TRANSPORTATION OF ORGANS BY AIR: SAFETY, QUALITY AND SUSTAINABILITY CRITERIA

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The donation-transplant network is a complex system of activities in which the standardization process must take into account a large number of variables, last but not least the innovative techniques from the technological point of view which have reduced damages to organs from picking to transplantation due to the time of ischemia. Supply chain management aims at planning, implementing and controlling the supply chain in an efficient and economically viable way, designing the number of facilities, their location and the allocation of relative flows.

There is an inverse proportion linking the time the organ is outside the donor's body and the chances of a successful transplantation. If the transport time between a donor hospital and a recipient center exceeds cold ischemia time, another recipient center has to be found otherwise the transplant cannot take place. Scientific literature has focused on designing location–allocation of healthcare facilities or on optimizing organ transplant supply chains. Discrete facility location models which differ in their objective function: minimizing facility costs or facilities (set covering models), minimizing coverage distance (P-center models), minimizing demand weighted total (or average) distance (P-median models), minimizing facility costs and demand weighted total (or average) distance cost (UFL models) or maximizing the covered demand. Integration between location of healthcare facilities design and the optimization of organ supply chain networks as well as the provision of alternative transportation modes due to time and cost involved is needed. Furthermore, existing literature does not sufficiently address uncertainties in the system such as distribution of demand and supply, processing times and ischemic times. This project, developed in cooperation with the National Transplant Center (CNT), in focused on the development of organ transportation activities by air from the technological, operational and logistic points of view. Transplantation events are growing in importance; in particular organs and medical teams transportation by air is a complex topic to be dealt with due to the high levels of punctuality and reliability of the services required in order to ensure the safe outcome of the transplant. Nationwide rule for transportation activities of organs, patients and medical teams is the “Conferenza Stato – Regioni” agreement, issued in 2006 and emended in 2015, which enables the Regions to handle (in-house or by means of contractors) organ shipping activities according to CNT requirements, leaving the CNT a supervising role by mean of a trimestral relation on failures. EU directive 2010/53 foresees that whoever is involved in human organ transport is compelled to follow procedures ensuring the safe and timely shipment in addition to guidelines on how to use and keep the organ storage units. The necessity to identify minimum requirements for organ shipping agencies has been recently restated by the CNT in order to frame the topic of organ transportation in an homogeneous context of call for services on a national level. Those requirements stem from the analysis of both the market and the stakeholders in a trans-national context and encompass technical aspects of aircrafts and organ storage units, professional requirements of airlines and pilots as well as organizational parameters

The transportation of organs by air is basically needed for long distances and geographical reason; the transport chain usually starts and ends with a road transport phase. The multimodal transport chain has to be designed in order to be resilient, for example by making available the aircrafts at base airports with a consistent advance, providing aircrafts capable of operating irrespectively of adverse weather conditions, ensuring a safe storage and monitoring of the temperature inside the storage unit. The organ has then to be shipped from the donor hospital to the closest airport and from the arriving airport to the transplantation centre in the shortest time possible by road. These phases have proven to be the ones likely to be characterized by the higher level of uncertainty, given the variety of stakeholders involved. The study undergone by University of Bologna on behalf of CNT consists in the technical monitoring of organ transport activities in order to identify a shared procedure of data transmission and registration in a revamped database so as to optimize the organ shipment by

air, taken for granted the network of TCs and airports. CNT has started a survey of organ transport activities since 2002 which provides information on: municipality and Region of Donor Hospitals involved; municipality and Region of Transplant Centres involved; donation code – identification – transplant code – date, and cartographic distance between Donor and Transplant Centres.

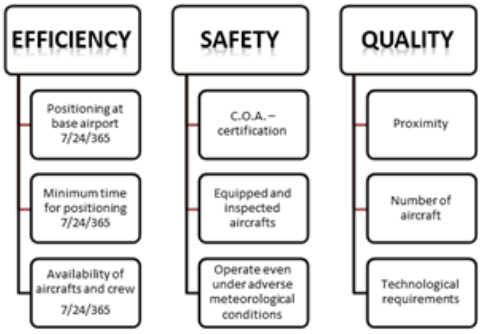

Fig. 1. Efficiency, safety and sustainability criteria for organ transport by air

Those information allow the knowledge of notices and effective transplantation activities carried out as well as the average and total length of displacement; on the other hand no information were available on transport mode (road-train-aircraft), presence on board of transplant teams, shipping agencies and the duration of each phase of displacement. In particular, the transport mode could only be supposed on the basis of the distance travelled and the origin-destination path.

Fig. 2. Air transport network for organ transport

The first phase of the creation of the new database has been the association of a principal and an alternate airports as well as the closest railway station to each of the 44 TCs identified in the previous step and to each Donor Hospital. To highlight the urgency associated with the topic, only nodes included in the National Plan for airports issued by the Ministry of Infrastructures and Transport or served by High Speed Train services have been taken into consideration. A trial phase – lasting four months - of survey has been started in June 2015, aiming at collecting a larger amount of data through the help of the operative unit of the CNT. Data made available refer to the period June ’15-Apr ‘16 during which 763 organ transportation events have occurred. In general, heart, liver and kidneys have been the most transplanted organs, confirming literature evidence on the topic. In addition, it is possible to assess that transports usually involve one or two organs. Lazio, Lombardia and Sicily are the regions involved more frequently by organ transportation activities. Further expanding O/D Matrices per organ as well as per Donor Hospital and TC it is possible to retrace the complete displacement of the organ. It is then possible to derive information on: average speed, average travel time for each transportation event and compare this time with the average ischemia time. Larger time windows in the future will allow comparison, trend analysis, calculation of average data and variance.

MAIN PUBLICATIONS

Mantecchini, L., et al., Transportation of Organs by Air: Safety, Quality, and Sustainability Criteria, Transplantation proceedings. Vol. 48. No. 2. 2016, pp. 304-308.

RESEARCH PROJECTS

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