Towards Realizing Benefits of Information Technology in Organ Transplant: A Review

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Abstract. Organ transplantation comprises of many phases, processes, and activities and involves multiple stakeholders. Effective management of such a complex and costly medical domain requires an efficient, multifaceted solution. Although, Information Technology (IT) can basically play an important role here, it is not clear how IT potentials have been deployed so far. We systematically reviewed MEDLINE, EMBASE, CINAHL, The Cochrane and IEEE databases and identified 27 publications describing IT application in organ transplantation. Although the IT coverage spans over waiting list management, donor-recipient matching, and inpatient and outpatient medication and lab monitoring practices, the coverage is still patchy and whole process IT support is missing in practice.

Keywords. Organ Transplantation, Information Technology, systematic review

Introduction

Replacing a defective organ with a healthy one has opened a new horizon in medical practice. With advances in transplantation filed over the last fifty years, many technical and medical hurdles have been overcome; and as a result of this, patients' survivals and their quality of life have greatly been improved [1]. Yet, there are many challenges to be met. Transplantation process, from organ procurement to recipients' follow ups, can practically be divided into 3 main interdependent phases of pre-transplant, inpatient, and follow-up care involving different stakeholders such as clinicians, provider organizations, donors and recipients. Information sharing and coordination among these stakeholders are at the center stage of the whole process; and if not managed properly, the quality and efficiency of the process can be hampered. In this regard, Information Technology (IT) has great potential to offer by removing many hurdles in the processes of this very specialized field. However, it is not clear how far IT potentials have been deployed and which areas still need more consideration.

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1. Methods

A systematic search was conducted in main databases (details in Figure 1, last search on Dec. 4th, 2015). Through a Boolean search strategy using key and MeSH terms related to *transplantation* AND *IT intervention*, we identified English qualitative or quantitative studies that described IT use by *care providers* to support organ transplantation's daily inpatient and/or outpatient clinical workflow. Editorials, opinion papers, reviews, stem cell transplant literature, simulation studies, and literature lacking a routinely used IT system in clinical workflow e.g., registries or systems used merely for collecting data for research purposes were excluded. We analyzed and categorized the final set of literature on the bases of the processes supported by IT systems.
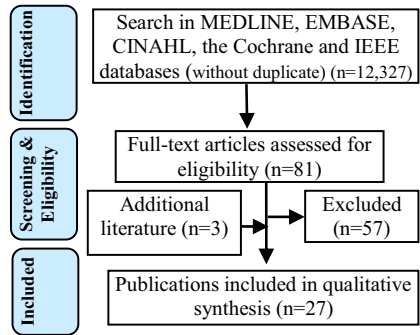

Figure 1. Flow diagram of study selection (search from Jan. 1990 to Dec. 2015)

2. Results

Twenty-seven publications describing IT application in each phase of organ transplant care were identified. These systems' main application area are described below and summarized in Table 1. The Pre-Transplant Phase: Managing rapidly increasing number of patients waiting for transplantation through IT systems brought about close cooperation among transplant programs and allowed retrieving, integrating, analyzing, and interpreting numerous pieces of patient clinical information quickly [2-5]. IT systems have enabled local or national organ procurement organizations to manage shortages of organs more efficiently [6]. When an organ is available, matching and selection of the best recipient becomes an essential task. In this regard, IT systems such as telemedicine applications, PDAs, and online sharing of information have successfully been used to facilitate the process with the aim of improving outcome, quality of life and longevity

Table 1. Summary of the literature describing the coverage of different processes in transplantation care by IT systems.

Phases	Application areas	References
Pre-Transplant	Waiting List	[2, 5, 7, 8, 10]
	Organ Procurement	[6]
	Matching best candidate	[3, 7, 8, 9]
	Decision Making	[3, 4]
	Survival Analysis	[7]
Inpatient	Med. CPOE/CDSS	[13-16]
	Lab CDSS	[17]
	Barcode-assisted medication administration	[18]
	Patient Education	[19]
Post-transplant Follow up	Outpatient Lab values Monitoring	[20-23]
	Immunosuppressive & other Med Monitoring	[22, 24-27]
General*	Managing clinical information in diff. phases	[5, 9, 11, 12, 28]

*   These IT applications supported activities of more than one phase of organ transplant.

of patients [3, 4, 7-10]. Before the hospitalization of donors and recipients, IT has also been used in supporting clinicians to manage and to evaluate information coming from different consultant physicians, and the results of para-clinical and laboratory investigations [5, 9, 11, 12].

The Inpatient Transplant Phase: Literature also described IT systems used in inpatient settings for better caring of grafted organs and for preventing its rejection or failure. These systems mainly focused on managing dosages of immunosuppressive and other medications, for example through applying CPOE and reducing incidence or severity of potential drug-drug interactions [13-16]. One study also explored the benefits of IT in managing lab resource utilization [17] and another on safety of inpatient medication process via application of Barcode-assisted Medication Administration System [18]. Another study reported on the application of an IT system to promote evidence-based inpatient education for improving the result of transplantation [19].

The Post Transplant Follow-up Phase: Post-transplantation care and lifelong follow-ups are required to protect patients against transplant rejection and also to detect and mange complications of long-term immunosuppressive drugs such as cancer and diabetes. Close monitoring of Lab values is a key to detect the early signs of graft rejection. IT systems have successfully been used to help clinicians to monitor relevant Lab values [20-23]. These systems can provide an integrated view of patient data over time and notify clinicians whenever changes in Lab values require special attention [23]. Literature reported application of IT systems and Informatics methods in order to reduce toxicity of immunosuppressive drugs (e.g., Tacrolimus) while making sure that patients receive necessary dosage [24-26]. IT systems have also supported clinicians in monitoring other medications such as antiviral drugs or anti-lipid therapy whenever needed [20, 27].

3. Discussion and Conclusion

Because of the existing need, many endeavors have been taken place towards the application of IT systems in organ transplantation. However, our review shows that the coverage is still patchy with a greater emphasis on pre-transplant process. This is most probably because managing of scarce resources of donated organs efficiently is of great importance. In fact, despite a comprehensive search, we could not find any setting that has had utilized a comprehensive IT solution that provides support for the all phases of organ transplantation. Given the fact that preserving the transplanted organ is also of great importance, IT solutions are also required to support lifelong post-transplant care. Supporting the implementation of well-established but complex, standard care protocols pertaining to transplantation would be a considerable value added by IT systems.

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