Brazilian Journal of TRANSPLANTATION

https://doi.org/10.53855/bjt.v26i1.515_ENG

ORIGINAL PAPER

Algorithm for Safe Hospital Discharge of Patients Submitted to Kidney Transplantation

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Section editor: Ilka de Fátima Santana F Boin

Received: May 19, 2023 | Accepted: May 31, 2023

How to cite: Girão CM, Sampaio EGM, Freitas TVS, Bachur TPR, Dallago CM. Algorithm for Safe Hospital Discharge of Patients Submitted to Kidney Transplantation. BJT. 2023.26 (01):e2123. https://doi.org/10.53855/bjt.v26i1.515_ENG

ABSTRACT

Objective: To develop and validate an algorithm for safe hospital discharge after kidney transplantation (ASDKTx). **Methods:** This is a methodological study of algorithm development based on the following steps: 1) literature review; 2) historical cohort study, carried out in a reference transplant hospital in the city of Fortaleza - Ceará, including all isolated kidney transplant recipients, adults and children, that occurred between June 2017 and June 2019, who were discharged from the hospital for outpatient follow-up (n=265); 3) construction of the algorithm from the scientific evidence obtained in the literature review and information from the cohort study; 4) validation of the algorithm by expert judges, with the evaluation of the instruments in the domains: Objectives, Structure and Presentation and Relevance. **Results:** The sociodemographic profile of the patients in this study converges with the national literature. The overall mean length of hospital stay (HS) was 11 days, seven for living donor recipients and 11 for those who received a deceased donor transplant. The main early complications were: infection (25.6%), delayed graft function (31.6%), and surgical complications (8.3%), seven (2.7%) patients had rejection. All complications were associated with HS prolongation. The ASDKTx was validated by 19 expert judges in kidney transplantation, who considered the instrument adequate to support professionals in making decisions about patient discharge. All items of the evaluated dimensions presented an excellent Content Validity Index (CVI) equal to 1.00. Thus, the CVI of each domain was equal to 1.00, with a total CVI = 1.00. In the binomial analysis, the items presented p = 0.135, indicating no disagreement between the judges in the assigned score. The comments and suggestions supported the changes in the instrument that made it possible to define the final version of the algorithm. **Conclusion:** Given the common context of prolonged HS, an algorithm for safe discharge can be an essential strategy to improve understanding of the post-transplant care line and assess each patient for an early and safe discharge.

Descriptors: Kidney transplantation; Postoperative Complications; Patient Discharge; Hospitalization Time; Algorithms.

Algoritmo para alta hospitalar segura do paciente submetido a transplante renal

RESUMO

Objetivo: Desenvolver e validar um algoritmo para alta hospitalar segura pós-transplante renal (AASTxR). **Métodos:** Trata-se de um estudo metodológico de desenvolvimento de algoritmo elaborado a partir das seguintes etapas: 1) revisão de literatura; 2) estudo de coorte histórica, realizado em hospital de referência em transplante na cidade de Fortaleza – Ceará, sendo incluídos todos os receptores de transplante de rim isolado, adultos e crianças, ocorridos entre junho de 2017 e junho de 2019, que receberam alta hospitalar para seguimento ambulatorial (n=265); 3) construção do algoritmo a partir das evidências científicas obtidas na revisão de literatura e em informações do estudo de coorte; 4) validação do algoritmo por juízes especialistas, com avaliação dos instrumentos nos domínios: Objetivos, Estrutura e Apresentação e Relevância. **Resultados:** O perfil sociodemográfico dos pacientes deste estudo converge com a literatura nacional. A média geral de tempo de hospitalização

(TH) foi de 11 dias, sendo sete para os receptores de doador vivo e 11 para os que receberam transplante de doador falecido. As principais complicações precoces foram: infecção (25,6%), função tardia do enxerto (31,6%), complicações cirúrgicas (8,3%); sete (2,7%) pacientes apresentaram rejeição. Todas as complicações foram associadas ao prolongamento do TH. A validação do (AASTxR) foi realizada por 19 juízes especialistas em transplante renal, que consideraram o instrumento adequado para apoiar os profissionais na tomada de decisão sobre a alta do paciente. Todos os itens das dimensões avaliadas apresentaram Índice de Validade do Conteúdo (IVC) excelentes, iguais a 1,00. Assim , o IVC de cada domínio foi igual a 1,00, com IVC total = 1,00. Na análise binomial, os itens apresentaram p = 0,135 indicando não haver discordância entre os juízes na pontuação atribuída. Os comentários e sugestões subsidiaram as modificações no instrumento que possibilitou a definição da versão final do algoritmo. **Conclusão:** Diante do contexto comum de TH prolongado, um algoritmo para alta segura pode consistir em importante estratégia para melhorar a compreensão sobre a linha de cuidado no pós-transplante e avaliação de cada paciente para uma alta precoce e segura.

Descritores: Transplante de Rim; Complicações Pós-Operatórias; Alta do Paciente; Tempo de Internação; Algoritmos.

INTRODUCTION

Kidney Transplantation (KTx) is considered the therapy of choice for end-stage chronic kidney disease (ESKD) because it provides the patient with a better quality of life, independence from the dialysis machine, non-limitation of water and food, and because it correlates with better indices of morbidity and mortality, in addition to being considered the best clinical and financial alternative when compared to dialysis.[1]

The recipient of a KTx is more susceptible to clinical and surgical complications when compared to patients undergoing conventional surgery. Complications result from the complexity of the surgery, the patient's comorbidities, immunosuppression and different epidemiological exposures between donor and recipient. Such complications can affect graft and recipient survival, directly linked to increased hospitalization time.[2]

Reducing costs associated with transplants and providing safe patient discharge have been the biggest challenges faced by transplant centers. Several factors, including drug costs, especially in the case of infections and rejections, immunological characteristics of recipients and donors, and the need for dialysis after transplantation, are considered responsible for the increase in treatment costs. However, most of the total cost of the process is directly linked to the duration of hospitalization.[3]

Evaluating these factors and complications in the postoperative period of patients undergoing KTx leads to searching for and encouraging interventions to prevent and/or recover from complications. The elaboration of an algorithm based on scientific evidence may provide technical, clinical, financial and administrative subsidies to improve care for transplant patients.

In this context, the objective of the present study was to build and validate an algorithm for safe hospital discharge of patients undergoing kidney transplantation.

METHODS

The following is a methodological study for developing an instrument, referred to as an algorithm, based on a bibliographic review and a historical cohort study. This methodological resource aims to investigate, organize and analyze data to build, validate and evaluate research tools and methods.[4]

In conducting this research, the ethical principles determined in Resolution 466/12 of the National Health Council, referring to research with human beings, were respected. The project was submitted to the Ethics and Research Committee of the Hospital Geral de Fortaleza (HGF) through the Plataforma Brasil and approved following opinion No. 3,348,699.

The study was developed in four phases: 1. Literature review; 2. Historical cohort study; 3. Construction of the algorithm; 4. Validation of the algorithm.

Literature review

Based on bibliographical research in July 2020, the literature review was conducted to identify and analyze scientific evidence and relevant and guiding information with indications for hospital discharge of the patient undergoing KTx. The following bibliographic databases were used: The Cochrane Library, Scientific Electronic Library Online (SciELO), Medical Literature Analysis and Retrieval System Online (MEDLINE), through the Higher Education Personnel Improvement Coordination (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior-CAPES*) Periodicals Portal; Bibliographical consultations were also carried out in books in the area published from 2010 onwards.

From the delimitation of the theme and definition of the databases, we proceeded with the definition of the controlled descriptors, using the health terminology consulted in the Descritores de Ciências da Saúde (DeCS)/*Medical Subject Headings* (MeSH), having applied the terms: *Transplante de Rim; Complicações Pós-Operatórias; Alta hospitalar; Tempo de Internação e Algoritmos* / Kidney Transplantation; Postoperative Complications; Hospital Discharge; Length of Hospital Stay; Algorithms.

Historical cohort study

Conducting the historical cohort aimed to identify characteristics of the population of kidney transplant patients in the study, perform an analysis of the predictive variables that were most associated with prolonged hospitalization in this population and, through the function of the graft after kidney transplantation, trace the profile of the patients, information that subsidized the construction of the algorithm.

The choice of the HGF as the location where the research was carried out was due to it being a reference center for the North and Northeast in high complexity assistance, a reference in kidney, liver and pancreatic transplants, and being an institution of assistance, teaching and search.

Kidney transplant recipients from living and deceased donors, adults and children who underwent surgery between June 2017 and June 2019 at the HGF were included. Patients who died or were transferred before discharge and underwent a double transplant were excluded.

Data collection was retrospective, through the analysis of pre-and post-transplant outpatient follow-up records, the records of the Customer Service Center and records in electronic records specific to the institution's kidney transplant; data were collected using an instrument developed by the authors.

The following variables were collected from the pre-kidney transplant recipient: age, biological sex, body mass index (BMI), primary kidney disease (a disease that led the patient to develop ESKD), type of renal replacement therapy (hemodialysis, peritoneal dialysis or preemptive transplant), time on dialysis, presence of diabetes mellitus (DM), presence of systemic arterial hypertension (SAH), retransplantation, hypersensitized recipient [for the service, the recipient is considered to be reactive with antibodies against a panel of HLA antigens (panel -reactive antibody-PRA) greater than 50% and donor-specific antibodies (DSA) positive with mean fluorescence intensity (MFI) greater than 1500].

The variables of immediate post-transplant evolution were also evaluated: length of hospital stay until discharge (HS), the occurrence of clinical complications (infections and/or early rejection, defined here as the one that manifested itself up to the moment of the first discharge) and surgical complications. (urinary fistula, surgical wound dehiscence (SWD), arterial and venous thrombosis, hematoma and others), daily serum creatinine level (pre-transplantation and from the 1st postoperative day (POD) to the 14th POD or until discharge) and graft function (immediate function, slow function and delayed graft function).

The criteria used to define each type of graft function were: 1) immediate graft function: abundant diuresis and rapid drop in serum creatinine (Cr), characterized by serum creatinine levels < 3 mg/dL on the 5th POD; two); slow graft function: diuresis is noticed from the beginning, but the patient does not need dialysis, and Cr drops slowly over the days. Cr is ≥ 3 mg/dL on the 5th POD; and 3); late graft function: need for dialysis in the first seven days after KTx.

In addition to having the median in days of hospitalization (day of admission for the transplant until hospital discharge), the duration of DGF was also subdivided by a number of dialysis procedures, with DGF1 corresponding to one dialysis, DGF2, characterized by two to five dialysis and DGF3 above five dialyzes, always considering the number of dialyzes performed from the transplant until the last one before hospital discharge.

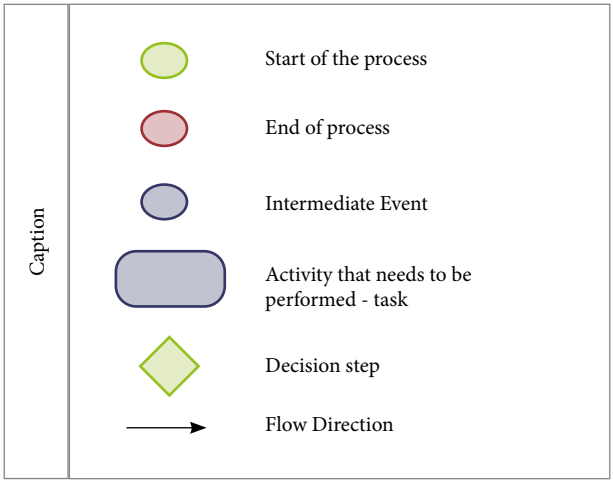
The evaluated outcomes considered the length of hospitalization (in days), and the situation of each patient based on the variables of immediate post-transplantation evolution and type of graft function, in addition to early hospital readmission (patient return within thirty days after first rise).

Statistical analysis was performed using the Statistical Package for Social Science (SPSS) version 23.0. Categorical variables were described using absolute and relative frequencies; continuous variables were described using mean and standard deviation or median and 25% and 75% percentiles, depending on whether or not they followed a normal distribution. The normality of quantitative variables was assessed using the Shapiro-Wilks test. The median length of hospital stay was compared between the categories of explanatory variables using the Mann-Whitney or Kruskal-Wallis tests. For all inferential procedures, a significance level of 5% was adopted.

Construction of the algorithm

The construction of the Algorithm for the Safe Discharge of Renal Transplanted Patients (ASDKTx) was based on the variables selected through the steps of the literature review and cohort study, considering factors that most impacted the length of hospital stay. For this, the free software Bizagi Modeler, version 3.0, was used, which allows modeling processes, preparing extensive

documentation of the entire procedure and publishing the material in various formats.[5] Modeling allows the creation of a structure with geometric shapes, each with its representativeness for the decision-making course (Fig. 1).



Source: Elaborated by the authors.

Figure 1. Captions for the Bizagi Modeler software, version 3.0, used in constructing the algorithm for the safe discharge of kidney transplant patients.

Algorithm validation

Judges validated the instrument through a quantitative and qualitative approach, measured by the specialists' agreement on a specific aspect. There has yet to be a consensus regarding the number and qualification of judges, ranging from five to twenty subjects, considering the instrument's characteristics, training, qualification and availability of professionals.[6] Forty five expert judges were invited, chosen according to criteria adapted from Fehring (1994)[7] and Joventino (2010)[8], and 19 actually participated in the study.

A Likert-type scale was adopted, and the assessment instrument was completed based on the degree of agreement for each item assigned a score of 1 to 4, respectively: 1 = strongly disagree; 2 = partially disagree; 3 = partially agree and 4 = totally agree. Quantitative analysis of scale validation by expert judges was performed using the Content Validity Index (CVI), which measures the proportion or percentage of judges who agree on certain aspects of the instrument and its items.[6]A cutoff point greater than 0.80 is recommended when the evaluation is carried out by more than six judges.[9] To evaluate the protocol in general, one of the calculation methods recommended by Polit and Beck (2006) was used.[9,] in which the sum of all CVI calculated separately is divided by the number of items in the instrument, and the value must also be more significant than 0.80 to be considered validated.

Data from the expert judges and their respective responses, derived from the questionnaire on Google Forms, were stored and organized in Microsoft Excel® and processed in the statistical program Statistical Package for Social Sciences (SPSS), version 23.0.

Sociodemographic, academic and professional data and content judges were evaluated using descriptive statistics. Categorical variables were expressed as frequencies (absolute and relative), and numeric variables as measures of central tendency (mean, median, minimum and maximum values and standard deviation). Data normality was demonstrated by the Shapiro-Wilk test, considering $p > 0.5$ as a normal distribution.

For the analysis of the evaluation items of the Algorithm for Safe Discharge of Renal Transplanted Patients (ASDKTx), the Exact Binomial Distribution test was performed, indicated for small samples, considering a significance level of $p > 0.05$ and a proportion of 0.80 of concordance to estimate the statistical reliability of the CVI.

Qualitatively, the answers referring to the open questions of the judges were examined, the gaps called "General Comments and Suggestions" were analyzed, and, for each domain term addressed, the Content Analysis methodology proposed by Minayo (2014) was used.[10,] subjects were identified by alphanumeric codes per letter (adopted the letter "J" for judges), followed by the serial number of their participation in data collection, to ensure anonymity.

The judges' responses to the following questions were also qualitatively evaluated: "Do you, as a specialist, think it is important to create technology for safe hospital discharge?", "Does the content follow current evidence-based practices?" and "Regarding the parameters evaluated in the algorithm, do you consider them relevant?".

After analysis by the judges, the validation process ended with the construction of a new version of the ASDKTx contemplating the suggestions pointed out by the judges.

RESULTS

Literature review

The literature review focused on early complications in the immediate post-transplant period for a theoretical basis, as they interfere with hospital discharge, including clinical, surgical, vascular and urological complications. The main early complications cited in the literature agreed with those found in the historical cohort study conducted.

Cohort study

During the study period (June 2017 to June 2019), 280 patients underwent transplants, 15 of which did not participate in the analysis (seven deaths before discharge, six double liver/kidney transplants, one transfer, and one record not found). The study sample, therefore, consisted of 265 patients.

In the distribution by age group, the age of the transplanted patients ranged from two to 78 years; most were adults aged 40–59 years (40.4%), followed by patients aged 18–39 years (29.8%) and over sixty years (19.2%). The age group up to 18 years represented 10.6% of the sample. The predominant biological sex of the transplanted patients was male: 159 (60%), concerning the female population, 106 (40%). According to BMI, most patients (115; 43.4%) had normal weight; the second largest group (79; 29.8%) were overweight. The obese corresponded to 13.2% of the sample (79 patients), while 11.7% were underweight.

Concerning primary kidney disease, it was observed that 97 patients (36.6%) had no definite diagnosis, another 46 (17.4%) had chronic glomerulopathies, 42 (15.8%) had diabetic nephropathy and 27 (10 .2%) hypertensive nephropathy. As for the type of renal replacement therapy, there was a predominance of hemodialysis (93.2%); only 18 individuals (6.8%) underwent the transplant without starting dialysis. Regarding dialysis time, 119 (44.9%) patients had dialysis time over 36 months, which is considered high, followed by 98 (37%) with time between 24 and 36 months. As for the immunological profile of the recipients, the vast majority of patients (90.6%) were not hypersensitized. Table 1 presents data on these and other clinical characteristics of the patients in this study.

Table 1. Distribution of clinical characteristics of kidney transplant recipients. Fortaleza, CE, 2021 (n= 265).

Variables	n	%
Diagnosis of primary kidney disease	265	
Diabetic kidney disease	42	15,8
Hypertensive nephropathy	27	10,2
Chronic glomerulopathies	46	17,4
Polycystic kidney disease	18	6,8
Urological pathologies – neurogenic bladder	13	4,9
Unknown etiology	97	36,6
Others	22	8,3
Diabetes mellitus	265	
Yes	61	23,0
No	204	77,00
Systemic arterial hypertension	265	
Yes	213	80,4
No	52	19,6
Type of kidney treatment	265	
Hemodialysis	247	93,2
Peritoneal dialysis	0	0
Preemptive	18	6,8
Dialysis time (months)	265	
Preemptive transplant	18	6,8
< 12	25	9,4
12 to 36	98	37
> 36	119	44,9
No information	5	1,9
Retransplantation	265	
Yes	21	7,9
No	244	92,1
Hypersensitized recipients*	265	
Yes	25	9,4
No	240	90,6

*Recipient with panel-reactive antibody (PRA) antibody reactivity greater than 50% and positive donor-specific antibodies (DSA) with mean fluorescence intensity (MFI) above 1500. Source: Elaborated by the authors.

Postoperative clinical and surgical complications in kidney transplant recipients were analyzed, including early rejection and occurrence of infections. It was observed that 91.6% of the patients did not present any surgical complications, 97% did not show early rejection, and 74.3% did not show infections until post-transplant hospital discharge. Table 2 details the distribution of patients regarding post-transplant clinical and surgical complications.

Table 2. Postoperative clinical and surgical complications in kidney transplant recipients. Fortaleza, CE, 2021 (n=265).

Variables	n	%
Surgical complications	265	
Urinary fistula	9	3,3
Drainage hematoma	7	2,6
Lymphocele	2	0,7
Thrombosis	3	1,13
Others	1	0,37
None	243	91,6
Early rejection (type)	250	
Cellular	5	2
Antibody-mediated	2	0,8
No	242	96,8
No information	1	0,4
Infection (site)	265	
Urinary tract	31	11,6
Respiratory	4	1,5
Surgical wound	15	5,6
Other infections	18	6,7
None	197	74,3

Source: Elaborated by the authors.

Regarding graft function in the group of recipients with deceased donors (n=250), the present study found 104 (42%) patients with immediate function, 84 (34%) with delayed graft function, 58 (22%) with slow function and 4 (2%) had graft loss. Living donor recipients (n=15) all had immediate graft function.

The frequency of graft loss after kidney transplantation was relatively low, with four cases occurring: two patients developed arterial thrombosis, one patient evolved with infection in the surgical wound in the renal pocket, being subjected to multiple approaches for renal pocket lavage, and another patient presented hemorrhagic shock due to arterial bleeding and renal-iliac anastomosis. All underwent graftectomy.

The length of hospital stay (HS) considered corresponded to the period between the admission of the patient for the surgical procedure (transplant) until the first discharge, with a median/IIQ: 11.0 (7.0-18.5) days. The minimum HS was 4 days, and the maximum was 139 days. In Tx from living donors, median/IIQ: 7.0 (7.0–8.0) days and in procedures from deceased donors, median/IIQ: 11.0 (7.0– 19.0)) days.

Comparing the sociodemographic and clinical characteristics of patients transplanted with HS, it was observed that the variables male gender, obesity and time longer than 36 months on dialysis before transplantation were significantly associated with higher HS. The underlying disease and comorbidities, such as SAH and DM, were not associated with HS. The occurrence of surgical complications, infections and early rejection significantly impacted HS. The median HS was 33 days for those with surgical complications and 10 days for those without ($p < 0.001$). For patients who had any infection in the postoperative period, the median HS was 25 days, while for the others, it was only ten days ($p < 0.001$) (Table 3).

The HS increased significantly the longer the time elapsed for the fall in serum creatinine levels, the main parameter that evaluates graft function. In patients with immediate graft function, the median HS was seven days, whereas, for those with slow graft function, it was ten days; for delayed graft function, twenty days; and for graft loss, 35 days. All seven patients with early rejection had late graft function (Table 4).

Table 3. Association analysis of sociodemographic and clinical characteristics of the recipient with length of hospital stay. Fortaleza, CE, 2021 (n = 265).

Variables	Hospital stay (days)			p-value
	Median	1st quartile	3rd quartile	
Age range (in years)				0,128[2]
< 18	8,0	6,0	12,0	
18 to 39	10,0	7,0	20,0	
40 to 59	11,0	7,0	18,0	
≥ 60	11,0	7,0	31,0	
Biological gender				0,028[1]
Male	11,0	7,0	20,0	
Female	10,0	6,0	16,0	
Weight classification by BMI* (n=260)				0,006[2]
Low weight (BMI < 18.5 kg/m^2)	10,0	7,0	12,0	
Normal (BMI between 18.5 and 24.9 kg/m^2)	9,0	7,0	17,0	
Overweight (BMI between 25 a 29,9 kg/m^2)	12,0	8,0	20,0	
Obese (BMI ≥ 30.0 kg/m^2)	13,0	8,0	31,0	
Diagnosis of primary kidney disease				0,166[1]
Diabetic kidney disease	11,0	8,0	20,0	
Hypertensive nephropathy	11,0	7,0	22,0	
Chronic glomerulopathies	9,5	7,0	13,0	
Polycystic kidney disease	7,5	6,0	13,0	
Urological pathologies – neurogenic bladder	11,0	7,0	17,0	
Unknown etiology	11,0	7,0	25,0	
Others	9,0	6,0	12,0	
Diabetes mellitus				0,150[1]
Yes	11,0	7,0	19,0	
No	9,0	7,0	15,0	
Systemic arterial hypertension				0,330[1]
Yes	11,0	7,5	20,0	
No	10,0	7,0	17,0	
Dialysis time (in months) (n=260)				< 0,001[2]
Preemptive transplantation	7,0	6,0	9,0	
< 12	8,0	7,0	11,0	
12 to 36	10,0	7,0	18,0	
> 36	12,0	8,0	26,0	
Retransplantation				0,830[1]
Yes	12,0	7,0	16,0	
No	10,0	7,0	19,0	
Hypersensitized recipients				0,105[1]
Yes	12,0	10,0	17,0	
No	10,0	7,0	19,0	

[1]Mann-Whitney test; [2]Kruskal-Wallis test; *BMI = body mass index. Source: Elaborated by the authors.

The association of hospitalization time with graft functions (IGF, SGF, DGF) and research variables resulted in essential impacts, such as BMI, surgical complications, early rejection and infection. Obesity was a factor that impacted the length of hospital stay for patients who had slow graft function (p = 0.04). On the other hand, early rejection impacted the HS of those recipients of deceased donors who developed late graft function (p = 0.01). Infections and surgical complications in HS, in the different graft functions of deceased donor recipients, significantly increased HS in all situations (Table 5).

Table 4. Association analysis of post-transplantation complications and graft function with the length of hospital stay. Fortaleza, CE,2021.

Variables	Hospital stay (days)			p-value
	Median	1st quartile	3rd quartile	
Surgical complications				< 0,001[1]
Yes (n = 22)	33,5	17	64	
No (n = 243)	10	7	17	
Early rejection				< 0,001[1]
Yes (n = 7)	48	20	81	
No (n = 257)	10	7	18	
Any infection				< 0,001[1]
Yes (n = 68)	25,5	16	42	
No (n = 197)	9	7	12	
Urinary tract infection				< 0,001[1]
Yes (n = 31)	31	20	63	
No (n = 234)	9	7	15	
Respiratory infection				0,4711
Yes (n = 4)	12	10,5	16,5	
No (n = 261)	11	7	18	
Surgical wound infection				< 0,001[1]
Yes (n = 15)	41	31	64	
No (n = 250)	10	7	17	
Infection at other sites				0,015[1]
Yes (n = 18)	17,5	9	28	
No (n = 247)	10	7	18	
Graft function (n=250)				< 0,001[2]
IGF (n=104)	7	6	11	
SGF (n=58)	10	8	17	
DGF (n=84)	20	12	35,5	
Graft loss (n=4)	35,5	6	101,5	

[1]Mann-Whitney test; [2]Kruskal-Wallis test. Source: Elaborated by the authors.

Table 5. Association of variables BMI, origin, surgical complications, early rejection, infections with the length of hospital stay in the different graft functions of the 250 recipients with a deceased donor. Fortaleza, CE,2021 (n = 250).

Variables	Immediate function			Delayed graft function			Slow function		
	n	Hospital stay time Median (1st – 3rd quartile)	Valor p	n	Hospital stay time Median (1st – 3rd quartile)	Valor p	n	Hospital stay time Median (1st – 3rd quartile)	p-value
Weight classification by BMI*			0,073[1]			0,893[1]			0,040[1]
Low weight (< 18,5 Kg/m^2)	23	7 (6 – 11)		5	15 (12 – 26)		2	27 (23 – 31) a	
Normal (between 18.5 and 24.9 Kg/m^2)	49	7 (6 – 9)		31	22 (12 – 34)		22	12,5 (9 – 17) ab	
Overweight (between 25 and 29,9 Kg/m^2)	23	10 (6 – 13)		30	19 (12 – 42)		22	9 (8 – 12) c	
Obese (≥ 30,0 Kg/m^2)	5	9 (8 – 20)		18	20,5 (13 – 43)		11	8,5 (8 – 12,5) bc	
Origin			0,877[1]			0,006[1]			0,872[1]
Fortaleza (State capital)	35	7 (6 – 11)		35	22 (13 – 34) a		23	10 (8 – 17)	
Upstate	57	7 (6 – 11)		37	16 (12 – 25) a		26	9,5 (8 – 13)	
Another state	13	8 (6 – 11)		12	45 (22 – 64,5) b		8	10,5 (7,5 – 17)	
Surgical complications			0,004[2]			0,002[2]			<0,001[2]
Yes	4	23 (13 – 36)		8	64,5 (32 – 77)		6	31,5 (17 – 35)	
No	101	7 (6 – 10)		76	18,5 (12 – 30,5)		51	9 (8 – 13)	
Rejection			-			0,019[2]			-
Yes	-	-		7	48 (20 – 81)		-	-	
No	104	7 (6 – 11)		77	19 (12 – 31)		57	10 (8 – 17)	
Infectious Complications			<0,001[2]			<0,001[2]			<0,001[2]
Yes	17	13 (10 – 20)		30	35,5 (22 – 64)		12	24 (16,5 – 31,5)	
No	88	7 (6 – 10)		54	15,5 (11 – 23)		45	9 (8 – 12)	

[1]Kruskal-Wallis test [2]Mann-Whitney test. Equal letters were given to equal medians and different letters for statistically different medians Source: Elaborated by the authors.

The analysis of the initial serum creatinine level up to the fourteenth postoperative day among patients with immediate function and slow graft function demonstrates that the first group presents a reduction of approximately 64% already on the fourth day. In contrast, the second group shows a similar percentage only on the 13th POD (Table 6).

Table 6. Evolution of initial serum creatinine until the fourteenth day after renal transplantation in patients who presented immediate and slow graft function. Fortaleza, CE, 2021 (n = 265).

Hospitalization days	IGF(n=119)		SGF(n= 58)	
	Mean Cr (mg/dL)	Reduction(%)	Mean Cr (mg/dL)	Reduction (%)
initial	6,54	0	7,85	0
D1	5,50	15,9	7,52	4,2
D2	4,16	36,3	7,50	4,5
D3	3,09	52,8	7,28	7,3
D4	2,33	64,3	6,75	14,0
D5	1,92	70,6	6,09	22,5
D6	1,78	72,8	5,41	31,0
D7	1,65	74,8	5,02	36,1
D8	1,68	74,3	4,52	42,4
D9	1,60	75,6	4,13	47,4
D10	1,59	75,7	3,62	53,9
D11	1,49	77,2	3,51	55,2
D12	1,51	77,0	3,14	60,0
D13	1,62	75,2	2,80	64,4
D14	1,64	74,8	2,76	64,9

Source: Elaborated by the authors.

Characterization of the judges, algorithm evaluation and content validation

Forty-five specialists were selected, of which 19 agreed to participate in the study by signing the Free and Informed Consent Form and responding to the questionnaire within ten days.

Among the selected specialists, five (26.0%) were male, and 14 (74.0%) were female. Age ranged between 27 and 59 years, with the predominant group being 30 to 39. As for the specialists' city of residence, 11 (57.8%%) were residents of Fortaleza, one (5.2%) of Goiânia, two (10.5%) of São Paulo, three (16.0%) of São Luís, one (5.2%) from Joinville and one (5.0%) from Porto Alegre.

Nine specialists (47.4%) were physicians, and ten (52.6%) were nurses, with professional training time ranging from 1 to 36 years, with an average of 15.2 years. The majority (13; 68.40%) worked exclusively in care, while six (31.6%) were also teaching. Most (ten; 52.60%) had a master's degree, followed by eight (42%) with specialization and one (5.2%) had a doctorate with a postdoctoral degree.

All specialists (19; 100.0%) had clinical experience with kidney transplantation, with scientific publications in organ transplantation and the development of health technologies.

A first version of the algorithm for ASDKTx was built and presented to experts for content validation. The instrument was evaluated regarding the domains: objectives, structure, presentation, and relevance. All items of the assessed dimensions presented excellent CVI, equal to 1.00. Thus, the CVI of each domain was equivalent to 1.00, with CVIt = 1.00. As for the binomial analysis, it was observed that all items had p = 0.135, indicating no disagreement between judges in the assigned score.

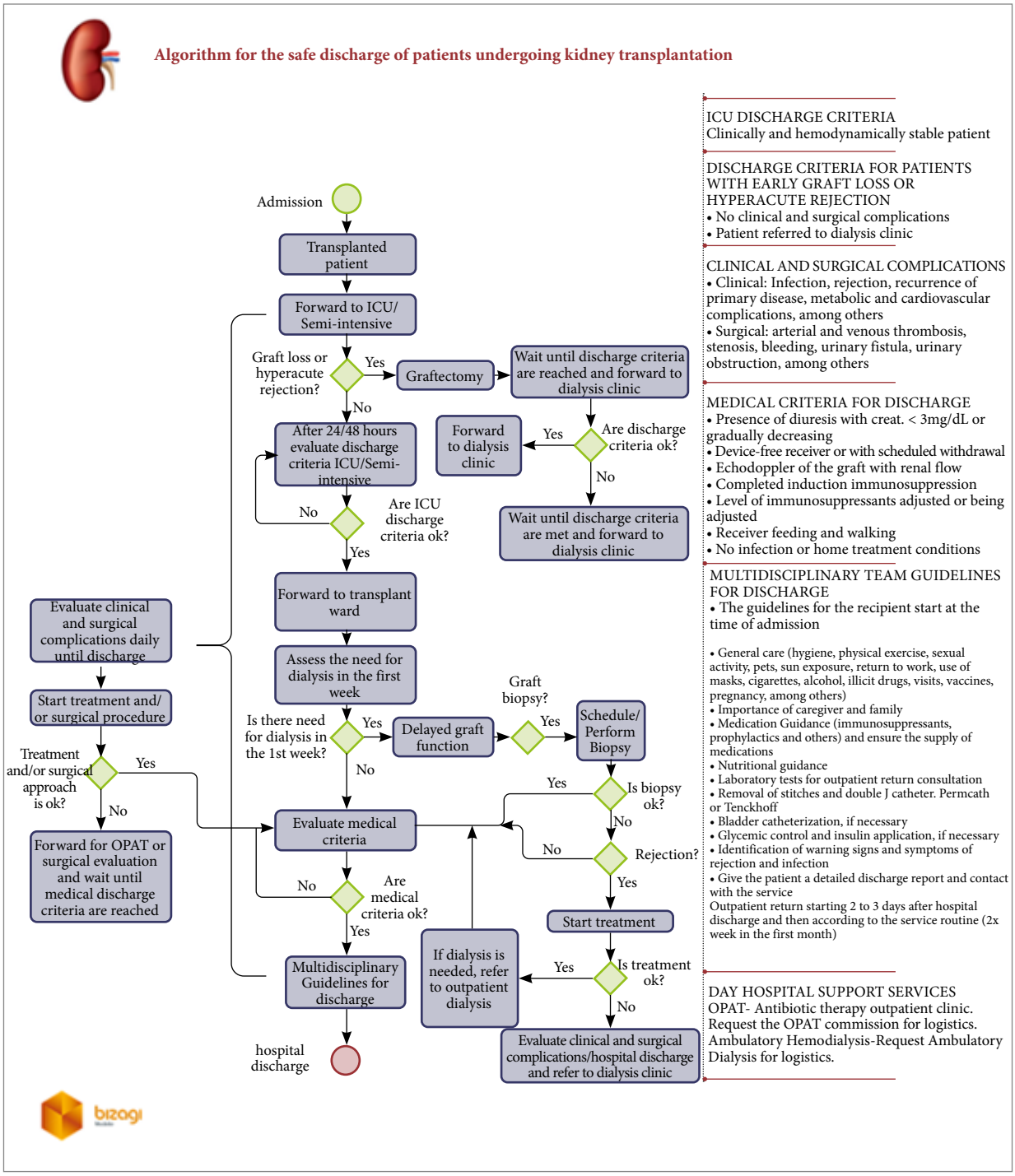
Ultimately, all judges (19; 100%) stated that technology was necessary for a safe hospital discharge, with content that follows practices based on current evidence and relevant parameters.

Discourse analysis of the experts' answers to the open questions showed that judges (J) J1, J9, J14 and J19 were concerned about the font size of the algorithm. The judges requested the inclusion of information regarding clinical and hemodynamic stability in the intensive care unit (UCI) discharge criteria (J4); initiation of suppression and evaluation, as well as prophylactic drugs (J5); acute cellular rejection, recurrence of the primary disease, renal artery stenosis and urinary fistula and guidance on medications (J17).

General comments on the importance of the algorithm revealed that the developed technology was considered relevant for use in institutions that perform transplants (J12, J14), given that its elaboration was based on current scientific literature (J3),

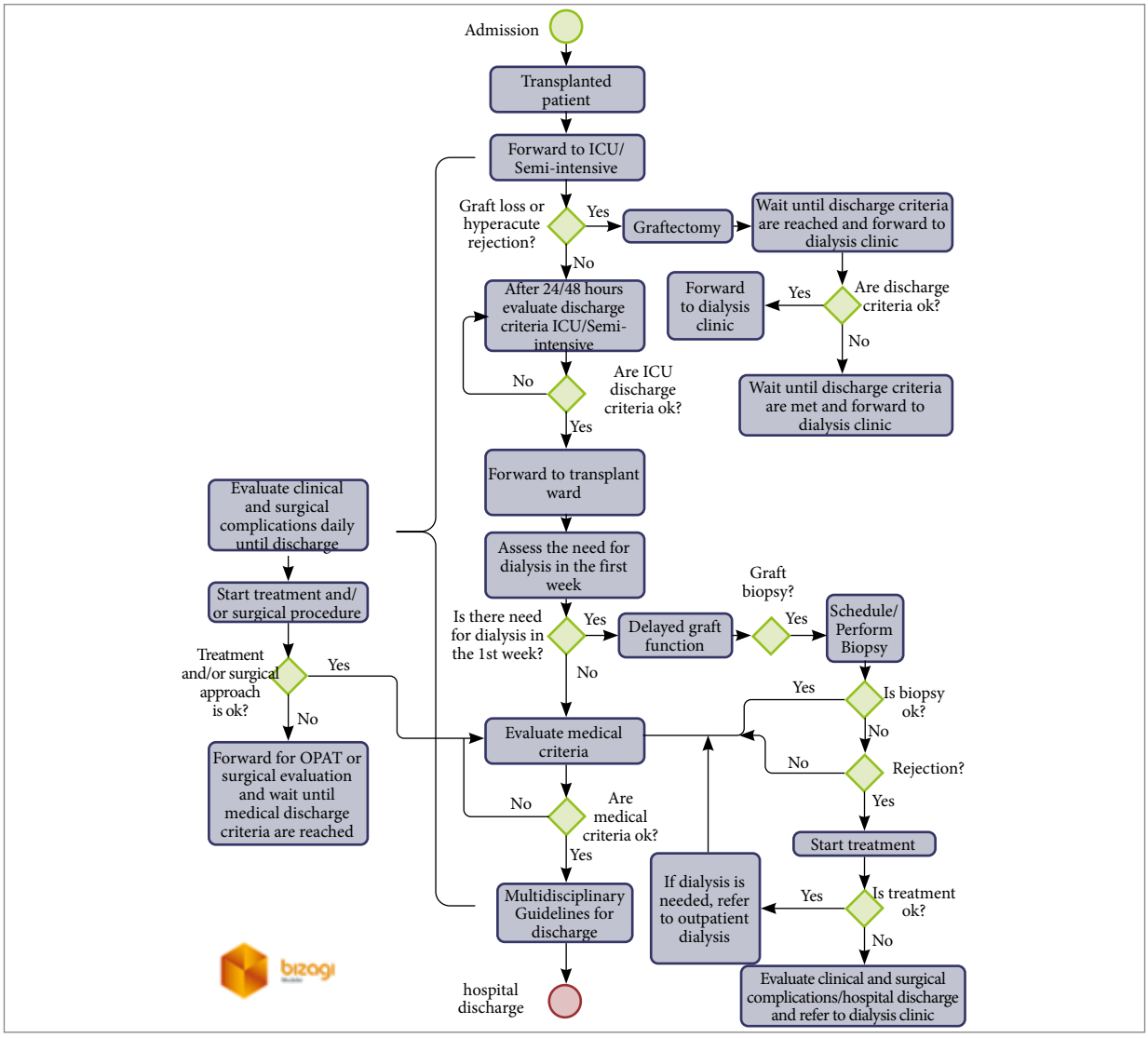
which allows the standardization of professionals' conduct and reduction of patient hospitalization time (J4), contributing to clinical decision-making (J5), which can positively impact the quality and survival of the post-transplant graft (J6). The patient is provided with quality care with safe discharge (J7).

Figs. 2 – 4 demonstrate the validated prototype of the algorithm for safe hospital discharge of patients undergoing kidney transplantation, divided into three parts for better visualization in this publication. The complete algorithm can be reproduced on A3-size paper as a poster or banner format to be posted in hospital units for kidney transplantation. It can also be converted into digital form for availability in applications or websites for consultation by professionals.



Source: Elaborated by the authors.

Figure 2. Part 1 of the validated algorithm for the safe discharge of patients undergoing kidney transplantation.



Source: Elaborated by the authors.

Figure 3. Part 2 of the validated algorithm for the safe discharge of patients undergoing kidney transplantation.

ICU DISCHARGE CRITERIA
Clinically and hemodynamically stable patient

DISCHARGE CRITERIA FOR PATIENTS WITH EARLY GRAFT LOSS OR HYPERACUTE REJECTION
- No clinical and surgical complications
- Patient referred to dialysis clinic

CLINICAL AND SURGICAL COMPLICATIONS
- Clinical: Infection, rejection, recurrence of primary disease, metabolic and cardiovascular complications, among others
- Surgical: arterial and venous thrombosis, stenosis, bleeding, urinary fistula, urinary obstruction, among others

MEDICAL CRITERIA FOR DISCHARGE
- Presence of diuresis with creat. < 3mg/dL or gradually decreasing
- Device-free receiver or with scheduled withdrawal
- Echodoppler of the graft with renal flow
- Completed induction immunosuppression
- Level of immunosuppressants adjusted or being adjusted
- Receiver feeding and walking
- No infection or home treatment conditions

MULTIDISCIPLINARY TEAM GUIDELINES FOR DISCHARGE
- The guidelines for the recipient start at the time of admission

- General care (hygiene, physical exercise, sexual activity, pets, sun exposure, return to work, use of masks, cigarettes, alcohol, illicit drugs, visits, vaccines, pregnancy, among others)
- Importance of caregiver and family
- Medication Guidance (immunosuppressants, prophylactics and others) and ensure the supply of medications
- Nutritional guidance
- Laboratory tests for outpatient return consultation
- Removal of stitches and double J catheter. Permcath or Tenckhoff
- Bladder catheterization, if necessary
- Glycemic control and insulin application, if necessary
- Identification of warning signs and symptoms of rejection and infection
- Give the patient a detailed discharge report and contact with the service

Outpatient return starting 2 to 3 days after hospital discharge and then according to the service routine (2x week in the first month)

DAY HOSPITAL SUPPORT SERVICES
OPAT- Antibiotic therapy outpatient clinic.
Request the OPAT commission for logistics.
Ambulatory Hemodialysis-Request Ambulatory Dialysis for logistics.

Source: Elaborated by the authors.

Figure 4. Part 3 of the validated algorithm for the safe discharge of patients undergoing kidney transplantation

DISCUSSION

In the first days after kidney transplantation, from admission to the first hospital discharge after the procedure, complications may occur that condition the patient's evolution and cause a prolonged stay in the immediate postoperative period and damage to the function of the transplanted kidney, which can have an impact with increased institution's costs. Such complications are directly related to the surgical procedure and the immediate function or not of the graft.

The construction of an algorithm for the safe discharge of patients undergoing kidney transplantation, the objective of this work, was based on the literature review and analysis of the cohort study that focused on the results of the factors that impacted the length of stay of 265 patients.

In the present study, the length of hospital stay had a median/IIQ: 11.0 (7.0-18.5) days, similar to that observed by Yazawa *et al.* (2020)[11] (mean of 11 days) and by Serrano *et al.* (2019)[12] (mean of 10.07 days for patients undergoing live-in transplantation and 13.84 days for deceased donors).

In the association of length of stay with sociodemographic variables, two variables were significant: BMI and time on hemodialysis. Patients with high BMI had delayed graft function and slow graft function more frequently, but only with statistical significance in relation to slow function, in agreement with what was observed by Lentine *et al.* (2012).[13] The influence of the BMI of transplant recipients concerning this factor, the finding that obesity complicates the surgical procedure and influences the normal function of the graft, leading to a longer HS being a predictor of chronic dysfunction and lower graft survival, had already been described by Potluri and Hou (2010).[14]

As for early readmissions, an essential metric for an early and safe discharge, the present study showed a readmission rate of 20%. In a recent study in a Brazilian transplant center, the incidence of hospital readmission was 26.6% among 1,175 kidney transplant recipients between January 2011 and December 2012, and the leading causes of readmission were infections and surgical and metabolic complications.[15]

After the cohort study and the construction of the algorithm, its validation was carried out to check its reliability. It was observed that the experts gathered practical and teaching experiences, contributing to a meticulous validation process; the experts showed a high ability to judge the instrument's applicability.

The algorithm was evaluated regarding the domains: objectives, structure, presentation, and relevance. All items were considered validated, given that all items of the evaluated dimensions had excellent CVI, equal to 1.00. Some experts made suggestions that were mainly accepted.

To Soares (2010)[16], using a validated algorithm supports the multidisciplinary team to act preventively and make decisions more quickly, with reduced risk and high chances of success. The algorithm proposed in this research aims to improve the measures for the early and safe discharge of patients undergoing kidney transplantation.

CONCLUSION

The algorithm for the safe discharge of patients undergoing kidney transplantation can help professionals in decision-making for the safe discharge of these patients. Expert judges, doctors and nurses, most with more than ten years of experience in the area, had the opportunity to point out the weak points in the algorithm and make suggestions to improve the instrument. Most observations were accepted after being analyzed and considered relevant, and only those that did not have clinical evidence were discarded.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Girão CM, Sampaio EGM, Freitas TVS, Bachur TPR, Dallago CM; **Conception and design:** Girão CM, Dallago CM; **Data analysis and interpretation:** Girão CM, Sampaio EGM, Dallago CM; **Article writing:** Girão CM, Bachur TPR, Dallago CM; **Critical revision:** Freitas TVS, Bachur TPR, Dallago CM; **Final approval:** Girão CM, Sampaio EGM, Freitas TVS, Bachur TPR, Dallago CM.

DATA AVAILABILITY STATEMENT

All datasets were generated or analyzed in the current study.

FUNDING

Not applicable.

ACKNOWLEDGEMENT

Not applicable.

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