REVIEW OF THE LATEST TRENDS IN TRANSPLANTATION IMMUNOLOGY AND ITS ROLE IN MORTALITY REDUCTION

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ABSTRACT

Transplantation immunology deals with the process of moving cells, tissues, or organs, from one site to another, either within the same person or between a donor and a recipient. If an organ system fails, or becomes damaged because of disease or injury, it can be replaced with a healthy organ or tissue from a donor. The process of transplantation has become increasingly popular due to its life saving benefit. In 2015 /2016 4601 patients' lives were saved or improved by an organ transplant in the United Kingdom alone. Kidney transplants are the most common organ transplant followed by liver and pancreas. However, the complexity of the immune system of humans makes the process challenging. None the less immunosuppressive regimen has been introduced to reduce rejection and life-threatening consequences associated with transplant rejection. Data support the increasing benefit of the transplantation in the reduction of mortality for individuals with life threatening conditions improving their quality of life considerably. This work aims at exploring the overall benefit of transplantation in health care especially as it pertains to the reduction of mortality rate for patients in the United States and around the world.

Keywords: immunosuppressive, transplantation, immunology, recipient, mortality.

Keywords: Transplantation, immunology, immunosupression, antibody, antigen

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CHAPTER 1

INTRODUCTION

Transplantation is the process of moving cells, tissues, or organs, from one site to another, on the same person or between a donor and recipient of the same or different species. If an organ system fails, or becomes damaged because of disease or injury, it can be replaced with a healthy organ or tissue from a donor. Organ transplantation is a major operation and is only offered when all other treatment options have failed. Consequently, it is often a life-saving intervention. In 2019, 39,720 patient lives were saved or improved in the U.S by an organ transplant. Kidney transplants are the most common organ transplanted (23,401) followed by the liver (8,896) and heart (3,551), lungs and kidney/pancreas. However, whole organs are not the only types of transplant. The cornea, for example, is the most transplanted single tissue, with 5,734 procedures carried out in 2015/16. Hematopoietic stem cell transplantation (HSCT), often called blood and marrow transplantation (BMT), is another common tissue transplantation procedure. Used to treat a broad spectrum of diseases, though most commonly for blood or bone marrow cancers such as leukemia and lymphoma

Over the course of the last century, organ transplantation has overcome major technical limitations to become the success it is today. The process of transplanting a foreign organ such as a kidney to a different individual of the same species is called an allograft. On the other hand the recipient of the foreign organ experiences an auto immune response that is triggered by the immune system of the recipient whose body recognizes the new organ as an antigen resulting in an attack that involves the initiation of T-cells activation, and the consequent production of antibodies that causes allograft rejection or death. Although the challenges of transplantation

immunology in transplant rejection and complications have been overwhelming, however solid organ transplantations have been used to save lives of patients who have terminal organ failures as well as improve their life quality.

Patient's survival with renal transplantation have increased over dialysis and many other forms of transplants have been used to treat patients with lung, heart, liver, and other irreversible diseases. The results of organ transplantation continue to progress, both because of the new innovations and the improvements in pre and postoperative management. (Watson, 2012) Innovation in immunosuppression have led to the reduction of acute rejection and complications that can be fatal. Nonetheless the rate of transplantation activity is far from the global need. According to activity data reported to the Global Observatory on Donation and Transplantation (GODT) (World Health Organization 2012a), analysis from 2010 transplant activity for 95 countries, representing nearly 90% of the worldwide population, shows that ~106,879 solid organ transplants were performed worldwide: 73,179 kidney transplants (46% from living donors), 21,602 liver transplants (15% from living donors), 5582 heart transplants, 3927 lung transplants, 2362 pancreas transplants, and 227 small bowel. This activity increased 2.12% during 2009. Reports from studies show that from year 2000 and forward, there has been approximately 2,200 lung transplants performed each year worldwide.

The intensity of the immune response against the organ or tissue, also commonly referred to as the graft, will depend on the type of graft being transplanted and the genetic disparity between the donor and recipient. To reduce the possibility of rejection, the donor and recipient are carefully matched for immune compatibility prior to transplantation. However, the small pool of eligible donors can make it difficult to find a donor-recipient match and there will always be a

degree of rejection against the graft. A critical undersupply of donated organs means that waiting lists for transplants are extremely long. Patients needing a kidney transplantation, for example, wait on average 944 days (more than two and a half years) for a life-saving transplant. There were 6,943 patients registered for organ transplant in the UK as of March 2015.Unfortunately, 479 of these patients died during 2015/16 whilst waiting for a transplant due the small pool of transplantable organs. These figures underline the value of every organ and highlight the importance of a successful transplantation and maintaining long-term transplant survival. Manipulation of the immune system can support long-term survival of the graft ensuring that every transplant is as successful as possible.

From between 2000 and 2006, the median survival period for lung transplant patients has been 5-and-a-half years, meaning half the patients survived for a shorter time period and half survived for a longer period". Lung transplant can substantially improve the quality of life of recipient, although people have lived for ten or more years after a lung transplant, only about half the people who undergo the procedure are still alive after five years. These data underline the value of every organ; it highlights the importance of a successful transplantation and maintenance of long-term transplant survival. Manipulation of the immune system can support long-term survival of the graft ensuring that every transplant is as successful as possible. This review is therefore focused on testing the hypothesis that Transplantation is beneficial in reducing mortality rate as well as improving the quality of life among patients with irreversible health condition associated with terminal organ or tissue malfunction.

TYPES OF TRANSPLANTATION INVOLVING TISSUES AND ORGANS

AUTOGRAFT –Transplantation of cells, tissues or organs between sites within the same individual e.g. skin graft.

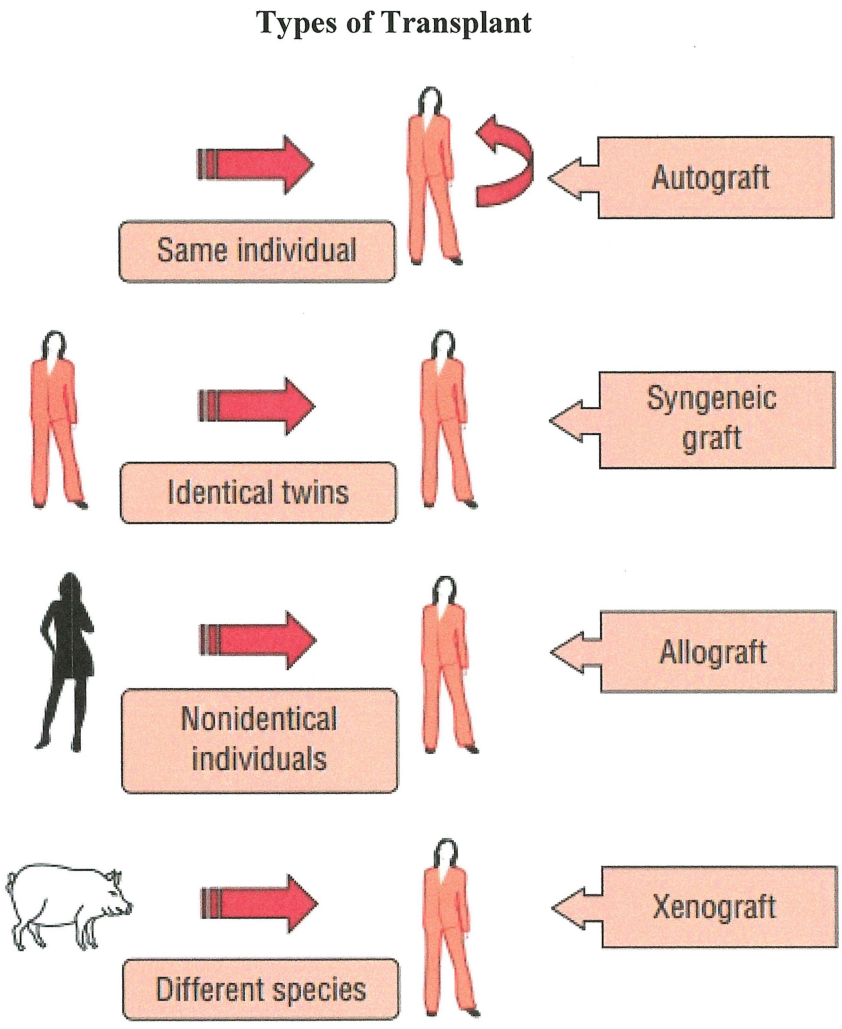
ALLOGRAFT – Transplantation of organs or tissues from a donor to a non-genetically identical individual of the same species. Allografts are the most common type of transplant.

XENOGRAFT – Transplantation of an organ or tissue between two different species. 'Pig valves', for example, are commonly used to repair or replace a defective heart valve in humans. Xenotransplantation of whole organs is not currently viable, although it is an area of huge scientific interest as a potential solution for the existing critical undersupply of adequate organs

ABO INCOMPARTIBLE – ABO refers to blood group, which can vary between individuals. For most transplant types, matching of blood group between donor and recipient is a key strategy in reducing rejection risk. However, blood group compatibility is not always required for transplantations. For example, in the case of very young children with immature immune systems, ABO incompatible transplants can be carried out with less risk of transplant rejection.

STEM CELL TRANSPLANT – Stem cells are cells that have the capacity to develop into a range of different types of cells in the body. Blood stem cells (hematopoietic stem cells) can develop into all the different cells found in the blood and are donated to replace damaged or destroyed blood cells. Hematopoietic stem cell transplants are used to treat certain types of cancer e.g. leukemia, and blood diseases where the bone marrow has become damaged preventing the production of healthy blood cells. These stem cells can be harvested either directly from bone marrow (see image on left) or from the cord blood (blood from the placenta and umbilical cord) from consenting mothers following childbirth.

Figure 1: Transplant Immunology and Types of Transplants (BrainKart.com)



The Immunology of Transplant Rejection

Distinguishing between self and non-self

When the immune system encounters a foreign organism, it mounts an attack against it to protect the body from infection. To prevent an attack on our own cells and tissues (autoimmunity), the immune system must be able to differentiate between our own healthy tissues and foreign invaders.

Foreign invaders are presented to the immune system in the form of small molecules called antigens. Identification of these non-self antigens will trigger an immune response and will stimulate the production of antigen specific antibodies that mark infected cells for destruction by the immune system and help amplify the immune response.

Mechanism of Rejection

Graft rejection occurs when the recipient's immune system attacks the donated graft and begins destroying the transplanted tissue or organ. The immune response is usually triggered by the presence of the donor's own unique set of HLA proteins, which the recipient's immune system will identify as foreign.

The degree of similarity between the HLA genes of the donor and recipient is known as histocompatibility; the more genetically compatible the donor and the recipient, the more tolerant the recipient's immune system should be of the graft. However, unless the donor and recipient are genetically identical (e.g. as in identical twins) there will always be some degree of rejection. As well as non-self HLA proteins, other surface proteins on the donor graft can also be identified as a foreign antigen and illicit an immune response.

Clinical Stages of Rejection

Hyperacute rejection

This occurs within minutes or hours after a transplantation and is caused by the presence of preexisting antibodies of the recipient, that match the foreign antigens of the donor, triggering an immune response against the transplant. These antibodies could have been generated because of prior blood transfusions, prior transplantations or multiple pregnancies. The antibodies react with cells in the blood vessels of the graft, causing blood clots to form, which will prevent blood supply from reaching the graft resulting in immediate rejection of the transplant.

Acute rejection

This occurs within the first 6 months after transplantation. Some degree of acute rejection will occur in all transplantations, except between identical twins. Recipients are most at risk in the first 3 months, but rejection can still occur at a later stage. Acute rejection is caused by the formation of antibodies following the detection of non-self-antigens in the donated graft. If diagnosed early enough, acute rejection can be treated by suppressing the immune system and permanent damage to the graft can be avoided in some cases.

Chronic rejection

Repeated episodes of acute rejection can ultimately lead to chronic rejection of the graft and failure of the transplant. Chronic rejection commonly manifests as scarring of the tissue or organ which can occur months to years after acute rejection has subsided. At present, there is no cure for chronic rejection other than removal of the graft.

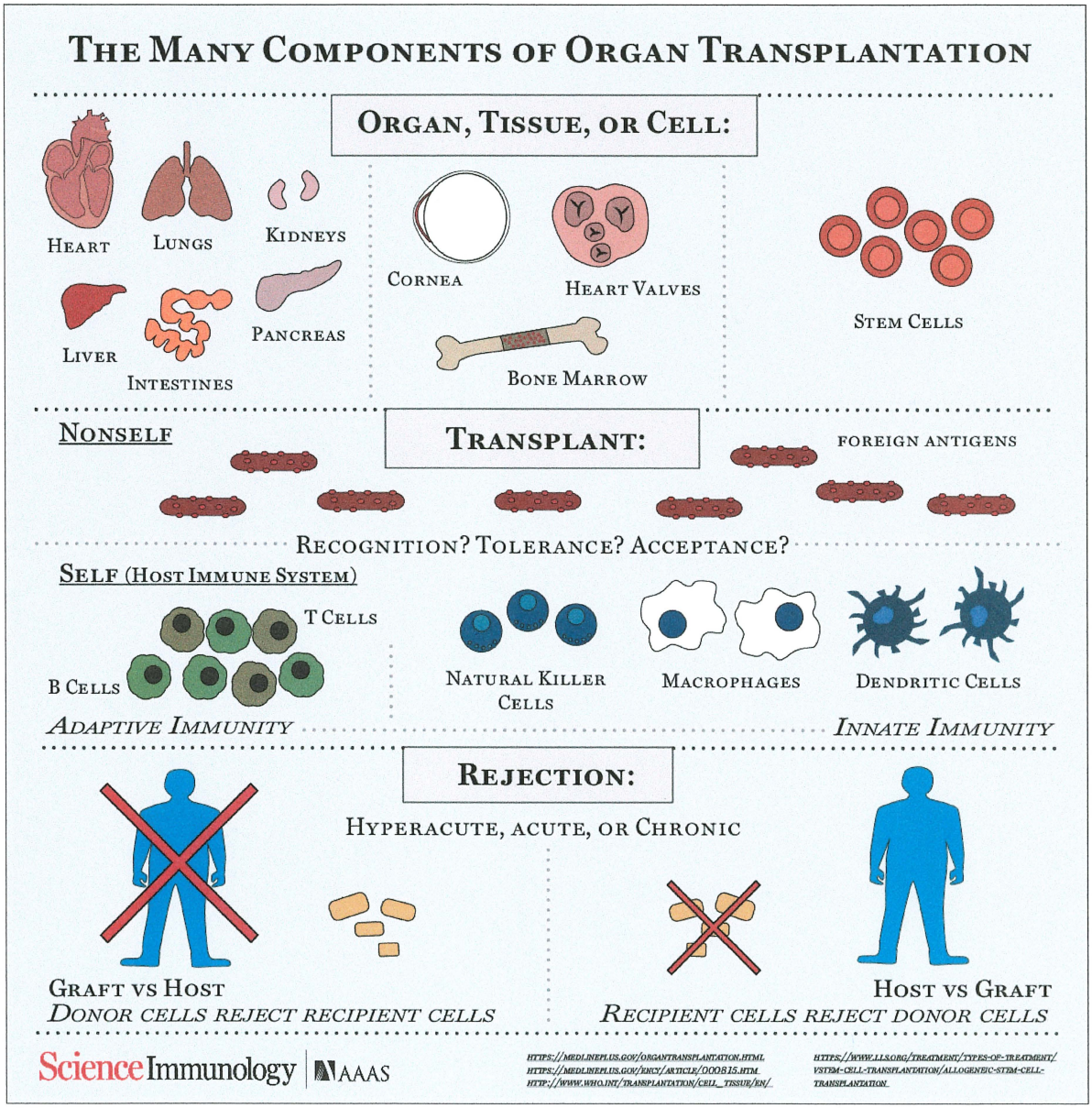
Immunosuppressive drugs

To reduce the risk of transplant rejection, patients are treated with immunosuppressive drugs that will dampen their immune response. Immunosuppressive drugs are given in two phases; an initial induction phase involving a high dose, and a later maintenance phase which involves using the drug in the long term at a lower dose.

The combination of drugs, and dosage given, will vary depending on the type of transplant and the chosen treatment regime. If a patient experiences an episode of acute rejection the drug combination is subject to change and the dosage is also likely to increase. Side effects can also cause alternative drugs to be used. Steroids, in the past, have been the most commonly used immunosuppressant drug. However, their use is being reduced due to the adverse side effects associated with them.

Immunological research has led to huge advancements in transplant medicine. However, immune rejection remains the most formidable barrier to successful transplantation. Continued research is needed to find ways to alleviate the risk of rejection, improve diagnosis and maintain long term survival of the transplant; all of which would have a significant impact on the strained organ supply.

Fig 2: During organ, tissue or cell transplant rejection, the foreign (non-self) graft is met by responses from both the adaptive and innate arms of the immune system (middle tier). Now, Dai et al. have discovered one source of the recipient's innate immune responses that drive donor rejection. Credit: Carla Shaffer / AAAS



CHAPTER II

METHODS

A qualitative analysis of the role of transplantation in the reduction of mortality rate. The study is based on available literature covering present and past organ transplantation studies. Scholarly peer reviewed articles and journals from Google scholar, PubMed and other trusted sources were used.

LITERATURE REVIEW

Peter Brian Medawar, a Brazilian born British zoologist is described by Thomas E Starzl (1995) as the father of the transplantation field, who at the age of 45 shared a Nobel prize for his work on acquired immunologic tolerance in 1960. After Macfarlane Burnet theorized that the ability of the body to distinguish between self and foreign tissues was acquired in the fetus stage. He successfully transplanted tissues between mouse fetuses without rejection. He also carried out new transplants on the adult mice which could not be done during the fetus stage. His work had since significantly impacted the field of organ transplantation.

Gooley. et al, 2010 in their research on reduced mortality after allogeneic Hematopoietic cell transplantation discovered that there was substantial reduction in the hazard of death related to allogeneic transplantation and improved long-term survival from the 1993–1997 period to the 2003–2007 period with an overall of 52%. It suggests that transplantation offers overall quality-adjusted survival benefit for myelodysplastic syndromes (MDS). These disorders are more common in patients aged $\geq$ 60 years and are incurable with conventional therapies. Pilmore , et al (2002) reported that cardiovascular (CVS) disease is the commonest cause of death in patients

with end-stage kidney failure and remains so in the kidney transplant population. Although the incidence of CVS death is markedly reduced in the transplant population compared with those on dialysis, it is significantly greater than that of the general population. Even though reduction in CVS death has occurred in the general population, this has not been reported in the renal transplant setting. During the 20th century, there was a marked reduction in the rates of CVS mortality in the general population, with U.S. death rates declining by more than 50% between 1980 and 2000. The mortality of patients who undergo dialysis has decreased by 26% since 1985 nut the mortality for dialysis patients is still far greater than that obtained among the general population and transplant patients. Another study by Grinyo (2013) reports that the total rates of hospitalization and readmission with dialysis have not shown any significant improvement in the last decade as per 1000 patient years; period-prevalent patients by age, gender, ethnicity, and primary diagnosis were 1889 in 1993 and 1856 in 2010. For transplant patients, the rates were 1020 in 1993 and 841 in 2010.

According to world health organization(WHO), 347 million people live with diabetes projecting that the number will double in 2005 to 2030 (World Health Organization 2012b). The complications associated with diabetes leads to deterioration of their clinical condition consequently reducing their life expectancy. Of a total of 57 million deaths during 2008, 36 million (63%) were attributable to non-communicable diseases, principally cardiovascular diseases (17 million), cancer (7.6 million), chronic respiratory diseases (4.2 million), and diabetes (1.3 million). Diabetes entails a high risk of End stage renal disease (ESRD) and premature mortality, even higher than in cancer patients. The mortality risk of patients with diabetes and nephropathy is higher than the average mortality rate of all types of cancer (Lambers Heerspink and de Zeeuw 2011). Recent studies have shown an increasing trend of

older patients on the waiting list, in the past decade more than 30% were 60 years or older. With an increase in the prevalence of older patients it has been observed that renal transplantation from deceased or living donor decreases mortality in elderly patients by more than 30% over those remaining in dialysis (ERA-EDTA Registry 2010).

Pauly et. al., (2009) studied the survival among nocturnal home Haemodialysis patients compared to kidney transplant recipients. They performed a matched cohort study that compared the survival between Nocturnal haemodialysis(NHD), deceased and living donor kidney transplantation (DTX and LTX). The association between the treatment modalities was determined by Cox multivariate regression. The results revealed a better survival rate with LTX (HR 0.51, 95% CI 0.28–0.91) while minimal difference was found between NHD and DTX ((HR 0.87, 95% CI 0.50–1.51; NHD reference group). This study suggests that LTX is a more suitable while DTX and NHD are comparable. It was further established that NHD can a suitable alternative in the absence of a living donor transplant serving as a bridge to transplantation especially in an era of extremely long wait list and shortage of organs.

According to Gruessner (2011), Patient survival now reaches over 95% at 1 year posttransplant and over 83% after 5 years. The best graft survival was found in SPK (pancreas transplantation that was performed simultaneously with a kidney) with 86% pancreas and 93% kidney graft function at 1 year. PAK pancreas graft function was 80%, and PTA pancreas graft function reached 78% at 1 year. The study reported Patient's survival at 5 years post-transplant, unadjusted survival rate reached 87% in SPK, 83% in PAK, and 89% in PTA. At 10 years post-transplant, more than 70% of recipients were reported to be alive. The highest patient survival rate was found in PTA (pancreas transplantation alone) recipients, with a 10-year patient survival rate of 82%. According to the corresponding registries, during the last part of 2011, 106 heart–

lung transplants were performed in the United States and 50 in Europe. The results of heart–lung transplantation have progressively ameliorated in the last 30 years, mainly owing to the reduction of early mortality. Recipients who survive the first year have generally good outcomes, with a half-life of 10 years conditional on surviving at least 1 year.

Benora-Centelles, et al. (2009), studied and applied strategies for renovating damaged cells after injury as an idea to boost cell therapy and regenerative medicine. Having identified stem cell plasticity hope is being continually raised for cell transplantation as an available measure in the near future. This procedure will result in replacing diseased hepatocytes while stimulating regeneration by stem cells. These are the main aims of liver-directed cell therapy.

Life expectancy and transplant effect, stratified by type of end-stage lung disease by Meester et.al., (2001) used the competing risk method, the Kaplan-Meier method to analyze waiting list outcome and global mortality, posttransplant survival and transplant effect, respectively were stratified for end-stage lung disease. The global mortality of the cohort revealed by the study was amounted to about 46% at 2years. The two year survival post transplant was 55%. When compared to continued waiting it was shown that patients with transplantation experienced more benefit by day 100 which was consistent through the two year period. The study observed the highest global mortality for cases of pulmonary fibrosis and pulmonary hypertension (54%and 52%) while emphysema patients experienced the lowest mortality (38%). Transplanting organs were found to benefit pulmonary fibrosis and cystic fibrosis much earlier on (At 55 and 90 days) for patients with emphysema they experienced benefits later at day 260.

Reports of the several benefits of transplantation in reducing mortality and improving quality of life are captured in many studies. A report by Bernand Christian was documented

when the first human heart transplant at Groote Schuur hospital in Cape Town was conducted. Washkansky, a South African grocer dying from chronic heart disease, received the transplant from Denise Darvall, a 25-year-old woman who was fatally injured in a car accident. Surgeon Christiaan Barnard, who trained at the University of Cape Town and in the United States, performed the revolutionary medical operation.

Mauer M, and Fioretto P. studied renal structure before and five and ten years after pancreas transplantation in non-uremic patients with long-term type 1 diabetes and established diabetic nephropathy lesions at baseline. Their research showed that Pancreas transplantation is the only available treatment which has restored long-term (10 or more years) normoglycemia without the risks of severe hypoglycemia.

This review article by Wakako Tsuji, and J Peter Rubin provides an overview on adipose-derived stem cells (ASCs) for implications in tissue regeneration. Adipose-derived stem cells obtained in high yields from copious adipose tissue in the body and have the ability to go into multi-lineage differentiation Thus, the review projects ASCs as promising tools for regenerating tissues and organs damaged by injury and diseases when transplanted. This article further reviews the implications of ASCs in tissue regeneration.

Late kidney transplant dysfunction is a suggested forerunner of graft disappointment, studies suggest that twenty percent to thirty percent of patients develop de novo donor-specific antibodies next to kidney transplantation. For several years, researchers thought that calcineurin inhibitor toxicity was the cause of graft dysfunction with fibrosis and transplant loss. This led to more exploration on other approaches, including splenectomy, bortezomib, and eculizumab.

The study of infectious complication in pulmonary allograft recipients by Dauber J.H et al., (1990) reports that better selection of donor lungs and prophylactic measures such as the "administration of broad-spectrum antibiotics and amphotericin B in the early postoperative period, and the chronic administration of trimethoprim-sulfamethoxazole reduced the rate of infection only and P. carinii, respectively. Despite these relative successes, however, the risk for infection of the allograft remains high because the defense mechanisms in the lung allograft are breached".

Hosenpud,, et al. (1999) , conducted a study on Lung transplantation and discovered that it still remains the only therapeutic option for patients with end stage lung disease. They concluded, that the underlying primary disease influences graft survival after lung transplantation in patients with pulmonary hypertension compared with all other patient and procedure dependent factors.

Kesten,(1994) studied the causes of death in lung transplant patients and discovered that lung transplant patient died mainly because of infection after the operation. The most common infection was reported to be bronchiolitis obliterans as the primary cause of death after lung transplantation.

In this study by Abendroth, et al .(1998) conducted by thermography revealed significant improvement in diabetic microvascular disease after successful pancreas transplantation was done. Am J. Pathol, (1998), studied the fate of porcine antigens in pig-to-primate xenotransplantation. It suggested that there was no antigen modulation. However, it is still possible that changes in antigen expression might have a role in long-term xenograft survival.

Aiuti et al.(2009), investigated the long-term outcome of gene therapy for severe combined immunodeficiency (SCID) due to the lack of adenosine deaminase (ADA), a fatal disorder of purine metabolism and immunodeficiency. The results showed that patients were alive after a median follow up of 4yrs with increase in T-Cell count as well as other significant improvement. Furthermore, they concluded on the need to use gene therapy with combined reduced-intensity conditioning as a safe treatment for SCID.

According to Altman et al. (2010), progenitor stem cells obtained from adipose tissue has gone beyond plastic and constructive surgery and is now becoming a focus for therapeutic medicine in the treatment of many disease conditions affecting areas such as bone, cartilage, muscle, liver, thus advancing the field of transplantation into regenerative medicine.

The literature reviews available reveals the benefit and importance of transplantation as it remains the only option in some end stage diseases or conditions for certain patients, however, healthcare providers and researchers continue to battle with the challenges of transplantation rejection, infection and the body's immunology as it wages war against the transplant that is perceived as a foreign entity. Advancement in immunosuppressive therapies continues to help combat death and prolong the longevity of these organs and the recipients at large.

CHAPTER III

DISCUSSION

The concept of transplantation immunology has advanced from allograft rejection to cellular and more recently to the molecular level. Immunosuppression is normally recommended as a combination of agents with different sites of action and different side-effect profiles, following similar principles to antimicrobial and antineoplastic chemotherapy. The first successful transplant therefore came about by avoiding an immune response altogether, which Joseph Murray's team achieved by performing a kidney transplant between identical twins.

In 2018, 36,528 transplants were performed, a new record high for the sixth consecutive year, in 2017, there were 16,473 Donors, 34,770 Transplants, and 115,759 Waiting list. Kidney transplants are the most common, followed by pancreas and liver transplants. More than 84,000 corneal transplants were performed in 2017 and over one million tissue transplants are performed each year. About 62% of organ recipients are male while the other 38% female. Furthermore, about 95 percent of patients with kidney transplants survive beyond 1 year, while majority of the tissue grafts last for the recipient's entire lifetime. Incredibly, 74 lives are saved each day as a result of this medical innovation.

This scientific innovation have empowered medical practitioners to perform more complicated procedures with success. Notwithstanding the most significant challenge in organ transplantation is small supply and large demand. People whose lives could be saved by an organ transplant die every day while waiting. Interestingly, most Americans, when polled, claim that they would like to donate their organs, but in practice, less than 50 percent do.

The literature reviews available reveals the benefit and importance of transplantation as it remains the only option in some end stage diseases or conditions for certain patients, however,

healthcare providers and researchers continue to battle with the challenges of transplantation rejection, infection and the body's immunology as it wages war against the transplant that is perceived as a foreign entity. Advancement in immunosuppressive therapies continues to help combat death and prolong the longevity of these organs and the recipients at large. Although recipients of solid organ suffer from transplant-inherent-related comorbidities, such as hypertension, new-onset diabetes mellitus, cardiovascular events, infections, and cancer, and in nonrenal transplants a high percentage of patients develop chronic kidney disease (CKD). Despite these limitations, solid organ transplants increase life expectancy and generally improve quality of life. In a systematic review of clinically relevant outcomes in adult kidney transplantation compared with dialysis, in addition to the reduction of mortality, renal transplantation compared with dialysis reduced cardiac events, heart failure, ischemic heart disease, hospitalization, and hospitalization for infection (Tonelli et al. 2011). Among the adult LT recipients population, increasing age has a gradual negative impact on survivals from 65% 10-year patient survival in recipients aged 15–45 years, 59% in 45–60 years, and 49% in patients ≥60 years. Despite the negative impact of donor and recipient age on LT outcomes, survival rates reported are considered clinically relevant in patients with life-threatening irreversible liver failure. Other transplant registries show similar data on LT (Scientific Registry of Transplant Recipients and OPTN Annual Data Report 2011).

The donor source also plays an important role in the survival advantage of kidney transplantation. Patients with living donor transplant survival is better than those with deceased donor transplant or NHD treatment. Furthermore, the quality of life and cost still favors transplantation treatment. With increasing incidence of ESRD it has led to an increase in the waiting list for organ transplant and organ shortage. Long-term exposure to conventional dialysis

has been associated with a reduction in patient and allograft survival. NHD are linked to poor cardiac outcomes it is also associated with patient centered locus of control, there's flexibility and improvement in life quality none the less the patient is hampered with a life sustaining therapy and complications related to dialysis. On the other hand, transplantation gives the patient autonomy while also exposing the patients to serious side effects that includes immunosuppression associated infections and malignancy, hypertension and post-transplant diabetes

TABLES AND GRAPHS

Figure 3: Incidence of acute rejection by 1 year posttransplant among afult kidney recipients by age, 2016 – 2017.

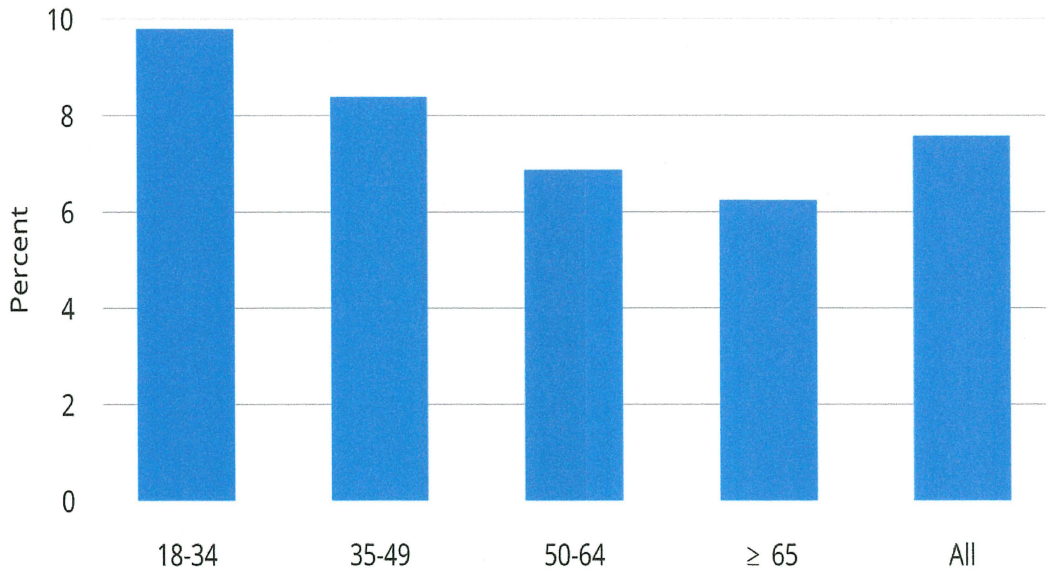
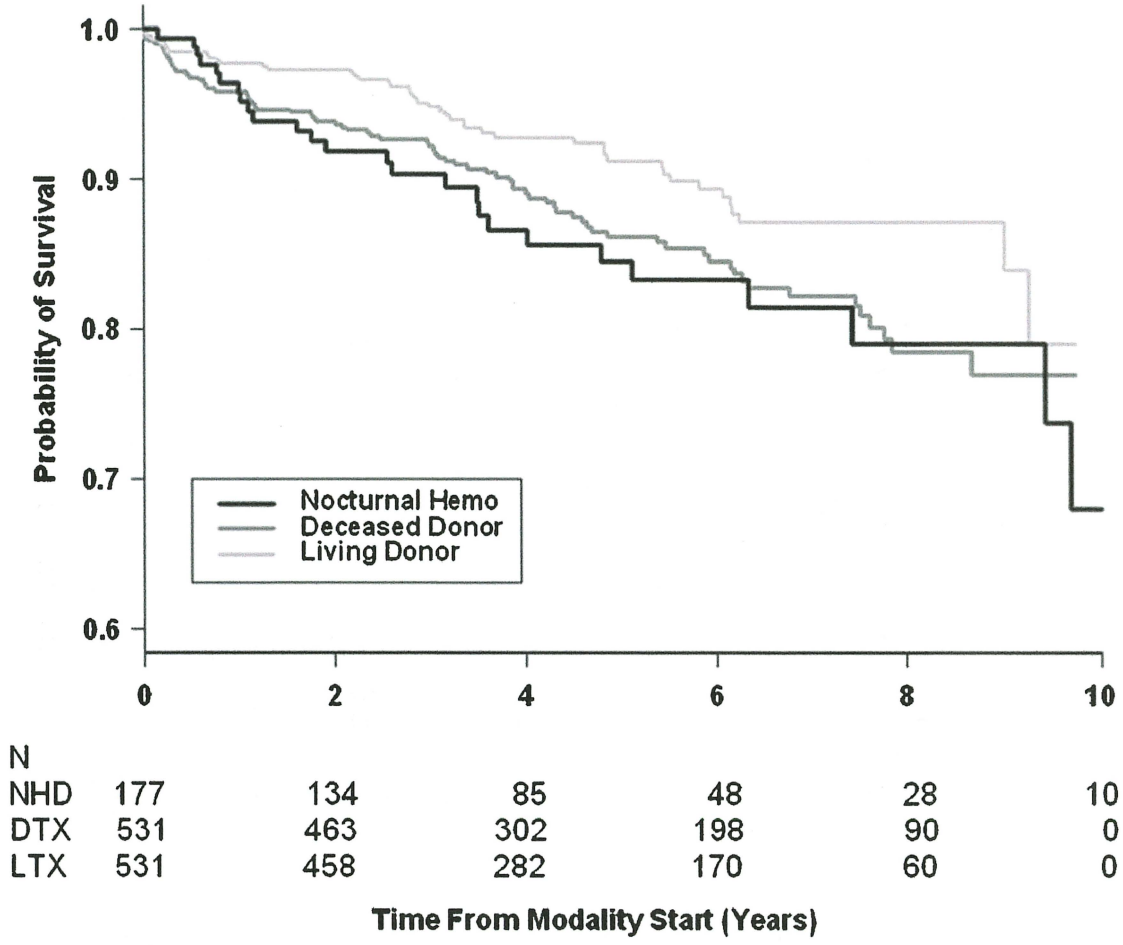


Table 1:
Unadjusted survival among nocturnal haemodialysis, deceased and living donor transplant recipients (intention-to-treat analysis)

	3-month survival	6-month survival	1-year survival	3-year survival	5-year survival
NHD	99.4%	99.4%	96.4%	90.3%	84.5%
DTX	98.1%	96.8%	95.9%	92.2%	86.2%
LTX	98.7%	98.5%	97.7%	94.9%	91.3%

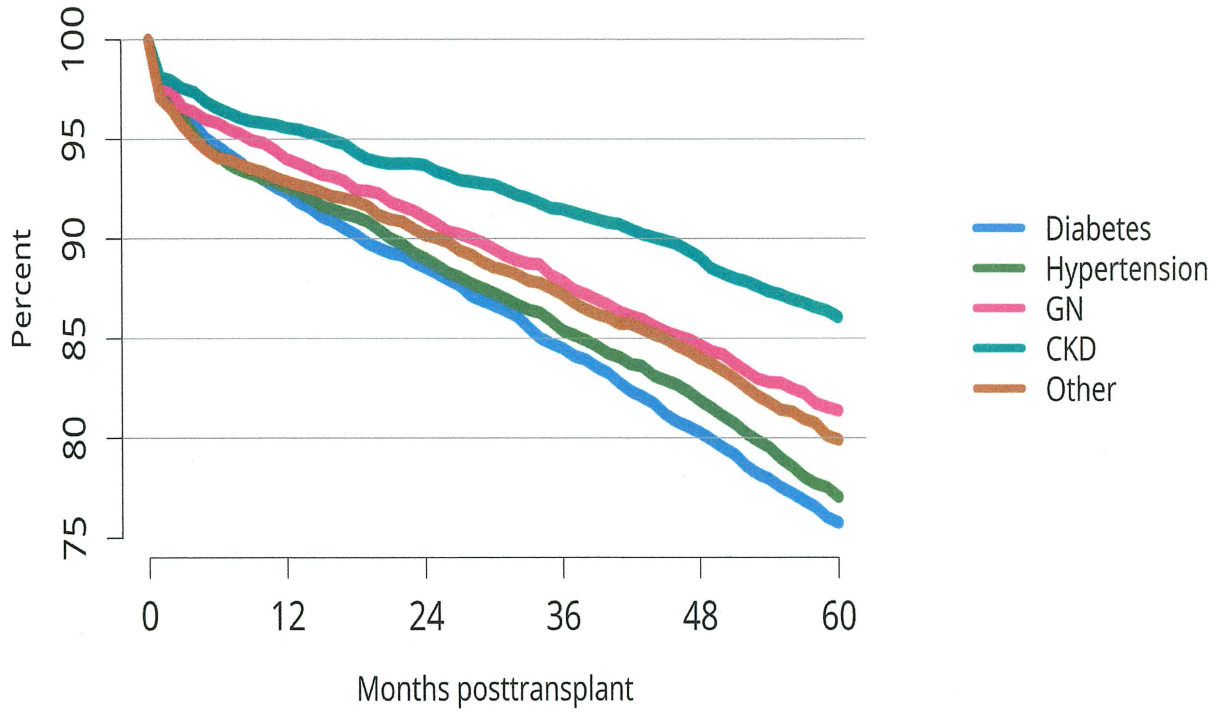
NHD, nocturnal haemodialysis; DTX, decease donor transplantation; LTX, living donor transplantation.

Figure 4 : Time to death in patients treated with nocturnal haemodialysis, deceased and living donor kidney transplantation (log-rank test, $P = 0.03$).



Robert P. Pauly, John S. Gill, Caren L. Rose, Reem A. Asad, Anne Chery, Andreas Pierratos, Christopher T. Chan, Survival among nocturnal home haemodialysis patients compared to kidney transplant recipients, *Nephrology Dialysis Transplantation*, Volume 24, Issue 9, September 2009, Pages 2915–2919, https://doi.org/10.1093/ndt/gfp295

Fig 5: Graft survival among adult deceased donor kidney transplant recipients, 2013, by diagnosis.



OPTN/SRTR 2018 Annual Data Report

Fig 6: Patient survival among adult deceased donor kidney transplant recipients, 2013, by age.

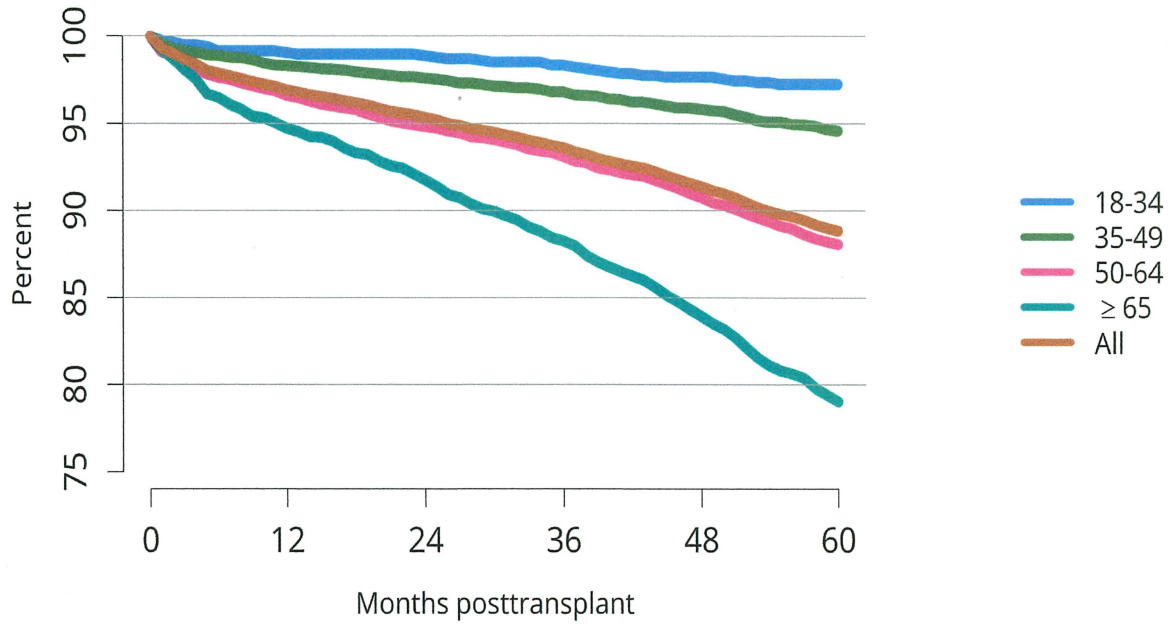


Table 2: 5-Year survival probalilities (cohort 2001-2005) in incident dialysis patients and transplant recipients (survival rates in %).

Age (years)	Dialysis	1st DCD	1st LDT
0–19		95.3	95.9
20–44	77.2	93.9	96.9
45–64	54.5	84.2	91.2
65–74	35.8	69.1	79.5
75+	19.9		

1st DCD, first deceased donor transplant; 1st LDT, first living donor transplant (ERA-EDTA Registry 2010).

Fig 7: Graft survival among pediatric kidney transplant recipients by age and donor type, 2009-2013.

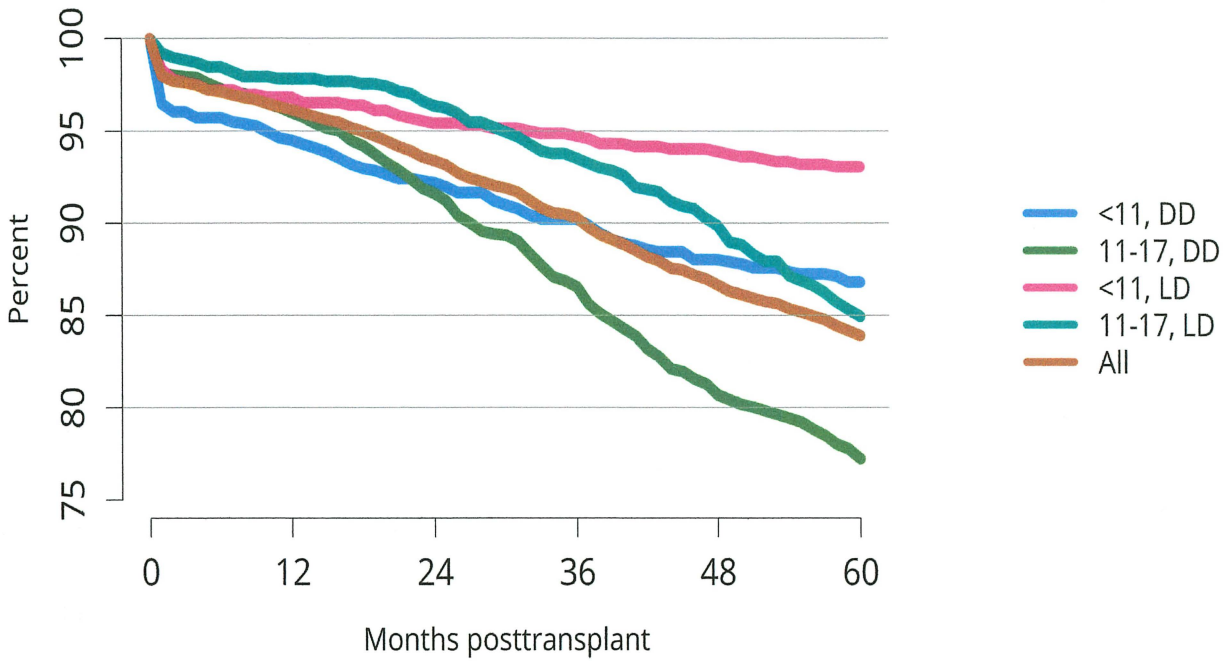
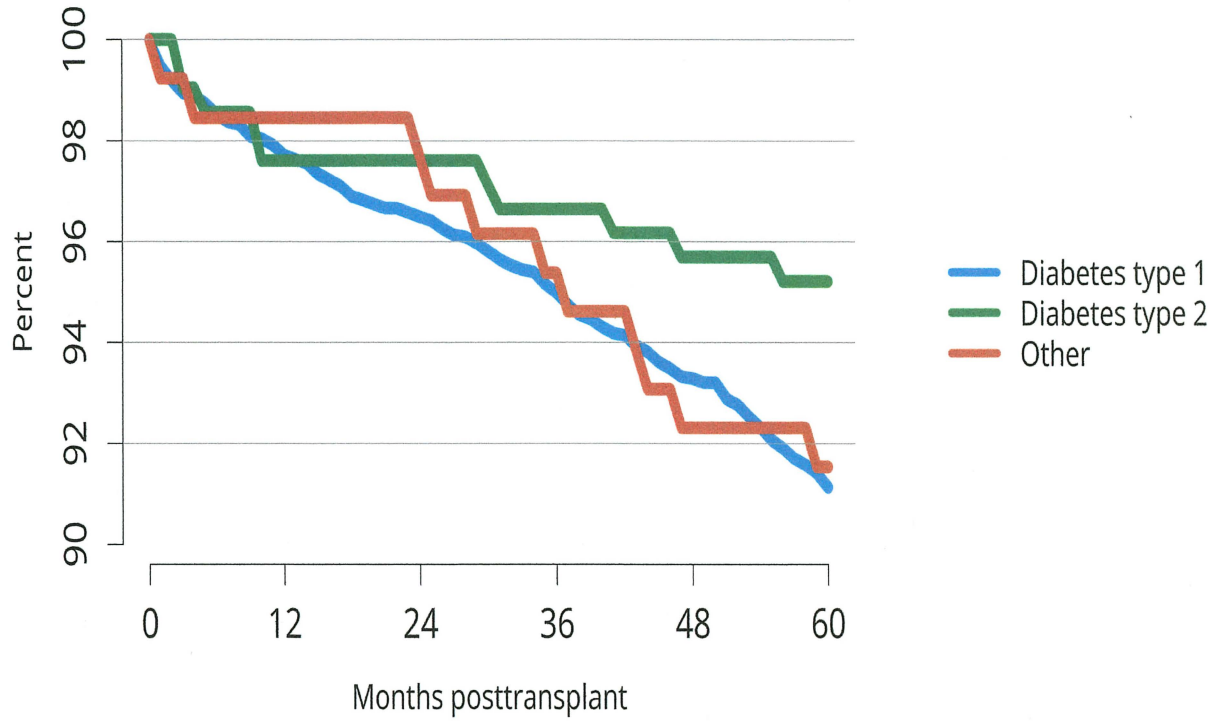


Figure 8: Patient survival among adult deceased donor pancreas transplant recipients, 2011-2013, by diagnosis.



CHAPTER IV

CONCLUSIONS

Results from this study is consistent with previous and recent studies where the impact of transplantation in mortality rate is exhaustively explored and examined. Solid organ Transplantation is key to survival for many patients whose lives depend on it and most times it remains the only option for their survival although the life expectancy post operation is optimal, however it is capable of prolonging and improving the patient's life and health as against the option of increased rate of mortality when transplantation is not done. There the study supports the hypothesis that transplantation reduces mortality in patients with end stage or terminal organ failure and other associated diseases.

Patients who received living donor transplants demonstrated favorable conditions than recipients of deceased organ transplant.

RECOMMENDATIONS

- Funding of clinical and basic science research.
- Use of stem cells for organ regeneration.
- Xenotransplantation (the transplantation of organs from other species into humans) through genetic engineering
- Awareness for more people to donate organs.

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