

RESEARCH ARTICLE

Open Access



Identification and weighting of kidney allocation criteria: a novel multi-expert fuzzy method

Nasrin Taherkhani¹, Mohammad Mehdi Sepehri^{2*} , Shadi Shafaghi³ and Toktam Khatibi²

Abstract

Background: Kidney allocation is a multi-criteria and complex decision-making problem, which should also consider ethical issues in addition to the medical aspects. Leading countries in this field use a point scoring system to allocate kidneys. Hence, the purpose of this study is to identify and weight the kidney allocation criteria considering the balance between utility and equity.

Methods: To do this, a new fuzzy hybrid approach is proposed, which consists of two steps: In the first step, Fuzzy Delphi Method (FDM) is used to identify the effective criteria in the kidney allocation algorithm. In the second step, Intuitionistic Fuzzy Analytic Hierarchy Process (IF-AHP) is employed to determine the weight of the criteria.

Results: The results showed that the highest weight belongs to “Medical emergency” criterion and the lowest weight to “5 HLA mismatches”, which is similar to Euro-transplant kidney allocation system (ETKAS). The developed method is evaluated in two steps. First, the proposed model is implemented using a real case study from the Iranian Kidney Allocation System. It was shown that the proposed model has the potential to improve allocation outcome. Second, the proposed model’s superiority to the current model is approved by the experts using the results display in the profile matrix. Finally, sensitivity analysis is performed to check the robustness of the proposed model.

Conclusions: This paper contributes to the kidney allocation literature by doing the following: (a) developing a comprehensive framework for identification and weightings of criteria for kidney allocation, (b) using, for the first time, the IF-AHP technique to consider hesitancy of decision makers and uncertainty in organ allocation, and (c) proposing an appropriate framework for the countries that intend to improve or modify their organ allocation system.

Keywords: Kidney allocation, Fuzzy Delphi method, Intuitionistic fuzzy AHP, Kidney allocation criteria

Background

In recent years, medical knowledge has paid special attention to organ transplantation so that the concerns of patients in the end stages of failure of the organ have been improved significantly. Among the organs that can be transplanted, the kidneys have the highest demand. In the United States, as of September 2018, there were about 114,000 patients on the waiting list of organ transplantation, with more than 94,000 of them requiring kidney transplantation (82.45%) [1]. In Iran, as of October 2018, 80.34% of the candidates’ waiting lists required

kidney transplant [2]. Among the most important challenges in organ transplantation process are the organ allocation policies and finding the most appropriate recipient. Over time, organ allocation policies have changed and improved. Stegall et al. have explained the changes and modifications that have occurred in the kidney allocation system in the United States from 2004 to 2014, leading to the new Kidney Allocation System (KAS) [3]. The central concept is that kidney allocation should create a balance between utility (the best use of kidneys) and equity (equal access to kidneys for all wait-listed patients). Currently, many allocation policies have been developed with the aim of balancing between utility and equity.

* Correspondence: mehdi.sepehri@modares.ac.ir

²Faculty of Industrial and Systems Engineering, Tarbiat Modares University, Tehran 1411713116, Iran

Full list of author information is available at the end of the article



© The Author(s). 2019 **Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.