

Long-Term Outcomes of Kidney Transplant Recipients with Glomerulonephritides by Induction Type and Steroid Avoidance

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Abstract

Kidney transplant programs have totally different approaches to induction immunological disorder, and conflicting information exist on the role of steroid maintenance in recipients with Bright's disease (GN). GN patients are distinctive thanks to a better risk for system exhaustion because of previous exposure to immunosuppressants to treat their GN; this raises queries relating to the best immunological disorder required for transplant success and reduction of complications. we tend to sought-after to assess the result of induction kind and steroid maintenance on the recipient and excretory organ graft survival in those with immune globulin renal disorder (IgAN), general autoimmune disease connected GN (SLE), small-vessel inflammation (SVV), and anti-glomerular basement membrane illness (anti-GBM). we tend to analyzed the Scientific register of Transplant Recipients (SRTR) info for adult, primary excretory organ recipients with the higher than glomerulonephritides through Sep 2019. Kaplan-Meier curves were generated to look at excretory organ graft and recipient survival. we tend to used multivariable Cox proportional hazard models

to research the impact of induction kind and steroid maintenance in every cluster

severally. Our study enclosed 9176 IgAN, 5355 SLE, 1189 SVV, and 660 anti-GBM recipients. Neither induction kind nor steroid maintenance medical aid influenced recipient or death-censored graft survival during this cohort of recipients. Our findings give a chance for recipients with a history of 1 of the studied glomerulonephritides to receive a additional tailored immunological disorder regime, considering their previous exposure to immunosuppressants.

Keywords : glomerulonephritis; immunosuppression; corticosteroids; induction

Introduction

In the us, Bright's disease (GN) is that the etiology of end-stage nephropathy (ESKD) in roughly seven-membered of patients initiating qualitative analysis and therefore the third leading indication for urinary organ transplantation [1].

The mainstay of managing glomerulonephritides is immunological disorder to induce and maintain sickness remission. Steroid regimens, as well as pulse doses or maintenance, area unit often utilised in glomerulonephritides with the customary goal to wean or replace with alternative immunological disorder agents as presently as doable. For those unable to realize sickness remission, current sickness activity could result in end-stage nephropathy (ESKD), similarly as system exhaustion (loss of essential useful activity of immune cells like anti-viral activity and growth surveillance), and immune senescence (reduced proliferative capability of immune cells or replicative senescence) thanks to chronic matter stimulation and perennial treatment tries [2,3].

Given that GN patients generally endure transplantation throughout sickness remis- sion and have risk factors for useful immune exhaustion and replicative senescence, it's unclear if depletional induction immunological disorder is required. to boot, al- though AN increasing range of transplant recipients area unit managed with

a steroid-free program, there's conflicting knowledge on the role of steroid maintenance in recipients with Bright's disease [4–6]. consequently, we have a tendency to wanted to judge the role of induction immunosuppression and steroid rejection within the setting of urinary organ transplant recipients with a history of Bright's disease, as well as Ig renal disorder (IgAN), general lupus erythematosus-related GN (SLE), anti-glomerular basement membrane sickness (anti-GBM), and small-vessel rubor (SVV).

MATERIALS AND STRATEGIES

Knowledge supply

This study utilised knowledge from the Scientific written account of Transplant Recipients (SRTR). The SRTR system includes knowledge on all donor, wait-listed candidates, and transplant recipients within the us, submitted by the members of the Organ procural and Transplantation Network (OPTN). This study was approved by the University of Gopher State Institutional Review Board and was compliant with SRTR and HRSA knowledge user agreement. The study authors were included within the project style and were approved to participate by the SRTR. the information encompass solid organs and recipient characteristics, similarly as outcomes once transplantation.

Study Population

We examined all adult, primary kidney-alone recipients with IgAN, SLE, SVV, and anti-GBM sickness between 1996 and 2019. IgN cluster enclosed those with IgA renal disorder or Henoch-Schoenlein peliosis. The anti-GBM cluster enclosed those with Goodpasture syndrome or anti-GBM Bright's disease. The SVV cluster enclosed those with anti-neutrophilic living substance antibodies. The disseminated lupus erythematosus cluster enclosed those with lupus nephropathy being the first reason behind their ESKD. we have a tendency to enclosed solely recipients United Nations agency received induction with either a depletional or non-depletional agent and were discharged on tacrolimus and mycophenolate with or while not steroid maintenance. Depletional induction was outlined as receiving anti-thymocyte simple protein or alemtuzumab. Non-depletional induction enclosed recipients of interleukin-2 receptor antagonists (IL-2RA).

Patients were excluded if they received AN obsolete agent like Gopher State anti-white cell simple protein or OKT3, no induction (corticosteroids alone), twin induction with depletional and non-depletional or had missing induction knowledge. Recipients United Nations agency were discharged on any

various maintenance immunological disorder program apart from tacrolimus and mycophenolate were excluded.

Outcomes of Interest

The primary outcomes were ten-year recipient survival and death-censored graft survival (DCGS) consistent with the sort of GN. to boot, we have a tendency to evaluated the annual rejection rate by induction kind for every GN cluster.

Applied mathematics Analysis

Kaplan–Meier curves were generated to look at the first outcomes of interest in every of the teams one by one. Follow-up was expurgated at 10 years. Multivariable Cox proportional hazard models were utilised to analyze the impact of induction regimens and steroid maintenance in every GN cluster one by one. Models were adjusted for recipient and donor age, sex, race, recipient {diabetes|polygenic disorder|polygenic sickness} and peripheral tube-shaped structure disease, human blood corpuscle matter (HLA) matching, pre-transplant qualitative analysis standing and length, donor type, and payor kind. To account for between center variability, transplant centers were enclosed as a random impact. Subjects with missing knowledge for any of the covariates were excluded from the multivariable analysis.

RESULTS

Baseline Characteristics

Overall, the volumes of recipients with glomerulonephritides enlarged over the study quantity (Figure 1). Our study cohort consisted of 9176 recipients with IgAN, 5355 recipients with lupus, 1189 recipients with SVV, and 660 anti-GBM recipients. Baseline characteristics of the cohort square measure listed in Table one. lupus recipients were younger on the typical and loads of ostensibly to be female compared to the other groups. regarding race, white recipients were predominant among all groups. the foremost necessary cluster of Black recipients was discovered inside the lupus cluster constituting forty second (n = 2283). Among the groups, the majority of patients were on analysis before transplant. Panel reactive macromolecule (PRA) proportion was higher inside the lupus cluster. In terms of HLA matching, most patients in all groups received a internal organ with 4–6 matter mismatches. regarding disorder, the majority of patients in all groups received depletional induction and steroid maintenance treatment. the majority of patients with lupus, SVV, and anti-GBM malady were in public insured. On the contrary, 54.8% of IgAN recipients were privately insured.

The 10-year recipient (Figure 2) and internal organ death-censored graft survival (Figure 3) varied between recipients by GN type. Recipients with lupus nephritis had the poorest graft survival compared to different GN varieties, whereas SVV recipients had the poorest recipient survival.

Outcomes of Recipients with immune gamma globulin pathology

In the univariable analysis (Figure 4), there was no distinction in recipient survival or DCGS in patients World Health Organization received depletion induction or steroid maintenance treatment compared to folks that did not. In the multivariable analysis (Table 2), recipient survival wasn't associated with induction type (HR zero.83, 95% CI (0.67, 1.03), $p = 0.09$) or steroid maintenance treatment (HR 1.21, 95% CI (0.97, 1.51), $p = 0.08$). DCGS wasn't associated with induction type (HR 0.98, 95% CI (0.83, 1.15), $p = 0.78$) or steroid maintenance treatment (HR zero.97, 95% CI (0.83, 1.13), $p = 0.66$). As compared to recipients of a zero-antigen mismatched internal organ, lower DCGS was discovered in folks that received a internal organ with one–3 matter mismatches (HR one.47, 95% CI (1.08, 1.98), $p = 0.01$) or 4–6 matter mismatches (HR one.48, 95% CI (1.11, 1.99), $p = 0.01$). different predictors of recipient survival and DCGS square measure reportable in Table 2.

In the univariable analysis (Figure 5), there was no distinction in recipient survival in patients World Health Organization received depletion induction compared to folks that did not. Patients managed with steroid maintenance treatment had diminished recipient survival compared to folks that did not (overall log-rank $p = \text{zero.033}$). In terms of graft survival, DCGS wasn't associated with induction type or steroid maintenance. In the multivariable analysis (Table 3), recipient survival wasn't associated with induction type (HR one.04, 95% CI (0.86, 1.26), $p = 0.69$) or steroid maintenance treatment (HR 1.24, 95% CI (0.99, 1.57), $p = 0.07$). DCGS wasn't associated with induction type (HR 0.90, 95% CI (0.76, 1.06), $p = 0.21$) or steroid maintenance treatment (HR one.01, 95% CI (0.85, 1.21), $p = 0.91$). Recipients of a internal organ with 1–3 matter mismatches had improved survival compared to folks that received a zero-antigen mismatched internal organ (HR zero.71, 95% CI (0.52, 0.98), $p = 0.04$). There was no distinction in recipient survival in patients World Health Organization received a zero-antigen mismatched internal organ compared to folks that received a internal organ with 4–6 matter mismatches (HR zero.80, 95% CI (0.60, 1.06), $p = 0.12$). additional predictors of recipient survival and DCGS square measure coarctate in Table 3.

Outcomes of Recipients with Anti-GBM nephritis

In the univariable analysis (Figure 6), there was no distinction in recipient survival or DCGS in patients World Health Organization received depletion induction or steroid maintenance treatment compared to folks that did not.

In the multivariable analysis (Table 4), recipient survival wasn't associated with induction type (HR one.11, 95% CI (0.62, 1.98), $p = 0.73$) or steroid maintenance treatment (HR 1.19, 95% CI (0.66, 2.16), $p = 0.56$). DCGS wasn't associated with induction type (HR 0.73, 95% CI (0.40, 1.31), $p = 0.29$) or steroid maintenance treatment (HR one.03, 95% CI (0.60, 1.77), $p = 0.91$). Recipients of a zero-antigen mismatched internal organ had improved survival compared to folks that received a internal organ with 4–6 matter mismatches (HR 2.77, 95% CI (1.10, 6.91), $p = 0.03$). different predictors of recipient survival and DCGS square measure coarctate In the univariable analysis (Figure 7), there was no distinction in recipient survival in patients World Health Organization received depletion induction or steroid maintenance treatment compared to folks that did not. Patients World Health Organization received non-depletion induction had improved DCGS compared with folks that received depletion induction (overall log-rank $p = \text{zero.042}$). There was no distinction in DCGS in patients World Health Organization received steroid maintenance treatment compared to folks that did not.

In the multivariable analysis (Table 5), recipient survival wasn't associated with induction type (HR zero.96, 95% CI (0.70, 1.32), $p = 0.80$) or steroid maintenance treatment (HR zero.91, 95% CI (0.66, 1.25), $p = 0.56$). DCGS wasn't associated with induction type (HR zero.64, 95% CI (0.40, 1.04), $p = 0.07$) or steroid maintenance treatment (HR zero.88, 95% CI (0.56, 1.38), $p = 0.57$).

Secondary Outcomes

There was a statistically higher incidence of rejection inside the initial year among patients with lupus World Health Organization received depletion induction ($n = 366$ (11.1%) vs. $n = 79$ (8.4%), $p = 0.020$). Among patients with IgAN, anti-GBM, and SVV, there are no necessary variations between groups regarding rejection. further details square measure in Supplementary Table S1

Discussion

In this comprehensive study of sixteen,380 transplant recipients whose etiology of ESKD was either IgAN, SLE, SVV, or anti-GBM sickness, we tend to examined the association between induction sort and steroid maintenance on recipient survival and DCGS with contempo- rary immunological disorder

maintenance. Our findings counsel depletion induction and steroid maintenance medical care don't improve recipient survival or DCGS compared to non-depletional induction and steroid-free maintenance immunological disorder medical care. Transplant programs worldwide have differing approaches to induction immuno- suppression and steroid maintenance medical care supported patient characteristics. Previous studies observing the utilization of depletion agents have shown them to cut back the chance of early acute rejection, significantly in highly-sensitized recipients [7,8]. However, the long-run recipient and graft outcomes area unit comparable between IL-2RA and depletion induction agents [9]. Overall, additional patients received depletion induction than non-depletional induction in our cohort. it's unclear if this can be because of transplant program observe variability or if clinicians read GN patients as having the next medicine risk. Viewing GN patients as having the next medicine risk might not take useful immune exhaustion or the additive result of previous immunological disorder into consideration. Immune exhaustion and senescence area unit advanced processes that result in a state of dysfunctional T cells wherever patients area unit additional at risk of microorganism infections, have reduced tumour police work, associate degree have an impaired protein response to stimulatory factors [3]. Thus, it should be prudent to think about the chance of immune exhaustion associate degree replicative senescence in GN patients once selecting an induction agent. Our results counsel no additional advantage to mistreatment depletion agents within the studied GN populations, that echoes previous results on the role of induction use in transplant recipients in danger for system exhaustion, like those receiving kidneys when non-renal solid organ transplants [10-12]. in addition, among SLE recipients World Health Organization received depletion induction, there was associate degree exaggerated incidence of rejection within the 1st year. Moreover, a trend towards additional frequent graft loss because of GN return was ascertained in recipients of depletion induction (Supplementary Table S1). though the etiology of those findings is unsure, it should be associated with doable over immunological disorder and blood disease generally related to depletion agents, which can need a discount in immunological disorder or the utilization of white blood cell colony stimulating issue (G-CSF), increasing the chance of rejection and graft loss [13, 14]. Another theoretical mechanism is that the loss of regulative T cells (Tregs) with depletion induction. Previous information have shown that depletion induction may end up within the depletion of Tregs [15,16]. additionally to their role in graft tolerance, Tregs could play a necessary role in GN

sickness remission by counteracting the immune reaction and bettering kidney disease [17]. yet, the finding of exaggerated rejection related to depletion induction wasn't seen within the different 3 GNs. more analysis into potential reasons for the upper rejection rate in SLE kidney disease related to depletion induction would be useful.

Concerning corticosteroids, conflicting information exist on the role of steroid-free maintenance medical care in GN recipients. A previous study has shown exaggerated GN return with speedy steroid conclusion [5]. However, extra studies have shown no increase in graft loss with steroid-free regimens [18]. Overall, within the u. s., regarding common fraction of excretory organ recipients area unit discharged on a steroid-free regime. Between 2000 and 2006, the amount of patients on a steroid-free regime at discharge when transplant exaggerated from third-dimensional to thirty second [19,20]. The adverse effects of long-run corticosteroids area unit well documented. However, providing a steroid-free regime is related to a rather exaggerated risk of acute rejection and conflicting long-run outcomes, several clinicians still use steroid maintenance within the u. s.. In our cohort of GN patients, the utilization of corticosteroids as a part of immune suppression maintenance didn't lead to a major distinction in patient survival or DCGS. Our findings complement those of Leeaphorn et al.: like recipients with immunoglobulin A renal disorder, recipients with different GNs had no improvement in recipient or overall graft survival related to steroid maintenance [21]. Of note, in their adjusted analysis, steroid maintenance was related to less graft loss because of immunoglobulin A return. However, they didn't modify for induction sort, that has been shown to influence sickness return [22,23]. Since GN patients could have had extensive steroid exposure before transplantation to manage their native sickness, utilizing a steroid-free regime is appealing and may be thought-about.

Additional findings of interest embrace that among all four teams, older recipient age was related to improved DCGS. As humans age, they develop a relative state of immune deficiency because of multiple mechanisms, as well as reduced signal associate degree proliferation of lymphocytes in response to an matter [24], which can have contributed to the improved DCGS.

Similar to the end result of publically insured excretory organ recipients normally, recipients with IgAN, SLE, and anti-GBM had shrunken recipient survival compared to their in private insured counterparts [25]. it'll be of interest to assess this

association within the future, significantly when implementation of the recently approved period immunological disorder drug coverage bill [26].

Strengths and Limitations

Our study is one in all the foremost intensive studies of the impact of induction regimens and steroid maintenance in primary excretory organ recipients with completely different glomerulonephritides.

Compared to a single-center info, the SRTR info offered an outsized sample size. Additionally, we tend to selected definitive endpoints, that allowed for strong multivariable analyses.

However, our study should be understood with many limitations in mind. Like all written record studies, inconsistency in center reportage patterns might have light-emitting diode to missing or incomplete knowledge. Moreover, despite adjusting for the transplant year and also the variabilities at intervals and between centers, we tend to might not have absolutely accounted for residual confounders, as well as the age impact. Though we tend to reportable the proportions of graft loss thanks to perennial illness, we tend to couldn't analyze overall illness repetition because it is merely captured if repetition resulted in graft loss.

The lack of measured drug levels meant that we tend to couldn't analyze or account for exposure levels of maintenance immunological disorder. To boot, thanks to an absence of complete follow-up knowledge, we tend to couldn't judge the impact of induction immunological disorder on long infection, post-transplant lymphoproliferative disorders, or malignancies. Sadly, laboratory assessment of system operate isn't attainable within the retrospective SRTR info thanks to the shortage of a biorepository.

Conclusions

In this giant cohort of transplant recipients with IgAN, SLE, anti-GBM, and SVV, depletion induction failed to end in superior graft or recipient outcomes. Moreover, there was a considerably larger rejection rate in disseminated lupus erythematosus related to depletion induction. To boot, steroid maintenance medical aid failed to end in superior outcomes compared to steroid turning away. Therefore, a history of nephritis shouldn't exclude patients from steroid-free immunological disorder maintenance. Ultimately, our findings offer Associate in Nursing opportunity for recipients with a history of GN to receive a lot of tailored immunological disorder programme, considering their risk of practical system exhaustion.

REFERENCES

1. Lim, W.H.; Shingde, M.; Wong, G. Recurrent and de novo Glomerulonephritis After Kidney Transplantation. *Front. Immunol.* 2019, 10, 1944. [CrossRef] [PubMed]
2. Carney, E.F. T-cell exhaustion limits immune reactivity and is associated with good prognosis in autoimmune disease. *Nat. Rev. Rheumatol.* 2015, 11, 501. [CrossRef]
3. George, R.P.; Mehta, A.K.; Perez, S.D.; Winterberg, P.; Cheeseman, J.; Johnson, B.; Kwun, J.; Monday, S.; Stempora, L.; Warshaw, B.; et al. Premature T Cell Senescence in Pediatric CKD. *J. Am. Soc. Nephrol.* 2017, 28, 359–367. [CrossRef] [PubMed]
4. Matas, A.J.; Kandaswamy, R.; Humar, A.; Payne, W.D.; Dunn, D.L.; Najarian, J.S.; Gruessner, R.W.G.; Gillingham, K.J.; McHugh, L.E.; Sutherland, D.E.R. Long-term Immunosuppression, Without Maintenance Prednisone, After Kidney Transplantation. *Ann. Surg.* 2004, 240, 510–517. [CrossRef]
5. Kukla, A.; Chen, E.; Spong, R.; Weber, M.; El-Shahawi, Y.; Gillingham, K.; Matas, A.J.; Ibrahim, H.N. Recurrent Glomerulonephritis Under Rapid Discontinuation of Steroids. *Transplantation* 2011, 91, 1386–1391. [CrossRef]
6. Ibrahim, H.; Rogers, T.; Casingal, V.; Sturdevant, M.; Tan, M.; Humar, A.; Gillingham, K.; Matas, A. Graft Loss from Recurrent Glomerulonephritis Is Not Increased with a Rapid Steroid Discontinuation Protocol. *Transplantation* 2006, 81, 214–219. [CrossRef] [PubMed]
7. Brennan, D.C.; Daller, J.A.; Lake, K.D.; Cibrik, D.; Del Castillo, D.; Thymoglobulin Induction Study Group. Rabbit Antithymocyte Globulin versus Basiliximab in Renal Transplantation. *N. Engl. J. Med.* 2006, 355, 1967–1977. [CrossRef] [PubMed]
8. Miller, J.T.; Collins, C.D.; Stuckey, L.J.; Luan, F.L.; Englesbe, M.J.; Magee, J.C.; Park, J.M. Clinical and Economic Outcomes of Rabbit Antithymocyte Globulin Induction in Adults Who Received Kidney Transplants from Living Unrelated Donors and Received Cyclosporine-Based Immunosuppression. *Pharmacother. J. Hum. Pharmacol. Drug Ther.* 2009, 29, 1166–1174. [CrossRef]

9. Webster, A.C.; Ruster, L.P.; McGee, R.G.; Matheson, S.L.; Higgins, G.Y.; Willis, N.S.; Chapman, J.R.; Craig, J.C. Interleukin 2 receptor antagonists for kidney transplant recipients. *Cochrane Database Syst. Rev.* 2010, 2010, CD003897. [CrossRef] [PubMed]
10. Riad, S.; Alexy, T.; Jackson, S.; Goswami, U.; Martin, C. Kidney Allograft and Recipient Survival After Heart Transplantation by Induction Type in the United States. *Transplantation* 2021. [CrossRef] [PubMed]
11. Riad, S.; Goswami, U.; Jackson, S.; Hertz, M.; Matas, A. Induction type and outcomes for kidney graft and patient survival in recipients with prior lung transplantation in the United States. *J. Hear. Lung Transplant.* 2019, 39, 157–164. [CrossRef]
12. Riad, S.M.; Lim, N.; Jackson, S.; Matas, A.J.; Lake, J. Outcomes of Kidney Allograft and Recipient Survival After Liver Transplantation by Induction Type in the United States. *Liver Transplant.* 2021, 27, 1553–1562. [CrossRef] [PubMed]
13. Hurst, F.P.; Belur, P.; Nee, R.; Agodoa, L.Y.; Patel, P.; Abbott, K.C.; Jindal, R.M. Poor Outcomes Associated With Neutropenia After Kidney Transplantation: Analysis of United States Renal Data System. *Transplantation* 2011, 92, 36–40. [CrossRef] [PubMed]
14. Schneider, J.; Henningsen, M.; Pisarski, P.; Walz, G.; Jänigen, B. Impact of G-CSF Therapy on Leukopenia and Acute Rejection Following Kidney Transplantation. *Int. J. Organ. Transplant. Med.* 2021, 12, 1–8. [PubMed]
15. Sewgobind, V.D.K.D.; Kho, M.M.L.; van der Laan, L.J.W.; Hendriks, T.K.; van Dam, T.; Tilanus, H.W.; Ijzermans, J.N.M.; Weimar, W.; Baan, C.C. The effect of rabbit anti-thymocyte globulin induction therapy on regulatory T cells in kidney transplant patients. *Nephrol. Dial. Transplant.* 2009, 24, 1635–1644. [CrossRef]
16. Niu, Q.; Mendoza Rojas, A.; Dieterich, M.; Roelen, D.L.; Clahsen-van Groningen, M.C.; Wang, L.; Van Gelder, T.; Hesselink, D.A.; van Besouw, N.M.; Baan, C.C. Immunosuppression Has Long-Lasting Effects on Circulating Follicular Regulatory T Cells in Kidney Transplant Recipients. *Front. Immunol.* 2020, 11, 1972. [CrossRef]
17. Herrnstadt, G.R.; Steinmetz, O.M. The role of Treg subtypes in glomerulonephritis. *Cell Tissue Res.* 2020, 385, 293–304. [CrossRef]
18. Barbour, S.; Djurdjev, O.; Gill, J.S.; Dong, J.J.; Gill, J. A propensity score matched analysis shows no adverse effect of early steroid withdrawal in non-diabetic kidney transplant recipients with and without glomerulonephritis. *Kidney Int.* 2019, 96, 460–469. [CrossRef]
19. Luan, F.L.; Steffick, D.E.; Ojo, A.O. Steroid-free maintenance immunosuppression in kidney transplantation: Is it time to consider it as a standard therapy? *Kidney Int.* 2009, 76, 825–830. [CrossRef]
20. Augustine, J.J.; Hricik, D.E. Steroid Sparing in Kidney Transplantation: Changing Paradigms, Improving Outcomes, and Remaining Questions. *Clin. J. Am. Soc. Nephrol.* 2006, 1, 1080–1089. [CrossRef]
21. Leeaphorn, N.; Garg, N.; Khankin, E.V.; Cardarelli, F.; Pavlakis, M. Recurrence of IgA nephropathy after kidney transplantation in steroid continuation versus early steroid-withdrawal regimens: A retrospective analysis of the UNOS/OPTN database. *Transpl. Int.* 2018, 31, 175–186. [CrossRef] [PubMed]
22. Bartosh, S.M.; Knechtle, S.J.; Sollinger, H.W. Campath-1H Use in Pediatric Renal Transplantation. *Am. J. Transplant.* 2005, 5, 1569–1573. [CrossRef] [PubMed]
23. Riad, S.; Jackson, S.; Chinnakotla, S.; Verghese, P. Primary pediatric deceased-donor kidney transplant recipients outcomes by immunosuppression induction received in the United States. *Pediatr. Transplant.* 2021, 25, e13925. [CrossRef] [PubMed]
24. Nikolich-Zugich, J. Ageing and life-long maintenance of T-cell subsets in the face of latent persistent infections. *Nat. Rev. Immunol.* 2008, 8, 512–522. [CrossRef] [PubMed]
25. DuBay, D.A.; MacLennan, P.A.; Reed, R.D.; Shelton, B.A.; Redden, D.T.; Fouad, M.; Martin, M.Y.; Gray, S.H.; White, J.A.; Eckhoff, D.E.; et al. Insurance Type and Solid Organ Transplantation Outcomes: A Historical Perspective on

How Medicaid Expansion Might Impact Transplantation Outcomes. *J. Am. Coll. Surg.* 2016, 223, 611–620.e4. [CrossRef] [PubMed]

26. Congress.gov, Library of Congress. H.R.5534-116th Congress (2019–2020): Comprehensive Immunosuppressive Drug Coverage for Kidney Transplant Patients Act of 2020. Available online: <https://www.congress.gov/bill/116th-congress/house-bill/5534> (accessed on 24 December 2020).