Patients with end stage renal failure (ESRF) present a number of challenges to the anesthesiologist. They may be chronically ill and debilitated and have the potential for multisystem organ dysfunction. Patients with primary renal disease are likely younger and have good cardiopulmonary reserve. Older patients with renal failure secondary to diabetes mellitus or hypertension may suffer the ravages of diffuse atherosclerosis and heart disease. To safely manage these patients we need to understand the benefits and limitations of dialysis, problems related with primary disease, pathophysiologic effects of ESRF, and the altered pharmacology of commonly used anesthetic agents and perioperative medications in ESRF. Problems encountered by anesthesiologist in ESRF patients include hypertension, ischemic heart disease, congestive heart failure, anemia, metabolic acidosis, hyperkalemia, hyponatremia and circulatory collapse. All surgical procedure in patients with ESRF carries significant risk of peri- and postoperative complications (mostly cardiovascular) and even fatal outcome.

Key words: preoperative assessment, end stage renal failure, peritoneal dialysis, hemodialysis

INTRODUCTION

Chronic renal failure (CRF) refers to a decline in the glomerular filtration rate (GFR) caused by a variety of diseases, such as diabetes, glomerulonephritis, and polycystic kidney disease. Patients with CRF have a high prevalence of hypertension. Whether hypertension is a cause or a result of CRF remains debatable. CRF may be categorized as mild (GFR of 60-89 mL/min/1.73 m²), moderate (GFR of 30-59 mL/min/1.73 m²), severe (GFR of 15-29 mL/min/1.73 m²), or end-stage renal failure (ESRF). Hemodialysis or peritoneal dialysis is typically initiated as the GFR falls to less than 15 mL/min/1.73 m². Some patients with CRF eventually receive kidney transplantation before (a few cases) or after (most recipients) initiation of hemodialysis or peritoneal dialysis.

Patients with CRF have a higher incidence of coronary artery disease (CAD) and peripheral vascular disease (PVD) compared to the general population. This is because they have the traditional risk factors for CAD, such as advanced age, diabetes, hypertension, and lipid disorders, as well as a high prevalence of nontraditional risk factors, such as hyperhomocysteinemia, abnormal calcium phosphate metabolism, anemia, increased oxidative stress, and, perhaps, uremic toxins. Based on the updated American College of Cardiology/American Heart Association (ACC/AHA) guidelines on perioperative cardiovascular evaluation of noncardiac surgery, patients with a creatinine level greater than or equal to 2 are considered to have a clinical predictor of at least intermediate pretest probability of increased perioperative cardiovascular risk. This increased risk warrants detailed cardiovascular surveillance before intermediate- or high-risk surgery.

Thus, patients with end-stage renal failure (ESRF) undergoing chronic extrarenal depuration program (peritoneal dialysis, hemodialysis) are at high risk of development of perioperative complications if subjected to any type of surgical intervention. Therefore, their preoperative preparation represents a great challenge for the medical team participating in the preparation (anesthesiologists, surgeons, nephrologists...). Anesthesia-related problems encountered in patients with ESRF include hypertension, ischemic heart disease, congestive heart failure, anemia, metabolic acidosis, hyperkalemia, hyponatremia and circulatory collapse. All surgical procedures performed in ESRF patients are associated with significant risk of peri- and postoperative complications (most commonly cardiovascular), even those with lethal outcomes1. The following aspects must be considered in patients with renal failure upon perioperative evaluation and assessment of surgical risk:
1. Problems associated with the underlying disease which led to ESRF
2. Pathophysiological effects of ESRF
3. Influence of ESRF on pharmacokinetics and metabolism of the anesthetic agents and other medications applied perioperatively
4. Influence of anesthesia on the renal function

Having in mind the above aspects, disorders such as anemia, coagulopathies, hydroelectrolyte and metabolic imbalance should be corrected, as well as functional disorders of the cardiovascular, respiratory, nervous, gastrointestinal and other systems.

PROBLEMS ASSOCIATED WITH UNDERLYING DISEASE

Conduct a thorough history and physical examination because they are essential in the evaluation of patients with CRF prior to surgery. Obtain information on the following during the history and physical examination: blood pressure and sugar trends, presence of anemia, radiocontrast exposure, prior surgical experiences, bleeding tendencies, allergies, use of potentially nephrotoxic drugs, nutritional and volume status, significant history of cardiovascular disease or peripheral arterial disease (PAD), presence of comorbid disease, functional capacity.

The condition underlying ESRF may be certain disease such as diabetes mellitus, hypertension, sickle cell anemia, systemic lupus erythematosus or vasculitis. The diseases may be accompanied by their inherent complications necessitating careful preoperative evaluation and preparation. Patients with primary renal diseases (e.g. IgA nephropathy) are usually younger with good cardiovascular reserve. Elderly patients who develop renal failure as a consequence of diabetes mellitus or hypertension may have arteriosclerosis or heart disease. ESRF resulting from sickle cell anemia, systemic lupus erythematosus or vasculitis includes multisystem dysfunction. Patients with ESRF are at high risk of onset of the acute renal failure (ARF) that may develop even after minimal hemodynamic disorders. These patients are usually treated for the underlying disease (hypertension, diabetes, etc.) and they are on low protein diet and potassium and vitamin D supplements).

PATHOPHYSIOLOGICAL EFFECTS OF ESRF RELEVANT FOR PREOPERATIVE PREPARATION

ESRF is characterized by a range of effects influencing homeostasis and function of almost all organs and systems of organs. From the aspect of significance for preoperative preparation, management of anesthesia and possible development of complications, fluid balance, electrolytes, metabolic and nutritive disorders are of particular importance, as well functional disorders of the organs and systems of organs (cardiovascular diseases, hemolytic changes, disorders of the pulmonary function, nervous and other systems).

Fluid balance is disturbed since the patients may be anuric or oliguric (with diuresis less than 500 ml/24h). In numerous patients diuresis ranges between 500 and 1000 ml/24h or more, however their kidneys do not have urine concentration capacity.

Metabolic acidosis - ESRF patients have chronically increased anion gap and metabolic acidosis due to retention of phosphates and sulfates, which are normally excreted via the kidneys. In chronically dialyzed patients, it is poor to moderate, however buffer bases are reduced.

Potassium balance - potassium level may vary from hypo- to hyperkalemia. Normal ratio between the intracellular and extracellular potassium concentrations is 35:1 (i.e. 140:4 mmol/l). The ratio is maintained owing to the sodium-potassium ATPase pump, which pumps potassium into the cells against a concentration gradient. The pump may be stimulated by beta agonists (which may lead to extracellular hypokalemia) or by beta-blockers (which may lead to extracellular hyperkalemia). In acute acidosis, serum potassium rises for approximately 0.5 mmol/l with each pH decrease of 0.1. Potassium level of 3.5 mmol/l in a patient having pH of 7.20 is indicative of the excessive potassium loss from the whole body. When pH is corrected to 7.40 serum potassium may even fall to 2.5 mmol/l. Conditions that may lead to life-threatening hyperkalemia in ESRF include catabolic stress (major trauma, major surgery, sepsis), acute acidosis, drugs (non-steroidal antiinflammatory drugs - NSAID, ACE inhibitors, spironolactone, beta blockers, nephrotoxic drugs: cyclosporin A, ami-noglycosides, amphotericin B).

Magnesium balance - Hypermagnesemia is a frequent finding in ESRF patients, and it is caused by inadequate dialysis or magnesium ingestion, most commonly by antacids. It may lead to weakness of the skeletal muscles and potentiate effects of the muscle relaxants.

Calcium and phosphate balance is disturbed since phosphate elimination is dependent on renal excretion. Vitamin D3 (1,25-dihydroxycholecalciferol) produced in the kidneys is deficient, which results in hyperphosphatemia with hypocalcemia while hyperparathyroidism may ensue as well. Due to aggressive dialysis and antacid treatment, the same patients may also develop hypophosphatemia (phosphate less than 1.5 mg/dl) resulting in muscle weakness, tremor, ventilatory failure, osteoporosis and hemolytic anemia.

Cardiovascular diseases

Hypertension (HTA) is the most common problem in ESRF patients. In one third of the cases, it is the consequence of increased renin activity and the results achieved with nephrectomy in these patients are excellent. HTA also develops as a consequence of hypervolemia due to salt and water retention, and it is generally well corrected by dialysis. HTA may also ensue as a consequence of increased sympathetic activity. In addition to dialysis, the treatment includes combinations of different antihypertensives, such as beta-blockers, ACE inhibitors, calcium channel blockers.

Atherosclerosis development is rapid in CRF patients as a consequence of hypertension, glucose metabolism and hyperlipidemia.
HTA, atherosclerosis and hyperlipidemia combined with anemia lead to the ischemic heart disease, which is the second most frequent coexisting heart disease in ESRF patients after hypertension, leading to congestive heart failure and uremic pericarditis, which may also be seen.

**Hemolytic changes**

*Anemia* is more commonly of the normochromic normocytic type, with hematocrit ranging between 0.25 and 0.28. It is primarily caused by disturbed erythropoiesis (due to decreased synthesis and release of erythropoietin), followed by shorter RBC half-life, activation of hemolysis and bleeding, recurrent blood losses in the course of hemodialysis, uremia-induced bone marrow suppression, aluminium toxicity and iron, folate, vitamin B6 and B12 deficiencies. In presence of low hemoglobin and hematocrit values, blood oxygen capacity is reduced even by 50%, with compensatory increase in cardiac output and production of 2,3-diphosphoglycerate in the erythrocytes causing right shift of the oxyhemoglobin dissociation curve. Application of biosynthetic erythropoietin enables considerable correction of anemia, owing to its capacity to return hemoglobin to normal values. On the other hand, erythropoietin may aggravate hypertension, and thus it should be cautiously dosed.

*Uremic coagulopathy* - standard coagulation tests such as prothrombin time (PT), partial thromboplastin time (PTT) and thrombin time (TT) as well as platelet count are usually normal in ESRF. Bleeding time is usually prolonged to 15 minutes or even more, which is indicative of abnormal platelet function. It is most frequently the result of insufficient production or poor release of von Willebrand factor (VWF) and factor VIII from the capillary endothelium. VWF-FVIII activates the platelets and it is responsible for normal aggregation. Functional thrombocytopenia increases the risk of surgical bleeding, intracerebral bleeding and pericardial hemorrhagic effusion. Thrombocytopenia is corrected by dialyses, transfusion of platelets, cryoprecipitate, 8-deamino-D-arginine vasopressin (DDAVP) and conjugated estrogens.

**Pulmonary function** is compromised in patients with ESRF. Hypoalbuminemia and low oncotic pressure lower the threshold for development of the pulmonary edema. Reduced surfactant production reduces forced vital capacity and increases the risk of onset of postoperative atelectasis. Abdominal distension and pressure on diaphragm may additionally hinder ventilation in patients undergoing peritoneal dialysis. Pneumonias and pleural effusions are by far more frequent in ESRF patients.

**Gastrointestinal tract** (GIT) is irritated in ESRF patients due to high urea values and development of uremic ente-ropathy. The entire GIT may be inflamed and irritable. The usual symptoms include: anorexia, nausea, vomiting GIT bleeding, diarrhea and hiccups ESRF patients suffer from decelerated intestinal passage along with increase in acidity and gastric volume, which is of the particular importance from the anesthesiological point of view, since regurgitation may ensue upon introduction of anesthesia as well as aspiration of the gastric content.

**Nervous system** is also damaged by the effects of uremia, with diverse dysfunctions encountered within uremic encephalopathy, ranging from drowsiness, reduced mental capacities and myoclonus all the way to epileptic seizures. Disequilibrium syndrome is characterized by dehydration, weakness, nausea, vomiting and hypotension, while seizures and coma are also possible. It is the consequence of sudden changes of the extracellular volume and electrolyte concentration as well as of the cerebral edema. Dementia is a severe, life-threatening disorder seen in chronically dialyzed patients with aluminium toxicity being its most probable cause.

**Peripheral neuropathy**, particularly affecting the lower extremities may also develop, as well as possible dysfunction of the autonomic nervous system. The consequences include development of painless ischemic heart disease, reduced gastric emptying and onset of the postural hypotension.

**Nutritional and metabolic problems.** Uremic patients are prone to hyperglycemia and hypertriglyceridemia due to increased peripheral resistance to insulin and reduced lipoprotein lipase activity. All the above influences the increase in incidence of the coronary diseases. *Malnutrition* may be seen in patients undergoing peritoneal dialysis with protein loss. Malnutrition associated with uremia and anemia leads to reduced resistance to infections5.

**EFFECTS OF ESRF ON PHARMACOKINETICS AND METABOLISM OF DRUGS AND ANESTHETIC AGENTS**

Pharmacokinetic of numerous anesthetic agents and drugs applied in the perioperative period is changed in patients with end-stage renal failure as a comorbidity. Elimination of the liposoluble, highly ionized drugs is either partially or completely dependent on renal excretion and it may be significantly reduced. Duration of action of drugs administered as bolus or rapid infusions depends on redistribution rather than on elimination. It means that the initial drug dose reduction is not necessary (if free drug fraction is not increased). In case of repeated doses, elimination plays a major role rather than redistribution. The former is of the utmost importance for planning and making a concept of surgical and intensive treatment of the patients, since it may lead to conclusion that maintenance doses of the drugs predominantly excreted via the kidneys should be significantly reduced (by 30-50%). The above primarily applies to muscle relaxants gallamine and di-methyltubocurarine, which are contraindicated in ESRF and presently practically out of use. As for antibiotics, penicillin, cephalosporins, aminoglycosides and vancomycin should be cautiously dosed, while when cardiovascular drugs are in question, particular attention should be paid to digoxin in order to avoid overdosing and manifestation of toxic effects of the medications 4.

Drugs partially dependent on renal excretion and frequently used in anesthesia include anticholinergics (atropin, glycopyrrolate), cholinergics (neostigmine, pyridostigmine, edrophonium), muscle relaxants (pancuronium,
pipercuronium, d-tubocurarine, vecuronium, doxacurium) and barbiturates (phenobarbital), and thus, caution is also required with their dosing. In addition to anesthetic agents, certain cardiovascular drugs (milrinone, amrinone, amphetamine) are also partially excreted via the kidneys, and therefore careful dose titration is required.

Drugs with active or toxic metabolites dependent on renal excretion, should be avoided in ESRF patients. They primarily include morphine (antianalgesic metabolite), meperidine (neuroexcitatory metabolite), diazepam (metabolite oxazepam is a sedative), enflurane (produces neurotoxic fluorides), vecuronium and pancuronium (metabolites have relaxant activity), procarbazine and benzodiazepines (diazepam is neurotoxic).

There are certain drugs, which in presence of ESRF increase their free fraction, which is non-protein, since CRF is associated with hypoalbuminemia and acidosis. The dose should be reduced by 30 to 50%. The former primarily applies to barbiturates (thiopental and methohexital) and benzodiazepines (diazepam).

**PREOPERATIVE EVALUATION AND PREPARATION OF PATIENTS**

Preoperative evaluation of patients with ESRF should include detailed history and physical examination related to the comorbidity as well as targeted laboratory, consultant and other examinations in order to assess surgical risk and make appropriate concept of management of anesthesia, administration of preoperative medications, intensive therapy and prevention of complications.

History should be focused on obtaining the information on CRF cause, daily diuresis, presence of arterial vascular fistula, method of dialysis, number of dialysis sessions per week, their duration in hours, tolerance, side effects, manifestations of the systemic diseases and CRF complications (bleeding, encephalopathy, neuropathy). Information on recent treatment and previous anesthesia as well as current therapy should be also obtained.

Clinical examination should include search of signs of bleeding (bruises, petechiae), anemia (hyperdynamic circulation, systolic murmur, palp), excessive hydration or dehydration, inflammations, pericardial effusion, pneumonia, encephalopathy, neuropathy. Arterial vascular fistula and peritoneal catheter should be examined as well.

Laboratory tests should include: hematocrit, total blood cell count (type of anemia, leukocytosis), urinary analysis (blood, proteins, infection), electrolytes (sodium, potassium, calcium, phosphates), urea, creatinine, coagulation testing (PT, PTT, TT, platelet count, bleeding time).

Electrocardiogram (ECG) is mandatory due to possible myocardial ischemia, left ventricular hypertrophy, arrhythmia and potassium level determination. In case of any evidences of ECG changes, consultative examination with the cardiologist is required. If considered indicated by the cardiologist, additional evaluation, primarily ultrasound examination of the heart may be carried out as well. Ultrasound of the heart may provide useful information on cardiac contractility, ejection fraction, condition of the heart valves or it may indicate presence of the left ventricular hypertrophy, pericardial effusion, etc.

Lung x-ray is also mandatory due to possible presence of pleural or pericardial effusion, pneumonia and heart enlargement. The so-called uremic lung may also be occasionally seen.

Preoperative transfusion is not indicated in patients with chronic, stable anemia and hematocrit value above 0.25. Unnecessary transfusion increases the chances of infection, overfilling of the vascular bed and onset of edema. If necessary, it should be applied in the course of dialysis in order to maintain fluid balance, potassium level and blood pH.

Correction of coagulopathy is performed in thrombocytopenic conditions characterized by diffuse petechiae and bleeding time longer than 15 minutes. In such conditions, platelet transfusion should be administered regardless of their count above 100000/mm³. Recovery of platelet function is also achieved within 1-2 hours by administration of 8-deamino-D-arginine vasopressin (DDAVP) in dose of 0.3 mg/kg i.v. for approximately 6 to 12 hours. Therefore, it would be best to apply it 1 hour before the surgery as slow infusion (20 - 30 minutes) in order to avoid hypotension. Cryoprecipitate infusion may be also applied, particularly if DDAVP was already applied over the previous days.

Control of hypertension is achieved by combination of antihypertensives such as beta blockers, ACE inhibitors, calcium channel blockers as well as by dialysis. Discontinuation of clonidine or beta-blocker therapy is not recommended in order to prevent reactive hypertension, tachycardia and myocardial infarction within the perioperative period. Some authors suggest withdrawal of ACE inhibitors in the postoperative period, particularly in patients in whom development of hypotension and large volume distribution is expected.

Control of hyperkalemia is best achieved by removal of potassium by dialysis, which is always performed when elective surgical interventions are in question. However, in case of emergency, vitally indicated surgical interventions when the patient cannot be subjected to extrarenal decontamination, certain alternative therapies may be applied for reduction of serum potassium values. Potassium effects may be antagonized on the cell membrane (using calcium chloride), or potassium translocation from the extracellular space to the intracellular space may be supported (using mechanical hyperventilation, sodium bicarbonates or glucose - insulin infusion).

Control of glycemia is of the great importance in order to prevent onset of hypoglycemia, catabolism and hydro-electrolyte imbalance in the perioperative period. Depending on the preoperative glycemic control regimen, as well as depending on the type and extensiveness of the planned surgical intervention (degree of stress), different strategies aimed at maintaining of normoglycemia and avoiding of diabetes-related complications are employed. To this end, it would be necessary to follow the recommendations, algorithm and protocols designed for
the patients in perioperative period and in the intensive therapy units.

Preoperative administration of immunosuppressive drugs is carried out in patients with ESRF planned for kidney transplantation, as well as in already transplanted patients. These drugs also have their inherent side effects and administration-related risks. Anti-thymocyte globulin (ATG) is most commonly applied preoperatively. It must be administered via the central venous catheter across the 0.2 micron filter. The infusion is administered slowly with only approximately 5-10% of the dose applied within the first hour. Antihistamine, corticosteroid and antipyretic premedication is necessary.

Preoperative dialysis is one of the most important elements of the good preoperative preparation of patients with ESRF as the comorbidity. It is currently routinely applied in preparation of patients with marked renal failure and it is essential in control of the pulmonary edema, hyperkalemia and acidosis, however it does not guarantee normal platelet function, rapid wound healing or avoiding of sepsis.

Inadequate dialysis may cause intravascular hypovolemia (even in presence of the peripheral edemas) and electrolyte deficiency (hypokalemia, hypomagnesemia, hypophosphatemia). It may lead to reduced left ventricular ejection fraction and perfusion defects in the heart in absence of visible ECG changes in individuals without previous positive history of the coronary disease. Urea is rapidly removed from the intravascular space by hemodialysis, unlike the brain, since blood-brain barrier does not allow it and brain cells become relatively hypertonic. The fluid is diffused toward the brain cells due to osmotic gradient resulting in brain edema and onset of dysequilibrium syndrome. Hemodialysis is performed before the surgery without heparin due to possibility of major intraoperative bleeding. Evaluation of fluid balance, electrolyte and coagulation status is also mandatory in the postoperative period. The patient usually undergoes dialysis as scheduled, however in case of significant imbalance in the organism caused by surgical intervention, the patient may also be dialyzed in the immediate postoperative period. Potassium solutions should not be used in the postoperative period due to the risk of hyperkalemia.

Fluid replacement in the perioperative period depends on whether the patient is with or without diuresis. As for the patients without diuresis, loss caused by surgery, perspiration-related loss (500-800 ml/24h) and third-space fluid loss (dependent on surgery) are replaced by physiological saline and glucose. If the patient is with diuresis and CRF, the fluid is replaced in the same way as in the patients without diuresis with additional compensation for the achieved diuresis. In case that forced diuresis is needed, mannitol and furosemide are applied.

Preoperatively administered immunosuppressive drugs are recurrent bacterial peritonitis, a peritoneal catheter tunnel infection, and fungal peritonitis.

In the perioperative period, the effects of anesthesia on the renal function and/or diuresis should be considered and anticipated, since the residual diuresis in ESRF patients may be completely extinguished. Application of anesthesia itself may lead to development of hypotension and thus also to renal hypoperfusion, which leads to hypoxia and renal cell injuries. Secretion of the kidney hormones remains preserved until mean arterial pressure falls below 60 mmHg. Fall of the mean arterial pressure by 50% over the period of 3 hours during anesthesia leads to acute renal failure in 80% of the cases. Ventilation regimen, primarily hyperventilation reduces the mean arterial pressure through increase of the intrathoracic pressure and direct vasodilatation caused by hypocapnia. Hypoventilation influences vasoconstriction of the renal arteries and reduces renal blood flow. Position of the patient on the operating table also influences kidney function. Positioning of a patient primarily in anti-Trendelenburg position, flexed lateral or sedentary position may cause major fall of the arterial pressure and hypoperfusion of the kidneys. Intraoperative bleeding, if not replaced by sufficient amounts of blood and solutions may led to reduced renal perfusion, since physiologically they are first excluded from circulation in the state of hypovolemia. Nephrotoxicity of the drugs is also important. Halogen inhalation anesthet-
ics, aminoglycosides, cytostatic agents, contrast media and cephalosporins all have toxic effects primarily on the distal tubuli, that is on the collecting ducts. They exert their effects through inhibition of sodium-potassium ATPase and calcium ATPase transport system mechanisms, also causing accumulation of calcium in the cell, which has noxious effects on the mitochondria. Certain halogen anesthetics release highly toxic fluorides. Drugs may also influence lysosomal membranes, while kidney lesions may also be caused by activation of the immune mechanisms.

**CONCLUSION**

Renal disease presents special issues in surgical patients. When consulted for a preoperative evaluation of a patient with renal insufficiency, mild, moderate or ESRF, or a patient with high risk for renal insufficiency it is important to remember the following points: Ensure hydration and avoid hypotension. Evaluate volume status clinically and correct any imbalance, check electrolytes including magnesium level and replace them if necessary. Hold medications that cause volume shifting such as diuretics. Avoid nephrotoxins when possible and if they cannot be avoided, minimize renal injury by ensuring hydration. When appropriate, use low -osmolality agents and try to space out procedures. Evaluate for anemia and platelet dysfunction. Consider the need for transfusion and DDAVP if risk of bleeding is high. Remember the high risk for infections, obtain cultures soon, start appropriate empiric treatment if signs of infection are present.

**SUMMARY**

**PREOPERATIVNA PRIPREMA BOLESNIKA SA TERMINALNOM FAZOM HRONIČNE BUBREŽNE INSUFICIJENCIJE**

Bolesnici sa terminalnim stadijumom bubrežne insuficijencije (ESRF) nose sa sobom niz izazova za anesteziolega. Oni mogu biti hronično bolesni i iznureni sa mogućom multiorganskom disfunkcijom. Bolesnici sa osnovom bubrežnom bolesti su obično mladi i imaju dobru kardiovaskularnu rezervu. Stariji bolesnici sa bubrežnom insuficijencijom nastalom kao posledica diabetes mellitusa ili hipertenzije mogu patiti od posledica difuzne ateroskleroze i bolesti srca. Da bi smo obezbedili sigurnu anesteziju i tretman ovih bolesnika moramo razumeti mogućnosti i korist dijalize, probleme povezane sa osnovnom bolesti, patofiziološke efekte ESRF, izmenjenu farmakologiju nječešće upotrebljavanih anestetičkih sredstava i perioperativno primenjenih lekova. Anestiziološki problemi kod bolesnika sa ESRF uključuju hipertenziju, ishaemičnu bolest srca, kongestivnu srčanu slabost, anemiju, metaboličku acidozu, hiperkalijemiju, hiponatremiju i cirkulaturni kolaps. Sve hirurške procedure kod bolesnika sa ESRF donose značajan rizik od peri- i postoperativnih komplikacija (najčešće kardiovaskularnih) pa čak i onih sa smrtnim ishodom.

**REFERENCES**


**Ključne reči:** preoperativna priprema, terminalni stadijum bubrežne insuficijencije, peritonealna dijaliza, hemo