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BACTERIAL TRANSLOCATION IN DECEASED ORGAN DONORS

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Objective: to ascertain the prevalence and risk factors for bacterial translocation (BT) in brain-dead donors (BDDs) during organ and tissue retrieval in health care facilities. **Materials and methods**. The study included 62 BDDs, featuring 44 males (71%) and 18 females (29%), aged 17 to 64 years. Organ was retrieved in health-care institutions located in Gomel Oblast in 2019–2022. Bacteriological examination of biopsy material taken from different parts of the intestine, mesenteric lymph nodes (MLNs) and spleen was carried out. The presence of BT was validated when bacterial growth was obtained from homogenized MLNs and(or) spleen by isolating an identical strain from the intestinal lumen. The anthropometric characteristics of BDDs, hematologic, biochemical parameters, and the length of stay in the intensive care unit (ICU) were assessed. **Results.** Evidence of bacterial translocation was detected in 22 BDDs (35.5%, 95% CI 24.7–48.0). Growth in MLNs and in spleen biopsies was noted in 21 (95.5%) and 7 (31.8%) patients, respectively. The BDDs were categorized into two groups depending on the presence of BT, and the main characteristics were compared. ROC analysis was used to determine the prognostic significance of the main parameters. Risk factors for BT were serum sodium level >144 mmol/L (AUC = 0.759) at the time of retrieval, weight >89 kg (AUC = 0.756), BMI >27.5 (AUC = 0.709), decreased hemoglobin <126 g/L (AUC = 0.665), and ICU stay >2 days (AUC = 0.656). **Conclusion.** Bacterial translocation is found in 35.5% of BDD cases, and it is accompanied by penetration of bacteria and yeast-like fungi into the MLNs and spleen. Bacterial translocation is linked to excess body weight, hypernatremia, prolonged ICU stay, and decreased hemoglobin levels at the time of retrieval. These factors should be taken into account in the medical management of brain-dead donors (organ donor conditioning).

Keywords: deceased organ donor, bacterial translocation, organ transplantation, transplantation coordination.

INTRODUCTION

Despite significant advances in therapeutic techniques, organ transplantation remains the only definitive treatment for end-stage organ diseases and is often the sole option when all other conservative treatments have failed [1–3]. With the continuous increase in the number of patients on the transplant waiting list and a decrease in the number of suitable donors, there is a growing organ shortage. This has led to the necessity of expanding the criteria for selecting viable donors. As a result, there is a trend towards accepting older organ donors (brain-dead donors, BDDs), extending the duration of the donor's stay in the intensive care unit (ICU), and adopting more flexible criteria for various homeostatic parameters, such as serum sodium levels, hyperglycemia, and acid-base balance shifts. In addition, there is consideration for donors with sanitized infectious foci [4–6].

Brain death triggers numerous pathological processes that directly impact both the quantity and quality of organs available for transplantation. With the expansion of eligibility criteria for organ donors and prolonged stays in the ICU with highly invasive medical support, a deeper understanding of the underlying pathophysiology of transplant-related organ dysfunction is essential to fully optimize the donor pool [5]. In kidney and liver transplantation, recipients of allografts harvested from deceased donors with a beating heart experience a significantly higher rate of post-transplant complications, such as acute rejection or chronic graft dysfunction, compared to those receiving organs from living donors, leading to worse overall transplant outcomes [6]. The decline in transplant effectiveness cannot be solely attributed to differences in the antigenic composition of donor-recipient pairs. Some studies suggest that the strength of immune response is more closely related to the extent of injury to the donor organ than to the degree of mismatches in donor and recipient human leukocyte antigens (HLA) [7].

Bacterial endotoxemia is a cytotoxic factor that causes injury to potential donor organs, primarily due to increased intestinal permeability. Bacterial translocation (BT) can occur in up to 30–40% of critically ill patients, according to various sources, and is directly associated with elevated inflammatory markers and reduced activity of blood coagulation factors. In response to these inflammatory markers, antigen-presenting T cells trigger cytotoxic reactions, leading to organ damage and dysfunction [8–11].

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Given this, it can be concluded that BT is a common condition in potential organ donors. However, the precise mechanisms and factors that correlate with the risk of BT development in effective organ donors are still not fully understood. Identifying these factors and implementing measures to mitigate them could reduce the incidence of organ donor injury and ultimately improve transplant outcomes [6–8].

Objective: to determine the prevalence and risk factors for BT in brain-dead donors (BDDs) during organ and tissue procurement in healthcare facilities.

MATERIALS AND METHODS

This observational cohort study included BDDs from whom solid organs were procured, following the legal methodology established for organ donation. Organ procurement was carried out at healthcare facilities in Gomel Oblast (Belarus) from 2019 to 2022. The exclusion criterion was the inability to obtain biopsy material due to a lack of access to the abdominal cavity during procurement (e.g., mono-heart procurement without laparotomy, lung procurement, or heart-lung procurement without laparotomy, vascular allograft procurement). The study received approval from the Ethics Committee of Gomel State Medical University.

The study included 62 BDDs, comprising 44 males (71%) and 18 females (29%), aged between 17 and 64 years. Brain death resulted from traumatic brain injury in 19 cases (30.6%) and non-traumatic brain injury in 43 cases (69.4%). Among the non-traumatic cases, 36 (58.1%) were due to intracranial hemorrhage and 7 (11.3%) to atherothrombotic cerebral circulatory disorders.

All BDDs were managed in the ICU and received enteral nutrition as follows:

– 16 donors (25.8%) received enteral nutrition based on the clinical protocol of the Ministry of Health of the Republic of Belarus;
– 19 donors (30.6%) received standardized enteral nutrition ("Enterolin," 1 kcal/mL) at a dosage of 20 mL/kg/day, in accordance with national clinical guidelines for intensive care in cerebrovascular insufficiency;
– 27 donors (43.6%) received standardized "Enterolin" enteral nutrition with continuous administration via enteral pumps, accompanied by pharmacological support (prokinetics, eubiotics, and antacids) at therapeutic dosages.

The anthropometric parameters, key hematological and biochemical indicators, as well as ICU length of stay, were assessed for all BDDs. The characteristics of BDDs at the time of organ retrieval are presented in Table 1.

Table 1

Characteristics of BDDs at the time of retrieval

Indicator	M ± SD
Age (years)	46.8 ± 10.7
Height (cm)	174.4 ± 6.7
Weight (kg)	80.9 ± 10.9
Body mass index (kg/m^2)	26.6 ± 3.5
ICU stay (days)	3.7 ± 2.3
Hemoglobin (g/L)	139.7 ± 16.1
Red blood cells (×10^{12}/L)	4.19 ± 0.79
Hematocrit (L/L)	0.42 ± 0.04
Platelets (×10^9/L)	274.0 ± 72.5
Leukocytes (×10^9/L)	11.4 ± 3.5
Urea (mmol/L)	5.9 ± 1.3
Creatinine (μmol/L)	76.7 ± 21.0
pH	7.39 ± 0.03
Lactate (mmol/L)	1.28 ± 0.51
Na (mmol/L)	146.0 ± 8.6
K (mmol/L)	4.23 ± 0.44

Bacteriological analysis was performed on biopsy samples taken from various sections of the intestine, mesenteric lymph nodes (MLNs), and spleen. BT was confirmed when bacterial growth was detected in homogenates of the MLNs and/or spleen, with identification of a strain identical to that isolated from the intestinal lumen.

Statistical processing and data analysis were conducted using SPSS Statistics for Windows, version 26 (IBM Corp., USA). Quantitative variables are presented as mean ± standard deviation (M ± SD). The Mann–Whitney U test was applied to compare quantitative variables between two independent groups. The predictive value of various parameters was evaluated using receiver operating characteristic (ROC) curve analysis in MedCalc version 19.4.1. The area under the curve (AUC), along with the corresponding 95% confidence interval (CI), sensitivity (Se), and specificity (Sp) at the determined cut-off points, were calculated. A p-value of less than 0.05 was considered statistically significant.

RESULTS

BT signs were detected in 22 BDDs (35.5%; 95% CI: 24.7–48.0). In most cases, microorganisms characteristic of the intestinal microflora were detected in MLNs (21 patients, 95.5%), and in a smaller proportion of cases, in the spleen biopsy samples (7 patients, 31.8%). The detected microorganisms included *Enterococcus faecium*, *Escherichia coli*, *Klebsiella pneumoniae*, *clostridia*, *Staphylococcus haemolyticus*, and yeast fungi such as *Candida albicans* and *Saccharomyces cerevisiae* found in various combinations.

Based on the presence or absence of BT, the BDDs were divided into two groups, and their main clinical and laboratory characteristics were compared (Table 2).

ROC analysis was performed to evaluate the predictive value of parameters that demonstrated statistical

significance at $p < 0.1$ between groups, and to determine their boundary values. The results are presented in descending order of AUC in Table 3 and illustrated in Figs. 1 and 2.

Table 2

Comparison of the characteristics of BDDs by the presence of bacterial translocation

Indicator	Group 1 (BT), n = 22	Group 2 (no BT), n = 40	P
Age (years)	48.0 ± 10.1	46.4 ± 11.2	0.802
Height (cm)	175.0 ± 6.4	173.7 ± 6.9	0.338
Weight (kg)	87.5 ± 10.8	77.0 ± 6.9	**0.0007**
Body mass index (kg/m^2)	27.8 ± 3.6	26.1 ± 3.2	**0.071**
Stay in ICU (days)	4.0 ± 2.7	2.5 ± 1.9	**0.044**
Hemoglobin (g/L)	130.5 ± 16.4	142.0 ± 15.3	**0.033**
Erythrocytes (×10^{12}/L)	4.51 ± 0.80	4.05 ± 0.78	0.216
Hematocrit (l/L)	0.41 ± 0.04	0.42 ± 0.05	0.844
Platelets (×10^9/L)	250.0 ± 74.9	278.5 ± 71.2	0.353
Leukocytes (×10^9/L)	12.0 ± 3.5	11.0 ± 3.5	0.269
Urea (mmol/L)	5.8 ± 4.3	5.7 ± 1.3	0.901
Creatinine (μmol/L)	82.5 ± 21.8	72.0 ± 20.8	0.594
pH	7.38 ± 0.03	7.39 ± 0.03	0.901
Lactate (mmol/L)	1.25 ± 0.54	1.15 ± 0.48	0.765
Na (mmol/L)	152.5 ± 7.4	143.0 ± 8.1	**0.0006**
K (mmol/L)	4.20 ± 0.46	4.20 ± 0.42	0.594

Table 3

Prognostic significance of laboratory and clinical parameters (in descending order of AUC)

Indicator	AUC; 95% CI	Cut-off	Se, %	Sp, %
Na (mmol/L)	0.759; 0.633–0.858	>148	81.8	75.0
Weight (kg)	0.756; 0.631–0.856	>89	50.0	87.5
Body mass index (kg/m^2)	0.709; 0.579–0.817	>27.5	68.2	72.5
Hb (g/L)	0.665; 0.534–0.780	≤126	45.5	87.5
ICU stay (days)	0.656; 0.524–0.772	>2	72.7	50.0

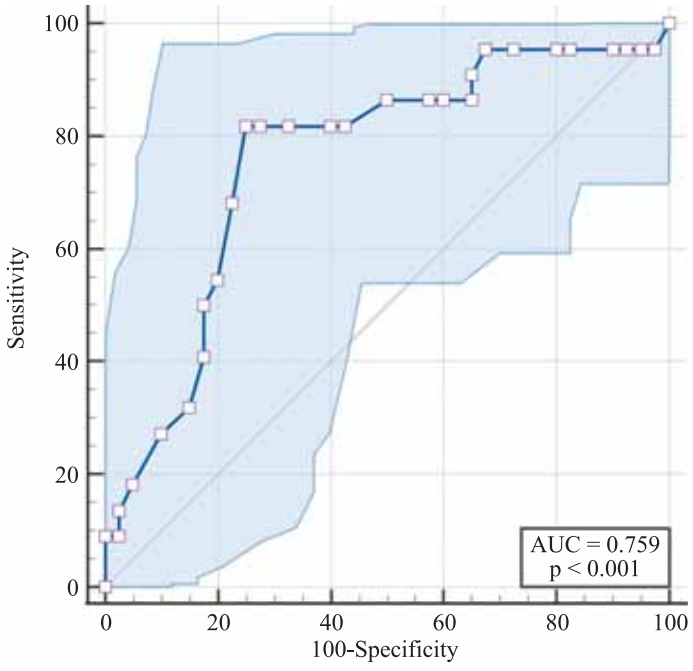

Fig. 1. Prognostic significance of serum sodium levels at the time of retrieval for the presence of BT in BDDs

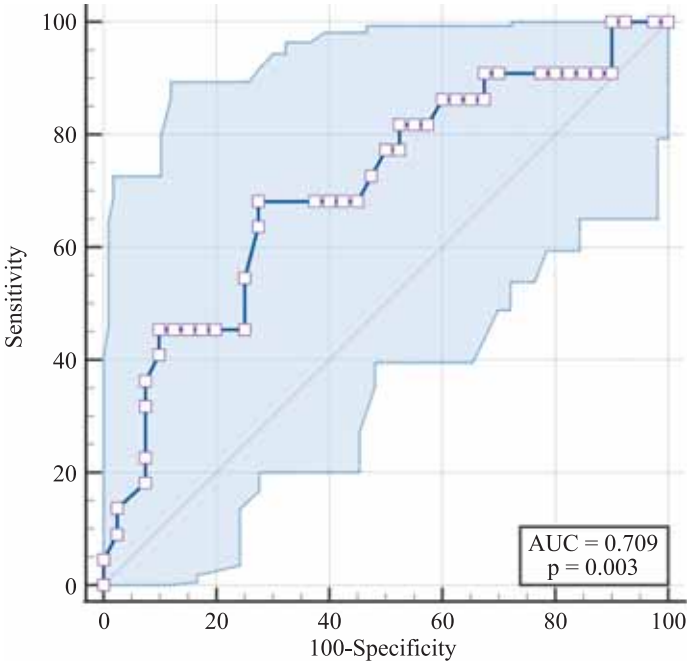

Fig. 2. Prognostic significance of serum sodium levels at the time of organ retrieval for the presence of BT in BDDs

DISCUSSION

The analysis identified the most significant predictor of BT in BDDs as a serum sodium level exceeding 148 mmol/L at the time of organ procurement, followed by a body weight over 89 kg (BMI >27.5). Additionally, a hemoglobin level ≤126 g/L and an ICU stay longer than two days were also associated with an increased risk of BT. Given the comparable predictive value of body weight and BMI, we recommend prioritizing BMI as a more objective and standardized metric, as it accounts for the donor's height.

Our findings align with previous reports indicating that hypernatremia and excessive body weight in BDDs are significant factors contributing to increased intestinal permeability [8, 9]. These observations underscore the importance of careful medical monitoring of potential organ donors prior to organ retrieval. The presence of BT may be associated with endotoxinemia, which can result in donor allograft injury and negatively affect post-transplant graft function [12].

CONCLUSION

The incidence of BT among effective organ donors was found to be 35.5%, characterized by the penetration of bacteria and yeast-like fungi into the MLNs and spleen. BT was significantly associated with excess body weight, hypernatremia, prolonged ICU stay, and reduced hemoglobin levels at the time of organ procurement. These findings highlight the importance of considering these risk factors during medical management of potential organ donors, as BT may contribute to allograft dysfunction and adversely impact transplant outcomes.

The authors declare no conflict of interest.

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