"Health Care Abbreviation System for Organ Donation"

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Abstract - *Organ transplantation is the therapy of choice for patients with end-stage diseases who are refractory to medical therapies (Shah 2012). Even though organ transplantation can increase the life expectancy and quality of life for the recipient, the operation can entail various complications, including infection, acute and chronic rejection and malignancy (Huynh 2014). The pre-operative anticipation of the risk associated with organ transplantation is a regular task that transplant centers perform in order to determine which patients would benefit from transplantation and accurately identify these for whom the risk of transplantation is too high and would therefore provide no survival benefits. Such a risk assessment task is quite complicated for that postoperative patient survival depends on different types of risk factors: recipient-related factors (e.g. cardiovascular disease severity of heart recipients (Wozniak 2014; Nwakanma2007; Russo 2006; Silva 2016)), recipient-donor matching factors (e.g. weight ratio and human leukocyte antigen(HLA) (Jayarajan 2013), blood group compatibility (Jawitz2013), race (Allen 2010), etc), and donor-related factors(e.g. diabetes (Arnaoutakis 2012; Taghavi 2013)).*

The interactions among all these risk factors make the prognosis problem for the organ transplant outcomes highly complex; the National Heart, Lung and Blood Institute (NHLBI) working group suggests resolving this problem by enhancing the phenotypic compatibility characterization of the pre-transplant recipient-donor population (Mancini 2010; Collins 2015; Shah 2012).

KEYWORD: kidney donation, organ transplant, transplantation, tissue donors, tissue and organ procurement.

I. INTRODUCTION:

Organ transplants can improve the life expectancy and quality of life for the recipient but carry the risk of serious post operative complications, such as septic shock and organ rejection. The probability of a successful transplant depends in a very subtle fashion on compatibility between the donor and the recipient - but current medical practice is short of domain knowledge regarding the complex nature of recipient donor compatibility. Hence a data-driven approach for learning compatibility has the potential for significant improvements in match quality. This paper proposes a novel system (Confident Match) that is trained using data from electronic health records. Confident Match predicts the success of an organ transplant (in terms of the 3-year survival rates) on the basis of clinical and demographic traits of the donor and recipient. Confident Match captures the heterogeneity of the donor and recipient traits by optimally dividing the feature space into clusters and constructing different optimal predictive models to each cluster. The system controls the complexity of the learned predictive model in a way that allows for assuring more granular and accurate predictions for a larger number of potential recipient-donor pairs, thereby ensuring that predictions are " personalized "and tailored to individual characteristics to the finest possible granularity. Experiments conducted on the UNOS heart transplant dataset show the superiority of the prognostic value of Confident Match to other competing benchmarks; Confident Match can provide predictions of success with 95% accuracy for 5,489 patients of a total population of 9,620 patients, which corresponds to 410 more patients than the most competitive benchmark algorithm.

II. LITERATURE REVIEW

The purpose of the present study was to ascertain firstly, the awareness about and the attitudes of the locale population representative sample to various current and emerging medical genetic and other biomedical advances, and secondly, to determine whether these observations were influenced by gender, religion, age, profession and education. The importance of such studies cannot be undermined. In fact, for effective and equitable implementation of innovative health-care, especially the genetic and biomedical technologies which have social and ethical implications, there is the requirement of their acceptance and legitimation by the public (Ishiyama et al., 2008). Besides cultural and demographic variables like ethnicity, age and education, regional differences in attitudes and awareness are strong predictors for availability of the genetic services (Jonassaint et al., 2010). It has been observed that the attitude is concerned with beliefs, interests, ideas and behaviour of a person (Sarna, 2005). The perceptions innate to each individual are shaped by each person's unique cultural, socio-economic and geographical background (c.f. Hariharan et al., 2006). Against this backdrop, in this chapter the background of the research problem is followed by review of literature on similar studies. The literature on awareness about and attitudes towards the medical genetic and biomedical technologies and procedures have been reviewed and is presented under International and National studies.

History of Organ Donation

Researchers experimented with organ transplantation on animals and humans in the 18th century. There were many failures over the years, but by the mid-20th century, scientists were performing successful organ transplants. Transplants of kidneys, livers, hearts, pancreatic, intestine, lungs, and heart-lungs are now considered routine medical treatment.

Important medical breakthroughs such as tissue typing and immunosuppressant drugs allow for more organ transplants and a longer survival rate for recipients. The most notable development in this area was Jean Borel's discovery of an immunosuppressant drug in the mid-1970s. Cyclosporine was approved for commercial use in November 1983.

Unfortunately, the need for organ transplants continues to exceed the supply of organs. But as medical technology improves and more donors become available, the number of people who live longer and healthier lives continues to increase each year.

World's First Organ Transplantation

Organ transplantation is a medical procedure in which an organ is removed from one body and placed in the body of a recipient, to replace a damaged or missing organ. The donor and recipient may be at the same location, or organs may be transported from a donor site to another location. Organs and/or tissues that are transplanted within the same person's body are called auto grafts. Transplants that are recently performed between two subjects of the same species are called allografts. Allografts can either be from a living or cadaveric source.

Organs that have been successfully transplanted include the heart, kidneys, liver, lungs, pancreas, intestine, thymus and uterus. Tissues include bones, tendons (both referred to as musculoskeletal grafts), cornea, skin, heart valves, nerves and veins. Worldwide, the kidneys are the most commonly transplanted organs, followed by the liver and then the heart. Cornea and musculoskeletal grafts are the most commonly transplanted tissues; these outnumber organ transplants by more than tenfold. Organ donors may be living, brain dead, or dead via circulatory death. Tissue may be recovered from donors who die of circulatory death, as well as of brain death – up to 24 hours past the cessation of heartbeat. Unlike organs, most tissues (with the exception of corneas) can be preserved and stored for up to five years, meaning they can be "banked". Transplantation raises a number of bioethical issues, including the definition of death, when and how consent should be given for an organ to be transplanted, and payment for organs for transplantation. Other ethical issues include transplantation tourism (medical tourism) and more broadly the socio-economic context in which organ procurement or transplantation may occur. A particular problem is organ trafficking. There is also the ethical issue of not holding out false hope to patients.

III. EXISTING SYSTEM

The OTM system [1] is a modular software agent-based platform, including adaptive anduser friendly graphical interfaces to facilitate the access for

nurses, physicians, surgeons, etc. (who are not necessarily IT experts) to both the data and the mechanisms requiredfor effective coordination of the main OTM tasks. Agent technology is one of the most promising approaches for designing and implementing autonomous, intelligent and social software assistants capable of supporting human decision making [9]. As mentioned earlier, the fundamental idea in the OTM context is to provide computational help for decisions that have to be taken by considering a substantial number of medical factors as well as legal rules and requirements under very strong time pressure.
In this perspective, we propose a pro-active, modular and flexible approach consisting of two main sub-systems: Various agents populating these two sub-systems interact and coordinate on behalf of medical practitioners, transplant coordinators and patients in order to improve the OTM process. The development tools that have been deployed to implement the OTM system are:

- Jade v. 3.0b1, a software development framework to develop multi-agent systems and applications conforming to FIPA standards for intelligent agents. (http://sharon.cselt.it/projects/jade/).
- The Sun Java Development Kit v. 1.4 (http://www.javasoft.com).
- Protegev. 1.8, an ontology editor used to create the OTM ontology in combination with the UMLS tab and the Bean Generator plug-in. (http://protege.stanford.edu/)

Before a more detailed description of the various software components, the definitions of some recurrent terms are given for clarity's sake.

Definition 2.1. Donor: a person who donates organs for organ transplantation.
Definition 2.2. Hard constraint: a compatibility condition on the selection of a patient for a given available organ that must be satisfied.
Definition 2.3. Patient: a person who receives medical attention, care, or treatment. A patient can be a recipient as well as a potential donor.

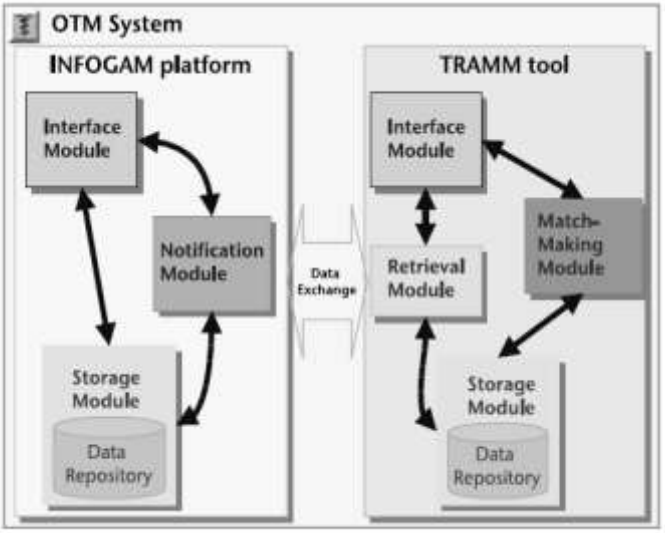


FIGURE 1. An overview of the OTM system architecture.

IV. PROPOSED SYSTEM

Organ transplantation is a very complex problem that summarizes most of the aspects examined until now: knowledge management, planning/scheduling, coordination, monitoring. Moreover, on top of this, there is also a very strict constraint in time due to the intrinsic nature of the problem (organs have a short time life outside bodies and can be stored for very few hours). All these characteristics, together with the wide diffusion of this practice all over the world, make organ transplantation management an exciting, challenging problem to be solved. Organ transplantation has raised to a great importance in the last years. Transplantation is more and more seen as a valid way to treat diseases and no longer as just the last option therapy. Thanks to frequent campaigns for citizens information, the number of donors is constantly increasing all over Europe. In Switzerland, there is a unique national centre of coordination, Swiss transplant [26], which is in charge of registering patients, analyse organs compatibilities, set up logistic for transplants. Currently, due to strict time constraints and legal aspects, the origin of transplanted organs is mainly local. However, most neighbouring nations share reciprocal agreements between their transplant organizations: in the event no matching is found among the recipients of a country, the organ is advertised to the neighbour countries (in the case of Switzerland: Italy and France). This gives better chances to find an appropriate recipient for each organ and avoid wasting. Also, an international European organization, Euro transplant [25], has been recently created with the aim of increase and better coordinate the transplants all over the

continent. The Euro transplant International Foundation is responsible for the mediation and allocation of organ donation procedures in Austria, Belgium, Germany, Luxemburg, the Netherlands and Slovenia. In this international collaborative framework, the participants include all transplant hospitals, tissue-typing laboratories and hospitals where organ donations take place. The Euro transplant region numbers well over 118 million inhabitants and it is open to new countries to join. Organ transplantation requires a delicate balance between fairness and medicine to decide in each case who will be the effective recipient. From a medical point of view, there is a set of information which has to be provided by both potential recipients and donors and on which the first operations of choice are performed. The main information among this set is about:

- blood group
- tissue characteristics (HLA groups)
- weight
- height
- age

Some of these characteristics (ex: blood group) determine a definite incompatibility, most of the others just give indications on how suitable the organ is (ex: weight) or on how much the donor matches with the recipient (ex: tissue characteristics). The latter aspect is the most important: in transplantation, a rejection against an organ occurs when the recipient's immune system recognizes the donor organ as alien; so, the more the tissue characteristics match those of the recipient, the less chance there is that a rejection reaction will occur. On the other side, from a fairness point of view, there are other important factors that influence the final assignation of an organ. Information of key importance for the definition of the effective recipient are:

- the age of the patient being under sixteen
- the relative position in the waiting list
- the presence of 0-emergency case

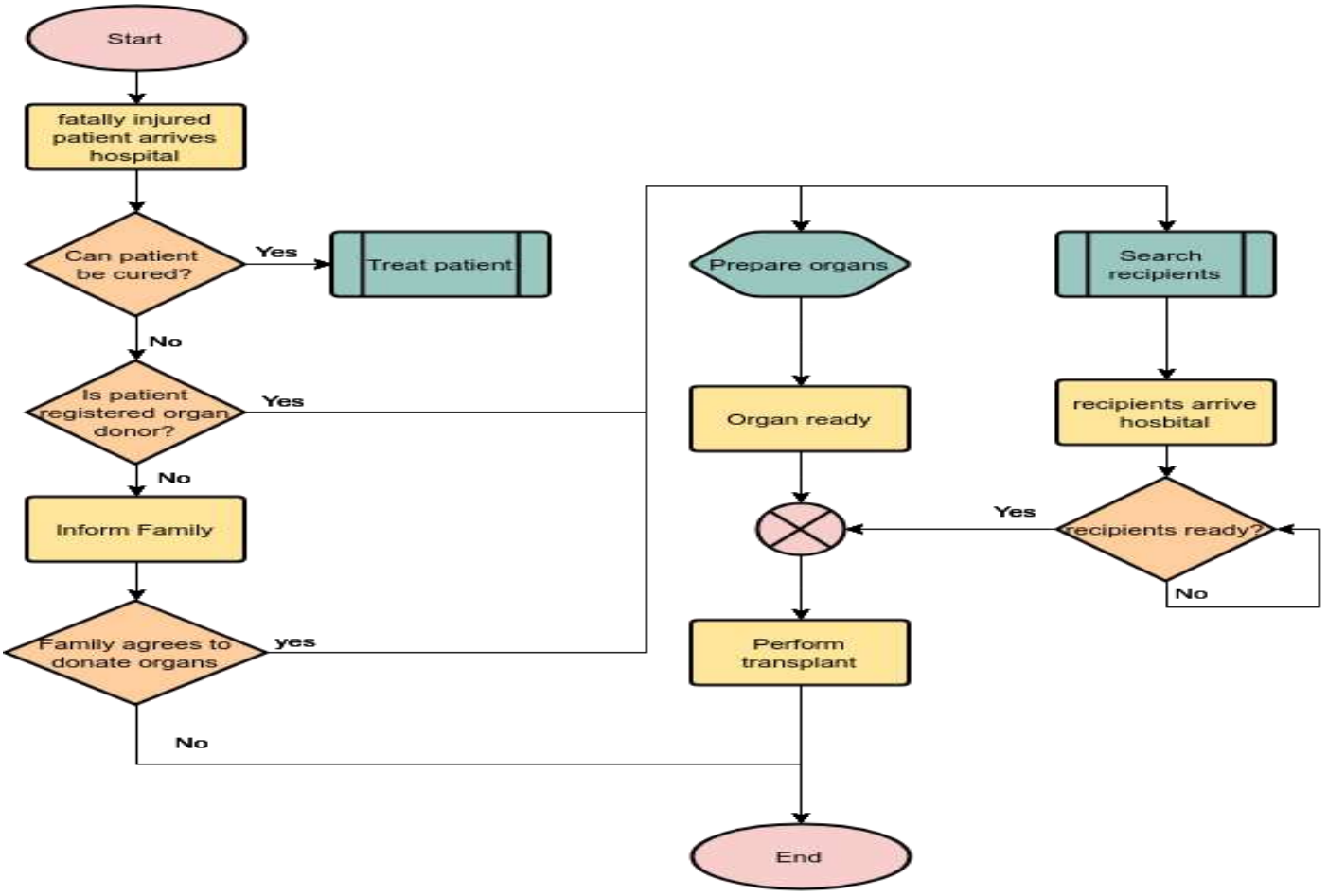
V. CONCLUSION AND FUTURE WORK

Organ transplants for patients with end-stage diseases carries the risk of various serious post-operative complications, the pre-operative anticipation of the transplant outcome depends on the compatibility between the donor and the recipient. In this paper, we have developed Confident-Match, a data-driven system that learns complex recipient donor compatibility patterns from the outcomes of previous transplants. Confident Match captures the complexity of such compatibility patterns by optimally dividing the recipient donor feature space into clusters and assigning different optimal predictive models to each cluster, thereby ensuring that predictions are personalized and tailored to individual characteristics of both the donors and the recipients. Experiments conducted on a public heart transplant dataset demonstrate the superiority of Confident Match to other competing benchmark algorithms. In conclusion, the concept of brain-death was clearly understood by only a small number of medical postgraduate students. They however, had positive attitudes and beliefs towards organ donation. Organ transplantation is the most preferred treatment modality for end-stage organ disease and organ failures repeal the dead donor rule.

Change the United Network for Organ Sharing (UNOS) measurement from all-cause mortality to donation-specific mortality.

Remove disincentives and provide incentives for organ donation.

Increase living will usage and include organ donation.



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