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Review Article

Managing Immunological High Risk Kidney Transplant Patients In Nigeria, A Microcosm Of Resource-Constrained Setting; Evidence And Practice.

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Abstract

Background: Black patients awaiting transplantation are more likely to be immunologically sensitized than White, Hispanic, or Asian patients. In Nigeria, the situation is compounded by multiple blood transfusions before and during dialysis, including patients on the waiting list for kidney transplantation. Tailored immunosuppressive regimens and allocation policies are being explored to address the unique genetic and immunological profiles of Black patients and improve outcomes. Comparing practice in the selected Nigerian center with international and local guidelines on induction immunosuppression is the main crux of this review. This review focused on current practices in induction regimen for kidney transplantation in immunologically high-risk patients in a Nigerian transplant setting, explores its outcome and compares this practice and its outcome with practice in other centers and international kidney transplant guidelines.

Keyword searches of academic databases - PUBMED, SCOPUS, AJOL, Cochrane, ISI, Google scholar and IBSS databases were conducted. Manual searches of other relevant journals and reference lists of primary articles.

Anti-thymocyte globulin remains the choice of induction agent, with the same dose used for both non sensitized and highly sensitized patients. Induction regimen used in the index center was given for a shorter duration of 3-5 days when compared to standard guideline recommendations of 21 doses over 28 days. However, the 3-month and 12-month graft outcome obtained was 90% and 90%, respectively, in the index center; and this was comparable to the outcome in centers where the standard protocol was employed.

There is no change in the choice of immunosuppressive agent for kidney transplant in Nigeria and other centers and guidelines reviewed. With ongoing efforts to reduce the widening gap in transplant care by having an individualized approach to care, this narrative explores current practices in a resource-constrained setting as compared to guideline recommendations and provides a basis for future studies.

Keywords: Kidney transplantation, High risk, Highly sensitized, ATGAM, thymoglobulin, Nigeria.

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Introduction

Kidney transplantation remains the definitive therapy for many patients with end-stage renal disease, with advancements in surgical techniques and immunosuppressive regimens significantly improving short-term outcomes and patient survival.[1] The primary goal of post-transplant management is to prevent allograft rejection while minimizing the significant risks associated with potent immunosuppressive drugs, including infections and long-term toxicities. [2] A particularly challenging sub-population is **immunologically high-risk transplant patients**, such as those with high panel reactive antibodies or pre-existing donor-specific antibodies, who face a substantially elevated risk of acute and chronic allograft rejection.[3] To counter this, intensive induction immunosuppression with antibody therapy has become a standard approach at most transplant centers.[4]

However, the optimal choice of induction agent and treatment protocol for this specific high-risk group remains a subject of debate, with clinicians weighing the benefits of potent rejection prevention against the potential for increased adverse events. This narrative review provides a comprehensive overview of current induction immunosuppression strategies in immunologically high-risk transplant recipients in a Nigerian setting, comparing them with practice in some other transplant centers and clinical guidelines for managing kidney transplant patients. It reviewed the cost, efficacy and safety profiles of the drug used.

Methods: This is a narrative review. Keyword searches of academic databases - PUBMED, SCOPUS, AJOL, Cochrane, ISI, Google scholar and IBSS databases were conducted. Manual searches of other relevant journals and reference lists of primary articles. Articles published from 2000 to 2025 were included. Search terms included kidney transplantation, high risk, highly sensitized, raised Panel Reactive Antigen (PRA), positive donor-specific antibody, ATGAM, thymoglobulin, and Nigeria. Only de-identified programmatic data were used, and ethics approval was exempted.

Definition of immunological high-risk transplant

An immunologically high-risk kidney transplant is one performed in a patient who has a high probability of organ rejection due to pre-existing immune sensitization.[5] This is typically defined by the presence of pre-transplant antibodies that target a significant percentage of the potential donor pool, such as high Panel Reactive Antibodies (PRA) or specific Donor-Specific Antibodies (DSA). Other factors, like a history of multiple failed transplants, blood transfusions, or pregnancies, also increase this risk.[6] While race itself does not determine a patient's immunological status, studies have consistently found that Black patients awaiting transplantation are more likely to be immunologically sensitized than White, Hispanic, or Asian patients.[7] Nigeria is the most populous black country in Africa.[8] It is considered a resource-constrained setting, particularly in its health sector, due to a lack of adequate funding and infrastructure.[9] Despite being rich in natural resources, the country faces challenges in allocating sufficient resources to vital areas, which necessitate priority setting for investments in health care and research. In such a setting, the ability to provide care is limited due to a lack of resources, such as trained staff, diagnostic tools, and treatment options.[10]

In Nigeria, most patients with end-stage renal disease present late to the Nephrologist, with anaemia and uraemia necessitating the need for repeated blood transfusions during treatment, including intra-dialysis blood transfusion.[11,12] This contributes to the immunologic risk of most Nigerians planning to undergo kidney transplantation. Although a successful third kidney transplantation has been reported in Nigeria, in a 44-year-old woman with hepatitis B infection and diabetic nephropathy, the contribution of previous transplant sessions to the pool of sensitized patients in Nigeria is expected to be low, as only a few patients will be able to afford and hence be evaluated for a repeat transplant due to affordability.[13]

Critical reflection on the chosen protocol in my workplace

Background of my workplace: The Federal Medical Centre Umuahia is a 600 bedded tertiary hospital located in Southeast Nigeria, located in the capital city of Abia State and serves as a Teaching Hospital for a nearby Private University, Gregory University Uturu.[14] The hospital has a dedicated full-time specialist in almost all specialties including Urology and Nephrology. The Nephrology Unit was created in 2012 and offers care in basic Nephrology, hypertension and transplantation. The main causes of kidney disease in the environment include hypertension, diabetes, chronic glomerulonephritis, HIV infection and use of herbal concoctions.[15] Others include obstructive uropathy, unknown causes. The hospital has eight functional haemodialysis machines for both in-patients and out-patients, and offers haemodialysis for all categories of patients with kidney failure. With about 10 dialysis sessions per day, haemodialysis is the main modality of renal replacement therapy available in our centre. Facilities and practice of peritoneal dialysis exist, but mainly for paediatric patients with acute kidney injury. Facilities for vascular access creation exist; permanent neck vascular access and arterio-venous fistula are the main types created. Another interventional nephrology procedure obtainable is the renal biopsy, and a histopathologist with some exposure to nephropathology interprets the slides. However, at the moment of this review, only light microscopy is available for microscopic interpretation of renal biopsy slides.

Most of the patients with renal failure cannot afford adequate dialysis due to out of pocket mode of payment for healthcare services in Nigeria. In 2018, only 3,000 people were receiving haemodialysis in Nigeria, and 80% of these cannot sustain the treatment beyond three months, resulting in repeated hospitalization, poor quality of life and premature death.[16] Hence, kidney transplantation offers a lot of hope for living for all patients with end-stage kidney failure in Nigeria.

Kidney transplantation in Nigeria: Kidney transplantation started in Nigeria in the year 2000 in a private facility, St Nicholas Hospital, Lagos, Nigeria; and this was followed two years later by two government hospitals- Aminu Kano Teaching Hospital, Kano and Obafemi Awolowo University Complex Ile Ife Nigeria.[17] In 2023, there were about thirteen centres performing kidney transplantation, with a total number of 1,425 kidney transplantations done in the country so far. Only the living kidney donor programme is available in the country at the moment of this report, as there is no facility for deceased organ donation. In 2025, Lagos State, Nigeria, passed the Human Organ Harvesting and Tissue Transplantation Law, which creates a framework to regulate transplants and combat organ trafficking and pave the way for a deceased donor program in Nigeria.[18]

Kidney transplantation in Federal Medical Center Umuahia: Kidney transplantation at the Federal Medical Center Umuahia, Abia State, Nigeria, started in 2017, with thirteen kidney transplantations performed so far. It can be categorized as a low-volume transplant centre. The personnel involved include nephrologists, urologists, vascular surgeons, anaesthetists, cardiologists, psychiatrists, medical psychologists, dieticians, nephrology and transplant nurses, pharmacists, etc. At the conceptualization, training and early stages of the programme, the hospital was in partnership with the University of Toledo Medical Centre, Ohio, USA.[19] Kidney transplant surgeons, perioperative nurses and other manpower from the University of Toledo Medical Centre gave support to the programme. After six successful and successive surgeries performed, the transplant unit in Federal Medical Centre Umuahia has been able to perform Kidney transplant surgeries with Nigerian surgeons. The Kidney Transplant Protocol used in the centre is a hybrid of the protocol used at the University of Toledo Medical Centre and other local centres performing kidney transplantation in Nigeria. In this protocol, the drug of choice for induction immunosuppression is anti-thymocyte globulin (ATG). Although the protocol gave a chance for basiliximab to be used too, only anti-thymocyte globulin has been used successfully due to easy access from the manufacturing company or its representative pharmaceutical outlets in Nigeria. Table 1 shows some demographic, clinical characteristics and cost implications of the induction regimen used in transplants in the hospital so far, while Figure 1 is a Kaplan-Meier curve indicating the graft survival over

an eight-year period.[20] It shows that the three-month, one-year, three-year and five-year graft survival were 90%, 90%, 70% and 60%, respectively.

Table 1: Some demographics and clinical characteristics of transplanted patients showing high immunologic risk factors, induction agent, acute rejection, delayed graft function and infection rates

Sex/ Age (years)	**Native kidney disease**	**High immunologic risk factor**	**Induction medication-quantity/ cost ₦ ($)**	**Procurement lead time (days)**	**Acute rejection**	**DGF**	**Infection**
Male/ 40	Hypertension	None	12 amps/ N2,640,000.00 ($4,800)	10	No	No	No
Male/ 65	ADPKD	None	10 amps/ N2,200,000.00 ($4,000)	11	No	No	No
Male/ 39	CGN	Blood transfusion	12 amps/ N2,640,000.00 ($4,800)	11	No	No	UTI
Male/ 42	Hypertension	Blood transfusion and presence of DSA	14 amps/ N2,860,000.00* ($5,200)	14	No	No	CMV& UTI
Male/ 32	FSGS	Blood transfusion	14 amps/ N2,860,000.00* ($5,200)	10	No	Yes	UTI
Male/ 48	Diabetes	Blood transfusion	12 amps/ N2,640,000.00* ($4,800)	13	No	No	No
Male/ 29	Unknown		10 amps/ N2,310,000* ($4,200)	10	Yes	Yes	Yes
Male/ 47	Diabetes	Blood transfusion and presence of DSA	10 amps/ N3,150,000.00** ($4,200)	12	No	No	UTI
Male/ 51	Hypertension	None	12 amps/ N3,750,000.00** ($5,000)	10	No	Yes	No
Female / 18	Vasculitis	None	10 amps/ N3,150,000.00** ($4,200)	14	No	No	No

Male/ 58	Diabetes	Blood transfusion	14 amps/ N4,300,000.00** ($5,800)	14	Yes	Yes	UTI
Male/ 55	Hypertension	Blood transfusion	12 amps/ N7,800,000.00*** ($5,200)	10	No	No	No
Male/ 65	Diabetes	Blood transfusion	10 amps/ N6,300,000.00*** ($4,200)	13	No	No	No

CGN- Chronic glomerulonephritis; CMV- Cytomegalovirus, UTI- Urinary tract infection; DGF- Delayed Graft Function. *Based on dollar-naira exchange rate of 1USD to N550, **1USD to N750 and 1USD to N1,500

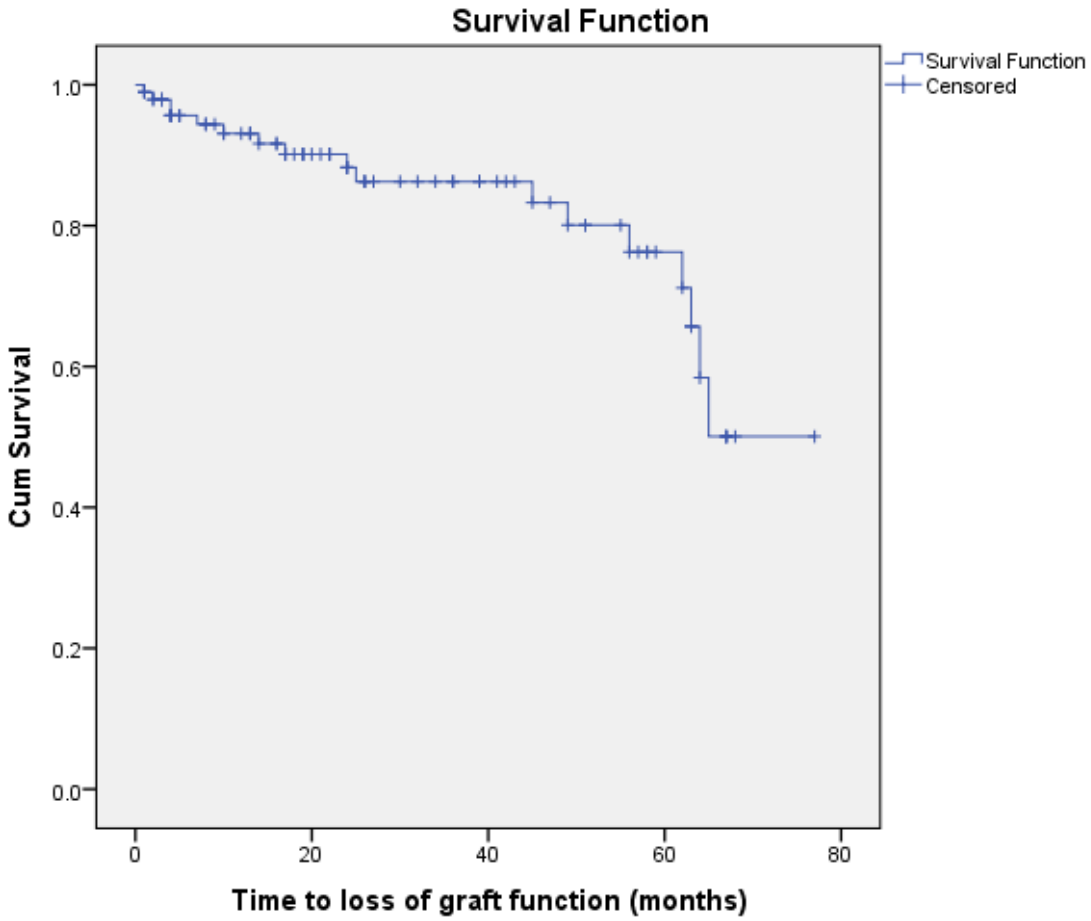

Figure 1: Kaplan-Meier curve showing cumulative survival of the graft over the time indicated

Relating activities in this area with evidence-based practice in my country and leading transplant centres in the world

In Canada, immunologically high-risk ESRD patients make up 30% of the wait-list but receive < 5% of the kidney transplants.[21]. In the United States, sensitized ESRD patients comprise nearly one-third of the UNOS wait-list and receive 14% of deceased donor (DD) transplants, a rate half that of non-sensitized patients.[22] The depleting antibody anti-thymocyte globulin been shown to be effective in preventing acute graft rejection in the face of a positive flow crossmatch.[23] In terms of mode of action, the depleting antibodies attach to target effector cells, which are the T-lymphocytes, leading to destruction mediated by complement activation and a significant reduction in circulating lymphocytes, resulting in impaired immunity mediated by the T-cells.[23] This is the desired response, which prevents allograft rejection in kidney transplantation.

According to US data, lymphocyte-depleting agents are the most commonly favoured as induction agents (54%), followed by non-depleting agents (24%).[24] In an open-label, prospective randomized controlled study conducted in France and Belgium over a 12-month period, 309 patients were allotted to be placed on either induction immunosuppression with ATG (n=151) followed by commencement of tacrolimus on day 9 or immediate tacrolimus-based therapy (n=158). In both study arms, the initial daily tacrolimus dose was kept at 0.2 mg/kg. Tapered doses of steroid boluses were given. Results of this study showed that at month 12, histologically proven acute rejections were recorded in 15.2% among induction group and 30.4% of patients in the non-induction group.[25] Thus, Induction treatment with ATG has the advantage of a lower incidence of acute rejection.

A retrospective study compared the efficacy of induction therapy [IL-2 receptor antibodies (IL2RA) or thymoglobulin] vs. no induction among 175 African Americans who were well matched for immunologic and demographic characteristics of interest.[16] The thymoglobulin group had notably higher-risk patients. Significantly fewer episodes of acute rejection occurred at one year in patients treated with thymoglobulin and IL2RA when compared to the no induction group (18% vs. 47%, $p = 0.003$, 26% vs. 47%, $p = 0.02$). In addition, there was a significant improvement in three-year graft survival in the IL2RA group compared to the non-induction group (85% vs. 68%, $p = 0.032$). Interestingly, there were similar graft survival rates between the thymoglobulin group compared to both the IL2RA group (76% vs. 85%, $p = 0.18$) and the non-induction group (76% vs. 68%, $p = 0.48$) despite being at high risk. Finally, multivariate analysis demonstrated that the risk of both acute rejection and graft loss is independently reduced on induction therapy (combining IL2RA and thymoglobulin).[27]

From the above studies, the use of ATG as induction therapy has been shown to be standard practice in world transplant leading centres. In the Federal Medical Centre, Umuahia, Abia State, Nigeria, Anti-thymocyte Globulin (equine type) (ATGAM) is the induction therapy of choice, administered at 10mg/kg for 3 days as shown in Table 2. Standard Induction doses range from 10-15 mg/kg/dose over 15-21 days. With limited resources and cost-constraints, we limited the duration of induction therapy of ATGAM to 3 days, but still have a graft survival comparable to other leading centers in the world. [20] Monitoring of ATG is with platelet and white cell count, and this is standard practice. Side effects such as thrombocytopenia and leucopenia are common and should result in subsequent dose adjustment. [28]

Table 2: Showing different types of anti-thymocyte globulin, brand name, recommended dose and local center practice

	Source animal designation	Brand name	Recommended dosage (R)	Local center practice
Antithymocyte Globulin	Equine ATG	ATGAM	10-15 mg/kg body weight daily for 15 days and then alternated day for 14 days; total 21 doses over 28 days	10mg/kg body weight for 3-5 days
	Rabbit ATG	Thymoglobulin	1.5mg/kg body weight for 3 days Or 4.54mg/kg total dose	1.5mg/kg body weight for 3 days

Laboratory monitoring of therapy with anti-thymocyte globulin

Laboratory monitoring of anti-thymocyte globulin (ATG) is crucial for balancing the need for sufficient immunosuppression to prevent transplant rejection with the risk of over-immunosuppression, infection, and delayed immune recovery. Monitoring allows for individualized dosing of ATG therapy, as patient responses and drug clearance can vary widely.[29]

The primary methods for monitoring ATG's effect are flow cytometry to measure T-cell counts and bioassays to measure active ATG drug levels.[30]

Flow Cytometry for T-cell Counts (CD3+ cells): This is the most common and accurate method to assess the immediate biological effect of ATG therapy.[31] Flow cytometry uses monoclonal antibodies (typically anti-CD3) to determine the absolute count of circulating T lymphocytes. The goal of therapy is often to reduce the T-cell count to below a specific threshold, such as less than 50 cells/µl or 100 cells/µl, depending on the specific protocol and clinical indication. This method is superior in accuracy and reproducibility compared to older methods like the E-rosette assay.[31]

Active ATG Level Bio-assays: These assays measure the concentration of active ATG protein in the patient's plasma or serum that is capable of binding to T-cells.[31] The active ATG concentration can be quantified using flow cytometry with target cells (e.g., Jurkat T-cells) or by advanced techniques like liquid chromatography-tandem mass spectrometry (LC-MS/MS) after immunoaffinity purification.[32] Monitoring active drug levels (therapeutic drug monitoring, TDM) allows clinicians to individualize the ATG dose to achieve a target drug exposure (area under the curve or AUC), which has been associated with better outcomes.

Total Lymphocyte Count (TLC): The total lymphocyte count from a routine complete blood count (CBC) can serve as a simple and inexpensive surrogate marker for T-cell counts.[33] A very low TLC (e.g., below 0.3 x 10^9/L) can be used as an indicator to temporarily hold or omit an ATG dose to prevent over-immunosuppression. However, the TLC is less specific and reliable than direct CD3+ T-cell counting, as it does not reliably predict T-cell levels when counts are higher, so CD3 analysis may be needed if the TLC rises above the low threshold.[34]

In addition to immune monitoring, other general laboratory parameters are routinely checked to manage potential side effects, and overall patient health, and these include:

Complete Blood Count (CBC): To monitor for leukopenia (low white blood cell count) and thrombocytopenia (low platelet count), which are common side effects and can necessitate dose reduction.

Comprehensive Metabolic Panel (CMP): To monitor liver and renal function, as ATG can affect these organs.

Infection monitoring: If there are concerns for infection (a major risk with immunosuppression), further labs like C-reactive protein (CRP), procalcitonin, and specific viral monitoring (e.g., CMV reactivation) may be ordered.

Other immunosuppressant levels: If used in combination, the blood levels of other drugs, such as cyclosporine or tacrolimus, are also measured.

Comparing our protocol with other kidney transplant protocols

We compare our protocol to international protocols and recommendations. Unlike our approach of using ATG for all our patients, in some kidney transplant programs, the choice of induction agent depends on the immunologic risk of the patients. In a kidney center in Germany, Eisinger et al reported a risk-adapted induction immunosuppression among 126 patients over a period of 40 months.[35] In their study, all potential recipients were risk stratified into immunologic low-risk, intermediate-risk and high-risk depending on their panel reactive antibody, number of HLA mismatches, presence of pre-formed donor-specific HLA antibodies and previous kidney transplantations. Low-risk group were defined as patients presenting for their first kidney transplantation and PRA 0% and ≤3 HLA antigen mismatches. Patients undergoing a re-transplantation of the kidney and/or PRA >0% - <85% and/or >3 HLA mismatches were classified as the intermediate risk group. High-risk immunologic group included those with ≥85% PRA or HLA-incompatible living donor kidney transplant. Patients in the low-risk group received Basiliximab 20mg on day 0 and day 4, those classified as intermediate risk group received ATG 1.5mg/kg body weight for three subsequent days (from day 0 to day 2), while high risk group received Alemtuzumab 20mg as a single dose on day 0.

After a follow-up period (median time of 1.9 [1.0-2.5] years), the kidney function (eGFR) was significantly higher in the intermediate group. There was no difference in delayed graft function across the groups and no difference in biopsy-proven acute rejection rates.

A French study across six transplant centers aimed at describing the prescription pattern for induction therapy among 4,157 patients over a six-year period.[36] The study discovered that all centers tended to align with international guidelines and preferred ATG induction therapy for all re-transplant patients or almost all immunological high-risk patients with anti-HLA class I or class II antibodies. Our protocol aligns with this guideline.

Also, the Kidney Disease Improving Global Outcomes (KDIGO) suggests the use of lymphocyte depleting agent in kidney transplant recipients with high immunologic risk, as its benefit in preventing acute rejection and graft failure outweighs its risk of increasing the rate of post-transplant infection.[37,38] While our protocol also aligned with this international recommendation, the KDIGO guideline was not clear if any of the depleting agents is superior to another, as meta-analyses do not appear to show any obvious differences in the effect of different lymphocyte depleting agents on acute rejection or death-censored graft survival.[38]

Compared with lymphocyte-depleting agents, the risk of CMV infection and malignancy is lower with interleukin 2 receptor antagonists (IL2-RA) like Basiliximab. While depleting antibodies are superior to prevent acute rejection, they are associated with more infections than IL2-RA.

One remarkable contrast between our protocol and others discussed above is the short duration of ATGAM. We administered ATGAM for a total of 3-5 days, whereas other protocols use the standard of 15 days and then alternate days for 14 days; a total of 21 doses over 28 days. Our reported graft survival at 3 months is comparable to 93.7% reported from a Netherlands study, [39] and 91.2% from a study in France.[40] Also, our one-year outcome is close to 95% from the US transplant registry[41] and 92% from a meta-analysis of global survival rates in children.[42]

Shortcomings in the implementation of the protocol in terms of patient's safety and how to address them

Patient safety places attention on safety in health care through the avoidance, reduction, documentation, and analysis of errors and other types of avoidable harm that frequently lead to unwanted patient events.

Shortcomings exist with the implementation of this protocol in the following areas.

1. Drug availability
2. Cost of medications
3. Side effect of medications

Drug availability: Anti-thymocyte globulin is not manufactured in Nigeria. It is supplied from outside the African continent in the USA, India, Germany, etc., and hence is not readily available. We have to ensure its availability prior to any preparation for kidney transplantation. With increasing kidney transplant centres in Nigeria using the ATG induction regimen, availability is increasingly becoming worrisome. Where available, it is expensive and contributes significantly to the overall cost of kidney transplantation. It takes an average of 10 to 14 days to transport ATG from the manufacturers to the Kidney transplant centre in focus (Table 1).

Cost of medication: The typical procurement cost of ATG ($400 per ampoule) is above the reach of common Nigerians, considering that for a 70kg patient, a total of 3 ampoules is needed per day for 3 days. Hence, $1,200 is needed for induction immunosuppression per day for three days (in our protocol), given a total of $3,600. The poverty rate in Nigeria is estimated to have reached 38.9% in 2023, with an estimated 87 million Nigerians living below the poverty line, as this translates to the world's second-largest population after India.[4]

This report, among other things, posits that nearly 40 percent of the total population earn below 137,430 naira ($381.75) per year. So an average Nigerian with end-stage kidney failure may not be able to afford medication. Out-of-pocket expenditure is the main modality of payment for health services in Nigeria. The existing health insurance programme has no coverage for kidney transplantation. This is a huge financial burden on patients, caregivers and family members and has a far-reaching consequence on kidney transplantation, as the majority who need it cannot get it done due to cost constraints.

Side effects of the medication: Side effects of ATG include Cytokine-release syndrome, leukopenia, thrombocytopenia, and venous thrombosis on administration through a peripheral vein.

Cytokine release syndrome: A cytokine release syndrome is a physiological condition in which there is an excessive and unregulated release of cytokines by the innate immune system.[44] Although cytokines are part of the normal functioning of the system, their release in large quantities can cause organ failure in the different body systems and death. Aetiologic agents can be infectious or non-infectious. Main infectious culprits include viral respiratory infections such as influenza, SARS-CoV-1, and SARS-CoV-2. Other causes include the EBV, group A streptococcus, and cytomegalovirus. Non-infectious conditions such as graft-versus-host disease are also documented.[45]

Leucopenia and thrombocytopenia: Anti-Thymocyte Globulin used for induction immunosuppression is non-specific for T-cells. In its composition are antibodies against other cell types, including different blood cells. Because these antibodies are cross-reacting against non-lymphoid cells, complications such as thrombosis, thrombocytopaenia, leucopenia and haemolytic anaemia are encountered.[46] Non-specific binding to white blood cells and platelets can be encountered at increased doses of ATG, causing transient leucopenia and thrombocytopenia.[47] The occurrence of ATG-induced leucopenia is variable, largely due to variation in dosing regimen and duration across the different kidney transplant centers. Incidence of Leucopenia, ranging from 10-50% have been reported in different studies.[48]

The main reason for adjusting or discontinuing the antithymocyte globulin dosage was low white blood cell count and thrombocytopenia or both. It is advised to consider withholding ATG with leucopenia of less than 2,000/mm^3, and reducing the dose by half if the WBC count is between 2,000-3,000/mm^3.[49]

Venous thrombosis: Infusing Anti-Thymocyte Globulin through the peripheral vein may lead to thrombosis of the peripheral veins.[50] Administering hydrocortisone and heparin in the same infusion solution may assist to reduce occurrence of this side effect. Administration of the infusion through a central vein is the recommended mode to avoid this side effect. Central catheter insertion is a common skill easily put into use in the surgical theatre to achieve this purpose in our centre. Occurrence of other side effects such as hives, fever, chills, joint pains, serum sickness, back aches and anaphylaxis is less frequent.

What other centres of transplantation can learn from our experience?

Based on our experience, we feel that this protocol gives us good comparable results. However, the following need to be learnt from our experience with regard to this protocol

1. Antithymocyte globulin should only be used by physicians with knowledge of different types (equine versus rabbit), brands (thymoglobulin, ATGAM, lymphoglobulin, ATG-Fresenius), dose and administration. The equine ATG has been replaced by the rabbit ATG. The rabbit ATG is better tolerated and has been found to be more effective for the prevention and treatment of rejection.[27] Equine ATG include ATGAM and Lymphoglobulin, while thymoglobulin and ATG-Fresenius are rabbit ATG. The dose of ATG varies depending on the brand. ATGAM 10-30 mg/kg, Lymphoglobulin 10mg/kg, Thymoglobulin 1.25-2.5mg/kg, ATG-Fresenius 1-5mg/kg.
2. All staff involved in the management of transplant recipients must be knowledgeable of the side effects associated with this medication. These include, but are not limited to, cytokine release syndrome, leucopenia, thrombocytopenia, venous thrombosis, hives, serum sickness and anaphylaxis. The medical and nursing team must be knowledgeable in the prompt and appropriate treatment of the side effects.
3. Due to the highly immunosuppressive nature of ATG, kidney transplant centres involved in this protocol should have a very good infection prevention and control protocol. The recipients should be nursed in a single room or a double isolation room.
4. It is good to exclude active infection in a recipient before induction therapy with antithymocyte globulin to prevent fulminant sepsis post-transplant.

5. ATG must always be given via a central line or a peripherally inserted central catheter in the antecubital fossa with its distal end in a central vein. Severe thrombophlebitis may occur if antithymocyte globulin is injected through a peripheral vein. We had a case of thrombophlebitis, hence we avoided this route of administration.
6. The responsible staff need to be fully aware of the concentrations of ATG in the given ampoule and administration. Each 5ml ampoule of ATG contains 250mg of horse gamma globulin. This is diluted in 1000ml of intravenous fluid of sodium chloride.
7. A test dose of ATG must be given one or two days prior to the surgery. It is important that this test dose is supervised by a doctor. To do this, give 100mg IV Hydrocortisone and 10mg Adrenaline intravenously, followed by administration of 5ml/hr of intended dosage for induction for the first hour. If there is a severe systemic reaction or anaphylaxis, then another induction regimen is chosen. On the day of surgery, pre-medication is given as above, followed by 10mg/kg of ATG through the duration of the recipient's surgery.

Modification of local practice to achieve good patient outcomes in the presence of available resources

It might be possible to modify local practice in the following areas.

1. Considering the cost implications of ATG in a resource-constrained environment like Nigeria, Kidney transplantation will be out of reach for common Nigerians. While it is non-compromising to change the induction protocol, the maintenance regimen can be modified to use cheaper alternatives to Tacrolimus. Cyclosporin-based immunosuppressive regimen, hence, becomes handy. Secondly, the existing National Health Insurance agency in Nigeria may need to incorporate kidney transplant care as part of its benefit package.
2. Also, patient selection for transplantation can be modified to include patients who can afford a transplant.
3. Modification of local practice to improve patient outcomes will also include advocacy for the involvement of the government to extend the coverage of the existing National Health Insurance Scheme in Nigeria to include kidney transplant surgeries.
4. Care of recipients during haemodialysis needs to be meticulous, as most patients with kidney failure in Nigeria are faced with the added financial burden of utilizing iron and recombinant human erythropoietin for control of anaemia of chronic kidney disease. Without meticulous attention to anaemia control, some patients receive numerous blood transfusions during dialysis, resulting in the pre-sensitized patients who find it difficult to get a compatible, negative cross-matched donor. The need for desensitization adds to the cost of care pre-transplant. Modification of pre-transplant care to reflect proper attention to anaemia control will be invaluable as the cost of kidney transplant preparation and surgery will be reduced, improving the acceptability of the induction protocol and cost.
5. Finally, local practice can be modified and improved by increasing the skill and number of personnel in Nigeria involved in kidney transplantation. Nigeria has a population of 230 million with only 13 kidney transplant centres. Among these transplant centres, just about 6 are actively involved in kidney transplantation; the others have tried and stopped for various reasons. Education programmes such as this masters degree programme serve as a veritable tool in improving the capacity of the health care personnel in kidney transplantation immunology, pre-transplant preparations, post-transplant care and research.

Limitations

There are certain limitations that call for caution in the interpretation of this review. First is that it is a single-centre experience with a low volume of kidney transplants and hence a restriction in generalizability of our findings. Secondly, the lack of a national registry on organ transplant in Nigeria makes it impossible to accurately assess the burden of highly sensitized patients on the waiting list. The consequences include heavy reliance on single-center data and a lack of planning for care of such patients, the absence of coordinated efforts for organ allocation and for future needs for the transplant program.

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