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Hemofiltration Romanian Registry – Typologies of patients identified by cluster analysis

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Nothing to declare

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ABSTRACT

Hemofiltration National Registry is one of the patient registries implemented lately in Romania, currently in use, in response to increased clinical and research needs. The registries of patients with extracorporeal support of vital functions were developed with the support of Romanian Society of Anesthesia and Intensive Care. The registry contains data on over 200 hemofiltration procedures that were per-

formed in the last 3 years in multiple Romanian hospitals. A sample of data containing records of 2018 was analyzed by K-means clustering, revealing patterns that are potentially useful for healthcare improvement. Among the 6 clusters identified, 3 contain patients with a high mortality rate (90-100%), 1 is defined by intermediate mortality (72%) and 2 by a lower mortality rate (62%). Further research is needed in order to refine the clustering criteria, by using a larger number of cases and potentially examining more outcomes.

Introduction

Patient registries are especially useful in the setting of rare diseases, or infrequently performed procedures, as they allow for data collection and centralized analysis, regardless of geographical localization and time constraints. In Romania there are currently a number of patient registries in operation. Among them, the National Artificial Lung registry and the Hemofiltration National Registry, for patients with extracorporeal support of vital functions, have been developed with the support of Romanian Society of Anesthesia and Intensive Care. The two registries became operational in 2016, and have been completely functional until now [1]. These registries were designed to be in use by a number of hospitals in the country, while there was a number of only 2 hospitals providing data in the last year (2018), up to the writing of this paper.

Material and Methods

Data entries, all recorded in the Hemofiltration National Registry (fig. 1) available on the website hemofiltrare.srati.ro, were used as input for a registry-based observational study [2]. The registry contains over 200 entries, for

as many hemofiltration procedures performed between 2016-2019. A total of 156 procedure recordings, performed in 2018, were selected for further analysis. The number of valid recordings was smaller, because 28 (17.9%) out of the 156 entries were unreliable regarding admission and/or release date from hospital and/or ICU (wrong or missing date field was the most common error made by the operators during data entry). Furthermore, in case of 6 patients, duplicate recordings were found in the database (all of these having only one hemofiltration procedure assigned), while in the case of 1 patient there was incongruent data regarding survival. For further patient data analysis a number of 61 datapoints were checked as reliable sources. The parameters followed were: duration of hospital stay (days), ICU stay (days), demographical data (age, sex), somatic parameters (height, weight, calculated BMI), pathological entities (syndromes, conditions), medical interventions (including hemofiltration) and outcomes (death/survival on discharge and after up to 28 days, renal function recovery status). K-means clustering of patients was performed, given the average survival rate, in order to attempt identification of patterns associated with patients status [3]. For statistical processing of data freeware SPSS and LibreOffice 4.1 were utilized.

Registru național de hemofiltrare					
Statistică		Export XLS			
Toate	Proprii	Caută <input type="text"/>			
Spital	Inițiale pacient	Număr FO	Data internare	Diagnostic	
Spitalul Județean de Urgență Oradea				MSOF, Soc septic, Insuficiența renală ac. plurifactorială, Bronhopneumonie, Insuficiența respiratorie protezată mecanică, Hipercalcemie, Anemie feripriva	
Spitalul Județean de Urgență Oradea				Vasculită ANCA pozitiv, Boala Wegener, IRC	
Spitalul Județean de Urgență Oradea				MSOF, Suspiciune Leptospiroza, insuficiența hepatică acută fulminantă, insuficiența renală acută, insuficiența respiratorie acută hipoxemică protezată mecanică, acidoză metabolică severă, trombocitopenie severă	
Spitalul Județean Timișoara				Bronhopneumonie asociată hospitalismului, Status post abdomen acut chirurgical, Insuficiența renală acută AKI III, Sepsis, Peritonită acută.	
Spitalul Județean de Urgență				SCR resuscitat, BPOC exacerbă, Acidoză respiratorie,	

Fig. 1. Patient chart in the Hemofiltration National Registry

Results

Among the 61 patients with recordings validated for this study, survival rate was 26.23%, given the multiple severe pathologies they were under. The most descriptive patient characteristics are described below in table 1.

Table 1. Patient data (n=61)

Characteristic	Frequency table or Mean±SD
Sex	Men: 42 Women: 19
Age (years)	64.31±12.65
Weight status (by BMI)	Normal: 17 Overweight: 22 Obesity I: 15 Obesity II: 3 Obesity III: 5
Referral type	Surgical: 10 Medical: 43 Mixed: 8
Hospital days	16.54±14.94
ICU days	13.57±14.20
SOFA score day 1	8.70±3.25
Hemofiltration count	2.02±1.49
HF duration (h)	27.59±22.39
Disease states	Acute kidney injury (AKI): 30 Chronic kidney disease (CKD): 14 Pneumonia: 6 Bronchopneumonia: 12 Pleurisy: 7 Chronic obstructive pulmonary disease (COPD): 8 Acute respiratory distress syndrome (ARDS): 13 Hyperbilirubinemia: 16 Hepatic cirrhosis: 5 Acute liver failure: 15 Acute pancreatitis: 8 Diabetes mellitus: 20 Atrial flutter/ fibrillation: 5 Hypertension: 5 Heart failure: 17 Severe sepsis: 11 Septic shock: 17 Multisystem organ failure (MSOF): 11

Metabolic imbalances	Acidosis: 39 Hyperkalemia: 10 Hypernatremia: 1 Hyperhydration: 17 Dehydration: 3
Mortality status	Deceased: 45 Survived: 16
Cause of death	Cardiac arrest: 23 Multiple organ dysfunction syndrome (MODS): 21 Others: 1
Survivor status	Recovered renal function: 10 In dialysis program: 6

Cluster analysis revealed an optimal classification of patients into 6 clusters: three with high mortality rate (between 90 and 100%), one of intermediate mortality (72%) and two with lower mortality (60-62%). The final mapping was performed according to over 20 criteria, the most important ones are described in the following table 2.

Table 2. Cluster Centers mapping (n=6 clusters)

Cluster No.	1	2	3	4	5	6
Diabetes	0	0	1	0	0	0
Cirrhosis	1	0	0	0	0	0
Obesity	0	0	1	0	0	0
Preserved diuresis	0	0	0	0	1	0
Hyper-hydration	0	0	1	0	0	0
Acidosis	1	1	1	1	0	1
Severe sepsis	0	0	1	0	0	0
Septic shock	1	0	0	1	0	0
Electrolyte imbalance	1	0	1	0	0	0
MSOF	1	0	0	0	0	0
AKI	1	1	1	0	0	0
Pneumonia	0	0	1	0	0	0
Broncho-pneumonia	0	1	1	0	0	0
Pleurisy	0	0	0	0	0	1
Heart failure (left)	0	0	1	0	0	1
Acute pancreatitis	1	0	0	0	0	0
CKD	0	0	1	0	0	1
Acute respiratory failure	0	1	1	0	0	1

Cluster 1 comprises 3 men, admitted for mixed (surgical and medical) conditions, with under 2 weeks hospitalization time (and ICU time). Age bracket: 45-65 years. Weight status: overweight or obesity stage 1. No previously diagnosed heart disease, valvular disease or hypertension, no chronic pulmonary or renal pathology. Hepatic cirrhosis and acute hepatic failure are present, with the setting of AKI with acidosis, diuresis impairment (oligo-anuria) and moderately increased creatinine: 2-3 mg/dL. Other prevalent associations: septic shock, acute pancreatitis, hyperbilirubinemia and pneumonia/bronchopneumonia. Treatments applied: CRRT hemofiltration (average of 1 procedure/2 days), mechanical ventilation, anticoagulants, UFH heparin, antibiotics, vasopressors. All the patients in cluster 1 progressed towards exitus (with shock and electrolyte imbalance). Registered cause of death: MODS.

Cluster 2 includes 5 women and 7 men, admitted for surgical or medical conditions, with hospital (and ICU) time between 2 and 54 days. Age bracket: 55-88 years. Weight status: normal or overweight. Defining associations: AKI and acute respiratory failure (without previous chronic involvement of the systems) with diuresis impairment (oligo-anuria) and higher creatinine level than cluster 1 (average 3.8 mg/dL). Other significant conditions: acidosis (58.3%), bronchopneumonia (50%), diabetes (25%), septic shock (25%). No heart failure, pneumonia or acute pancreatitis were associated with this cluster. Treatments applied: CRRT hemofiltration (average of 1.5 recorded procedures/patient), mechanical ventilation, anticoagulants, mostly UFH (but also LMW in 2 cases) heparin, antibiotics, vasopressors, diuretics. From the 12 patients in this cluster, 11 progressed towards exitus. Cause of death: MODS (3 cases), cardiac arrest (8 cases).

Cluster 3 represents 4 men, admitted for medical conditions, with hospital time of 6-51 days, and ICU time of 6-40 days. Age bracket: 76-86 years. Weight status: heterogenous. Defining associations: AKI overlapping on CKD and acute respiratory failure with bronchopneumonia, with severe sepsis as well as heart failure. Creatinine levels even higher (average 4.6 mg/dL). Other prevalent associations: hyperhydration (75%), pneumonia, diabetes and acidosis (50%). No liver involvement or acute pancreatitis were associated with this cluster. Treatments applied: CRRT hemofiltration (1 procedure/patient), mechanical ventilation, anticoagulants, mostly UFH (but also LMW in 1 case) heparin, antibiotics, vasopressors, diuretics. All the pa-

tients in this cluster progressed towards exitus. Cause of death: cardiac arrest.

Cluster 4 is the intermediate mortality group, including 4 women and 7 men, who were admitted for medical and/or surgical conditions. Hospital and ICU stay time were also moderate, between 2-28 days and 2-18 days respectively. Age bracket: 36-72 years. Weight status: heterogenous. Characteristic associations: septic shock and acidosis, without pneumonia, cirrhosis, COPD or acute pancreatitis. Diuresis was impaired (oligo-anuria) and creatinine levels very heterogenous (from normal range to 10 mg/dL). Other associated conditions: diabetes (45%), acute liver failure, history of cancer (36%), CKD, hyperbilirubinemia, hyperhydration (27%). Treatments applied: CRRT hemofiltration (average 2 procedures/patient), mechanical ventilation, anticoagulants, mostly UFH (but LMW instead in 1 case) heparin, antibiotics, vasopressors, diuretics. In this cluster 8 out of 11 patients (72.7%) progressed towards exitus. Cause of death: MODS (6 cases), cardiac arrest (2 cases). The survivors were non-diabetic, the 2 youngest in the cluster (CKD, without AKI, both in dialysis program after follow up) and also the eldest (renal abscess with AKI but low creatinine levels, complete recovery after 28 days follow up).

Cluster 5, the first lower mortality group, includes 17 men and 9 women, 77% admitted for medical conditions. Hospital and ICU time range between 1 and 38 days. Age 41 to 83 years (average 62 ± 12). These patients have mostly preserved diuresis (normal/oliguria with average serum creatinine of 3 mg/dL). Septic shock was absent, severe sepsis present in only 3 cases (11%), while 65% of the patients were non-obese. Acidosis was registered in 12 patients (46%), uncorrelated with diabetes status. Lack of pneumonia, bronchopneumonia and cirrhosis also define this group. Treatments applied: CRRT hemofiltration (average 2.4 procedures/patient), mechanical ventilation, anticoagulants, mostly UFH (but LMW instead in 3 cases) heparin, antibiotics, vasopressors, diuretics. In this cluster 16 out of 26 patients (61.5%) progressed towards exitus. Cause of death: cardiac arrest (9 cases), MODS (6 cases), other (1 case).

Cluster 6, the second lower mortality group, comprises 4 men and 1 woman all admitted for medical conditions. Hospital and ICU time range between 7 and 23 days. Age 52 to 80 years. These patients feature CKD (without AKI usually), with acidosis, heart failure and acute respiratory failure. None are obese, while pneumonia, bronchopneumonia, hepatic cirrho-

sis, acute liver failure and acute pancreatitis are also not present. Treatments applied: CRRT hemofiltration (average 2 procedures/patient), mechanical ventilation, anticoagulants, UFH heparin, antibiotics, vasopressors, diuretics. In this cluster 3 out of 5 patients (60%) progressed towards exitus. Cause of death: MODS. The survivors characteristics: no diabetes, no fluid/electrolyte imbalance, previous inclusion in dialysis program.

Discussions and conclusions

A comprehensive literature search revealed the worldwide need of data on hemofiltration for treatment of AKI [4]. Previous research suggests there is no significant improvement, regarding mortality or organ dysfunction, provided by hemofiltration alone, and compared with hemodialysis. There is also a lack of data regarding biological mechanisms underlining hemofiltration utility in AKI [2-4] and the procedure's therapeutic benefits, as well as in other procedures for vital functions replacement [2-5].

The present research attempts a classification of patients based on disease types and biological manifestations, with the aim of successfully identifying patient clusters related to favourable and unfavourable outcomes. To an extent, the initiative was successful in identifying clusters of patients with widely separated mortality/survival (given the average mortality/survival of 73.7%). Of the 6 clusters, some are better defined (1,2,6), others are less defined, with more intracluster heterogeneity. This indi-

cates potential for further cluster refinement by adding extra variables and increasing the number of cases undergoing analysis.

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