of procedures, diagnostics, anaesthetics, along with main patient's characteristics. In addition, an analysis on the input and output flow of the number of requests and interventions as well as the averaging waiting days between them was conducted.

[*] Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: cfp@dsi.uminho.pt

1. Introduction

In the last decade, corneal transplant has been rapidly evolving[1]. Cornea can be described as the layer on the front of the eye that helps focus light, in order to provide clear sight[2]. Blindness due to corneal disease emerges from corneal damage as well as various degenerative, infectious and inflammatory corneal disorders[1].

According to Borges et al. [3], the CHP has been performing corneal transplants for more than 50 years and is considered a reference in this area, with results presenting the same quality as the best Europeans Centers. The CHP cornea transplant program was the first in Portugal to be certified by the Portuguese Certification Association in 2010. The CHP began corneal transplants in 1958, at a time when few hospital centers in Europe were performing transplants, having an eye bank organized. Thus, for the CHP, the study of the corneal transplantation process is considered a priority. In order to support the CHP needs, this study focus on the transformation of raw data into knowledge, as well as to provide timely information and new insights based on a Clinical Intelligence (CI) system.

CI can be defined as a set of computer processes and methods capable of extracting and transforming clinical data into knowledge[4]. CI provides more effective clinical decisions from ambiguous, incomplete, and inconclusive data. A CI system integrates data from a wide variety of internal and external sources to the organization, providing an optimized and effective information platform for decision makers[5]. However, the application of CI solutions is still reduced. In fact, HIMSS[6] indicates that in the United States of America, only 43% of the hospitals have CI solutions. Budget Limitations, lack of sponsors, qualified professionals and data governance strategies, as well as data quality and interoperability issues among the different information systems, are factors conditioning the implementation of CI solutions in the Health Sector[7]. Thus, the purpose of this study is to analyze the process of corneal transplantation, using a CI system. Based on a set of business indicators and data provided by the CHP, the CI system was designed. The development of the CI system followed the Kimball's Lifecycle methodology[8], and it is divided in three main environments: data sources, development and visualization. Furthermore, the system contributes to an informed decision-making process for the management.

This paper is divided in five sections: introduction; background and related work; clinical intelligence system, results and finally, the conclusions and future work. Therefore, the second section shows a brief description of the key concepts related with this study and also addresses the work that has already been done in this field. Section 3 presents the methods, materials and methodology utilized during the development of the system along with the respective architecture. In section 4, the main results obtained through the use of the CI System are presented and discussed. Finally, in section 5, a summary of this paper is given, describing the main discoveries as well as the reflection of the whole process. In addition, a short description of the future work is presented.

2. Background and Related Work

2.1. Cornea

The history of corneal transplantation dates back to more than two centuries[1]. According to Sousa [2], the cornea is the first and most powerful lens of the eye's optics, accounting for about 70% of the total refractive power of the eye's dioptric system. In addition to the optic property, the cornea performs three mechanical functions: maintaining intraocular pressure together with the sclera, supporting the internal structures of the eye and resisting trauma. Macroscopically, the cornea is a transparent, avascular, fibrous membrane that lies in the anterior opening of the sclera presenting a greater curvature than the rest of the eyeball. Microscopically, the cornea is divided into five layers: epithelium, Bowman's membrane, stroma, Descemet's membrane and endothelium. Currently, corneas are the most commonly transplanted tissue worldwide[1].