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Organ Preservation Can Do More

Many research activities are going on to improve organ transplantation or working on finding replacement engineered tissues or improving dialysis and developing technologies such as artificial kidney and kidney-on-chip. However, the need to develop basic technologies for organ and tissue preservation is of utmost importance to enable wider usability of available organs. Hence, the importance of the subject is highlighted here.

In a recent paper, Giwa *et al.*[1] have provided an in-depth review of the current situation with organ preservation highlighting new possibilities and a futuristic way forward. Since its importance is not limited to transplantation community, but rather to other specialties and disciplines, we offer here a summary and comments on the paper with the view of opening up further discussion and stimulation of ideas and projects.

Advances in organ preservation will allow preserving organs for a longer time to give a chance to use marginal organs, send the organ to different locations, and the possibility of having better matching and improved outcome. Although organ transplantation is one of the most significant medical achievements in the last century, only 10% of transplantation needs are met at present. Provided that all current constraints can be removed, probably more than 30% of deaths, due to end-stage organ disease, can be prevented. Economically, the cost of treatment of end-stage renal disease worldwide is more than one trillion USD every decade.

Currently, the maximum time limit for organ preservation is measured in hours. Thus, organ donors and recipients must be matched within short distances and time. Organs may be turned down by one center after another until the permitted usage time is reached and the organ is discarded. Thousands of opportunities to save lives are lost. In the United States, for example, if 10% of hearts left unused were salvaged, one could meet transplantation needs (to cover the waiting list) of patients that would otherwise die or go sick because of the lack of hearts available for transplantation.[1] In the past 10 years, there have been advances in organ preservation and transplantation. Developments in organ storage and transport technologies can improve donor organ, bio-artificial organ, and engineered tissue utilization. Based on advances made in several fields, multidisciplinary groups of stakeholders are forming. Convergence of several approaches will pave the way for developing a new generation of preservation technology.

Advances in preservation can benefit from developments of perfusion circuits trying to mimic physiological conditions. *Ex vivo* organ preservation will build a basis for having a pool of organs by rehabilitating organs that would be otherwise unusable for transplantation. It will also provide an opportunity for drug immunomodulation and immune tolerance induction. It will allow for organ treatment, such as defatting fatty livers, which has already been demonstrated in animals. Organ treatment may also improve transplantation outcome. New biomarkers to predict health and translatability may also be used. Preservation will enable organ banking to have a backup supply, and it would make transplantation available to more patients.

The application of preservation technology also extends to engineered tissues for extension of their shelf life and also for benefiting from bio-artificial organs. Tissue-on-chip will also benefit from advances made in preservation technology. Reproductive tissue/organ preservation in young cancer patients can be preserved and subsequently reimplanted back into patients. There are more than one million patients in the US who survive after having cancer in childhood or young adulthood and may benefit from these advances. Furthermore, acute settings may benefit from banking and preservation technology, for example, extended preservation may allow for more limb reimplants.

Future preservation development should combine strategies for recapitulating the physiological environment while halting metabolism. New advances in areas of cellular imaging, organ-on-chip, regenerative medicine, and other relevant fields can also be harnessed. To achieve a greater impact from preservation advances, coordination and focused funding, a convergence of technologies, and integration of dispersed expertise are needed. Indications started, for example, the National Science Foundation -funded group to work on road mapping for organ banking and bioengineering. At the June White House Organ Summit, the Organ Preservation Alliance announced a coalition of leading organizations.[1] Both the public and private sectors have expressed an interest in the field. In the past 3 years, there has been a wave of new biotech companies. Further opportunities lie in the convergence of fields to develop innovative solutions. However, current restrictions have to be addressed to make a wider collaboration possible.

The key message of this commentary is that research to advance preservation technology is very important and badly needed. It requires integration of several disciplines and expertise as well as focused funding. It also requires a coordination system and new regulations and guidelines to achieve an impact on transplantation medicine and surgery. Advances made in fields of microfluidics, bioprinting,[2] and preservation technology should help developing organ repair centers[3] and salvage organs to make more of them available for patients with favorable impact on health, life, and economy.

Nureddin Ashammakhi[1,2], Elmahdi A. Elkhammas[3], Adam Elzagheid[2,4]

[1]Department of Surgery, Oulu University Hospital, Oulu, Finland, [2]Biotechnology Research Center, Tripoli, [4]Department of Pathology, University of Benghazi, Faculty of Medicine, Benghazi, Libya, [3]Department of Surgery, Division of Transplantation Surgery, The Ohio State University Wexner Medical Center, Comprehensive Transplant Center, Columbus, OH, USA

Address for correspondence: Prof. Nureddin Ashammakhi, Department of Surgery, Oulu University Hospital, P. O. Box 22, FI-90220 Oulu, Finland.
E-mail: nureddin.ashammakhi@oulu.fi

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