AI-Powered Organ Donation Notification and Matching System

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1)

Problem description:

The organ donation process in Saudi Arabia faces a complex set of challenges, each significantly impacting its efficiency and effectiveness. Among these challenges is the absence of standardized procedures for organ donation across hospitals. This lack of uniformity has led to disparities in how organ donation is approached and managed, creating inefficiencies and missed opportunities.

A pervasive misconception also hinders the organ donation process, namely the misunderstanding that organ donation is incompatible with Islamic beliefs. This misconception has led to reluctance among some healthcare professionals to proactively engage in the organ donation process, fearing that it contradicts their cultural and religious norms. This, in turn, affects the timely identification and assessment of potential donors.

Moreover, the labor-intensive and time-consuming process of creating the necessary documentation for organ donation compounds the issue. This manual paperwork not only consumes valuable time but also adds complexity to an already intricate process, further delaying the organ donation process.

These challenges collectively result in a critical time constraint. Once an individual is declared brain-dead, there exists a limited window of time before other vital organs irreversibly shut down. The delay in identifying potential brain-dead donors and the subsequent procedural inefficiencies contribute to this time constraint, which leaves little margin for error or delay in the organ transplantation process.

Another dimension to this challenge is the paradox where there are more potential donors who have expressed their willingness to donate organs than there are individuals in need of organ transplants. However, these challenges hinder the conversion of potential donors into actual donors. This inefficiency in the system exacerbates the shortage of organs available for transplantation.

The consequences of these complex challenges are far-reaching. Prolonged delays in the organ donation process deprive patients in need of life-saving organ transplants of their best chance at survival. The persistence of misconceptions about organ donation's compatibility with Islamic beliefs also casts a shadow over the potential for organ transplantation in Saudi Arabia, preventing the realization of its full life-saving potential. Ultimately, these multifaceted challenges contribute to a critical shortage of available organs for transplantation, prolonged patient suffering, and a race against time where every moment is precious in the quest to save lives. These issues underscore the urgent need for a transformative solution that streamlines the organ donation process, incorporates cultural and religious considerations, and removes unnecessary delays while making the most of the pool of potential donors.

2)

Solution:
To address the complex challenges in the organ donation process and maximize the number of donors, we propose the implementation of an "AI-Powered Organ Donation and Matching System." This innovative solution streamlines the entire process, making it more efficient, removing the reliance on individual doctors to initiate the notification, and ensuring that the necessary documentation is prepared promptly. Here's how this system works and how it eases the process, ultimately increasing the number of donors:

The operational foundation of the system deviates from conventional approaches. It engages from the moment a patient enters the intensive care unit (ICU), a pivotal moment where timely intervention can be the difference between life and death. The AI system commences continuous data analysis at this point for everyone at the ICU by using voice-recognition and by being connected to the monitor devices. Simultaneously, it evaluates data pertaining to individuals awaiting organ transplants. However, the distinction in this process lies in the fact that it analyzes patient data until the individual is declared brain-dead. Once a patient in the ICU is declared brain-dead, the AI system moves into its second phase of action, implementing automated workflows to generate a comprehensive patient profile.
This profile is not only inclusive of the patient's medical data but also enriched with essential information pertinent to organ transplantation. It is in this phase that the AI system conducts a sophisticated and precise matching process with potential organ recipients who urgently require organ transplants. The culmination of this process is a seamlessly generated package that encapsulates the patient's profile, their suitability for organ donation, and a streamlined matching with a potential recipient. This comprehensive package is then transmitted to the Saudi Center for Organ Transplantation (SCOT), transforming the notification and consent process.

3)

System Benefits:

1. **Timely Identification:** The system's continuous monitoring and detection of brain death ensures that potential donors are identified promptly, maximizing the viability of organs for transplantation.

2. **Elimination of Reliance on Individual Doctors:** The system removes the dependency on individual doctors to initiate the notification process. It operates autonomously, ensuring that no potential donor goes unnoticed due to variations in individual healthcare provider practices.

3. **Prompt Documentation Preparation:** By automating the documentation process, the system eliminates delays related to paperwork. This means that the necessary documentation is always ready when needed, streamlining the overall process.

4. **Proactive Organ Matching:** The system's unique approach to donor-recipient matching significantly enhances the likelihood of a successful match, ensuring that the right organ reaches the right recipient in a timely manner.

5. **Increased Donor Pool:** The efficient and automated process ensures that more potential donors are identified and their organs are retrieved promptly. This translates to an increased number of donors and a larger pool of organs available for transplantation.

4)

Cost:

Hemodialysis:
If a patient receives in-center hemodialysis three times a week (as is common), the annual cost can be calculated as follows:
Cost per session: SAR 700
Sessions per week: 3
Sessions per year: 3 sessions/week x 52 weeks = 156 sessions/year
Annual cost: SAR 700/session x 156 sessions/year = SAR 109,200/year

Peritoneal Dialysis:
For continuous ambulatory peritoneal dialysis (CAPD), with four exchanges a day, each taking about 40 minutes, the annual cost can be calculated as follows:
Cost per session: SAR 700
Sessions per day: 4
Sessions per year: 4 sessions/day x 365 days = 1,460 sessions/year
Annual cost: SAR 700/session x 1,460 sessions/year = SAR 1,022,000/year
Now, let's compare these annual costs to the potential cost of a kidney transplant:

Kidney Transplant:
- The cost of a kidney transplant can vary, but it often involves significant expenses for the surgery, post-operative care, and immunosuppressive medications. However, the cost is typically incurred only once.
- While the initial cost of a kidney transplant can be high, it is a one-time expenditure, and the patient may not need ongoing dialysis sessions.

In the long term, a successful kidney transplant can lead to significant cost savings compared to ongoing dialysis. Additionally, it offers patients a better quality of life and reduces the need for regular and costly dialysis sessions. These factors make kidney transplants a cost-effective and preferable option for many individuals with end-stage renal disease when a suitable donor is available.

5)

A case study done by the National Center for Biotechnical Information

The majority of Saudi Nationals are reluctant and unwilling to donate or consent for donation. This study was undertaken to determine the knowledge and attitude towards organ donation among males in Riyadh, Saudi Arabia. A questionnaire was distributed to 223 men attending the out-patient department of the National Guard Hospital, Riyadh. A total of 205 (92%) individuals answered the questionnaire. Of them, 187 (91%) were Saudis and 18 (9%) were non-Saudis. A total of 187 (88%) had heard about organ donation of whom 80 (43%) each, had acquired this knowledge through television or radio, 16 (8%) through newspaper and magazines, seven (4%) through friends and relatives, and four (2%) through health-care workers. Of the 205 study subjects, 88 (43%) claimed they understood the concept of brain-death, 96 (47%) did not, and 19 (10%) did not respond to this question. One hundred and thirty-eight (67%) were willing to donate, and 156 (76%) were willing to receive an organ. One hundred and fifteen (56%) believed that Islam permits people to donate organs, five (2%) thought Islam does not permit organ donation, 64 (31%) gave a "don't know" answer and 21 (11%) did not attempt to answer the question. In addition, 41 (20%) thought organ donation disfigures the body. In conclusion although 67% of the respondents in this survey were willing to donate, there was a significant lack of knowledge and misconception with regard to Islamic support to, and the mutilating effects of, organ donation.

Beliefs and Intention to Organ Donation in Saudi Arabia: An Online Cross-Sectional Survey

The influence of Islamic religious beliefs on organ donation decision-making in KSA is not encouraging based on previously published literature. A cross-sectional study among a random sample of 948 Saudi citizens between 20–60 years of age showed that 27.5% feared that the act of organ donation contradicted their religious beliefs [20]. In another recent study, around 39.29% of the study participants who opposed organ donations suggested religious beliefs as the reason for opposing organ donations [21]. Even though, the Islamic Jurisprudence Assembly Council in Saudi Arabia approved deceased and live donation in a landmark decision in 1988, the overall data indicates a lack of awareness of the permissibility of organ donation in the religion of Islam in the Saudi population [22]. Similar to past studies, around 20.3% of the study participants in this study disagreed with the statement that organ donation could have a positive impact on life after death and they will be rewarded by God for such an act. Around 70.1% agreed that their willingness for organ donation would increase if they know more about the viewpoint of their religion regarding organ donation, and around 26.6% agreed that they will consider organ donation after discussion with a religious leader. The study results showed the significant impact of religious beliefs in decision-making for organ donation, as well as the role of religious leaders in influencing beliefs and intention to donate organs. There is a need to increase awareness about Islamic

religious viewpoint regarding organ donation among the Saudi population, preferably by involving religious figures in awareness campaigns.

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Ethics Committee of University of Jeddah (protocol code UJ-REC-020, and 05/30/2021).

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ABSTRACT

Objective: Organ transplantation is successful. The main challenge in the Kingdom of Saudi Arabia (KSA) and elsewhere continues to be organ shortage. This shortage was not resolved by utilization of living donors. Previous studies indicate that there is underreporting of brain death cases, lack of completion of documentation process, poor medical care in some instances and finally high refusal rate for consent. In order to put this problem in perspective and find a solution, we initiated a collaborative project between 4 hospitals in Riyadh, KSA and The Saudi Center for Organ Transplantation. The initial result of this project is presented in this article.

Methods: A donor team was formed to deal and facilitate the logistical aspect of donation in the 3 main Ministry of Health hospitals in Riyadh. Data with regard to the number of donors reported, documentation and success rate were recorded over 3-months (October 2003 to December 2003) and compared with the preceding 9 months.

Organ transplantation continues to be the treatment of choice for end-stage organ failure. With the advancement in immunosuppression and surgical technique, there is a substantial increased in the success rate of organ transplantation, not only in terms of graft and patient survival, but also in terms of long term quality of life.[1] The main challenge for organ transplantation continues to be organ shortage. This shortage of organ was not resolved

Results: During the period from January 2003 to September 2003, the total number of case reported to the Saudi Center for Organ Transplantation in Riyadh region, was 94. Only 53% were fully documented. Families were approached in 45 of these 50 cases in terms of donation and consent was obtained in 15. However, the number harvested was only 10 (11% yield from total number reported). During the period from October 2003 until the end of December 2003, the total number of cases reported from 3 hospitals was 19. Seventeen (90%) of them were documented. The families were approached in 16 cases and consent was obtained in 6. All 6 (32%) donors were harvested.

Conclusion: The above result clearly indicates that a donor team supporting the intensive care unit (ICU) can improve the donation. It is expected that application of a similar project to more ICUs in KSA will have a substantial positive impact on the rate of organ donation.

Saudi Med J 2004; Vol. 25 (10): 1366-1368

by utilization of living donor.[2] Organ transplantation continues to depend on cadaveric supply. In the Kingdom of Saudi Arabia (KSA) the main hindrance against the expansion of organ transplant program is organ shortage.[3] Though in many countries many of the logistical problems pertaining to organ donation

have been aggressively approached.[4,5] In KSA, there are still a lot to be carried out in order to solve the logistical problem in

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Received 14th April 2004. Accepted for publication in final form 6th June 2004.

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relation to cadaveric donation. Previous studies indicate that there is underreporting of brain death cases, lack of completion of documentation process, poor medical care in some instances and finally high refusal rate for consent.[4] All these factors create a "domino effect" causing a severe shortage affecting organ transplant programs in KSA and hence, patients survival with end-stage organ failure. In order to put this problem in perspective and find a solution, we initiated a collaborative project between 4 hospitals in Riyadh, KSA and the Saudi Center for Organ Transplantation. The initial result of this project is presented in this article.

Methods. The following hospitals in Riyadh were selected for this project: Prince Salman Hospital, Riyadh Medical Complex and Al-Eman Hospital, Riyadh, KSA. A meeting was conducted between these 3 hospitals and representative from Health Outreach Program and Business Affairs at King Faisal Specialist Hospital and Research Centre (KFSH&RC). Two coordinators were employed by KFSH&RC in order to facilitate the logistics of organ donation in these 3 hospitals. Their work was supervised by a physician forming a donor action team, which helps to coordinate the effort in organ donation at all stages. The sole responsibility of this team includes insuring that all cases in these hospitals are being reported, documentation is completed, the medical care of these donors is optimal and finally all documented cases were approached for consent. Data were recorded in terms of the number of donors reported, completion of documentation process, medical condition of the donor, finally whether consent was obtained and if the consent was obtained organs were harvested. Data were gathered between October 2003 to December of 2003 and these were compared to similar data collected from January 2003 until the end of 2003.

Results. During the period from January 2003 to September 2003, the total number of cases reported to the Saudi Center for Organ Transplantation in Riyadh region was 94. Out of these 94 cases 50 were fully documented (53%). Families were approached in 45 of these 50 cases in terms of donation and consent was obtained in 15. However, the number harvested was only 10 (11% yield from total number reported). During the period from October 2003 until the end of December 2003, the total number of cases reported from 3 hospitals was 19. Seventeen (90%) of them were documented. The families were approached in 16 cases and consent was obtained in 6. All 6 donors were harvested (32% yielded from the total reported).

Discussion. The challenge facing of the organ donation in KSA includes: underreporting of cases, incompletion of medical documentation, improper medical care of donors, failing to approach the family and refusal to consent. In order to try to solve these problems, a donor action team was put together consist of coordinators and supervised by a physician. The team job was to facilitate the logistics in the

process of donation at 4 different stages. It was clear that the biggest impact of this team was to improve documentation. More than 90% of all cases were documented when the donor action team intervenes in terms of solving the logistical problems such as providing electroencephalogram machine, alerting the neurologist to the importance of early documentation and in some cases incentives to act promptly on the documentation in accordance with the protocol of The Saudi Center for Organ Transplantation. This is in comparison to only 50% in the first 9 months of 2003. This obviously has increased the percentage of number of cases where families were approached. Though there was no major difference in the percentage of cases approached, the total number available for family approach was increased as a result of the completion of the documentation process. The other striking difference was the percentage of harvesting and, hence, utilization of donated organs, in the consented cases, which was close to 100% in the last 3 months of 2003 as opposed to 67% in 9 months before that.[6] This most likely indicates a better medical care of these donors thus, they reached the stage where they could be harvested. The above data indicates clearly that at least in 2 areas the donor situation can be improved substantially. These are the documentation and the medical care, and improving these 2 factors will give a positive impact on the eventual number of donors available for harvesting. At the current health care system in KSA there are no trained donor coordinators in major hospitals, which certainly have negative impact in number of donors available for organ transplantation. From this short experienced it seems that having especially trained coordinators in major hospitals in Riyadh who will be working on the logistics of donation will have a positive impact on the number of donor and subsequently in the number of organ transplantations in the kingdom. It seems that an improvement at different stages of donation process will have an incremental increase in the eventual outcome of donors both in quality and quantity. We do feel that to expand and proliferate the organ transplantation in KSA and to help more patients with end-stage organ disease, organ donation has to be increased and this could be carried out by strategic process to improve the logistic aspects of

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