OPIS PRZYPADKU CASE REPORT

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Haemodialysis therapy in patients with low serum creatinine concentrations – case series

Hemodializoterapia u pacjentów z niskim stężeniem kreatyniny – opis serii przypadków

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Słowa kluczowe
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Summary

According to the KDIGO recommendations published in 2012, the absolute indications for initiation of dialysis therapy in patients with ESRD include at least one of such emerging symptoms as: serositis, electrolyte or acid-base imbalance, uncontrolled volume status or hypertension, pruritus, progressive cachexia or cognitive impairment. These symptoms usually occur when eGFR reaches values between 6 and 10 ml/min/1.73 m^2. The credibility of GFR estimation with the MDRD formula is limited. The bias may result from patient's race or ethnic origin different from the population for which the equation was prepared for. Moreover, the serum creatinine level may be inadequate due to extremely low or high muscle mass, growth, high-protein diet, administration of creatinine preparations, or muscle atrophy. These factors may significantly influence the efficacy of dialysis sessions, especially in the view of chronic dialysis therapy, and may result in inadequate prescription of the dialysis dose. Here we describe five patients, who require intensive chronic haemodialysis treatment despite the relatively high eGFR values.

Streszczenie

Zgodnie z wytycznymi KDIGO, opublikowanymi w 2012 roku, bezwzględne wskazania do leczenia nerkozastępczego w ESRD obejmują pojawienie się: zapalenia błon surowiczych, zaburzeń elektrolitowych i kwasowo-zasadowych, niekontrolowanego przewodnienia i nadciśnienia tętniczego, świądu skóry, wyniszczenia oraz zaburzeń funkcji poznawczych. Wystąpienie tych objawów zwykle ma miejsce, gdy eGFR obniży się do wartości 6-10 ml/min/1,73 m^2. Najczęściej w praktyce klinicznej stosowane są metody oceny eGFR oparte na stężeniu kreatyniny w surowicy krwi (Scr). Wiarygodność oznaczeń na podstawie wzoru MDRD jest ograniczona z przyczyn wynikających zarówno z przynależności pacjenta do innej populacji niż te, dla których opracowano wzór, jak i czynników wpływających na stężenie kreatyniny w surowicy: skrajnej masy mięśniowej i wielkości ciała, diety bogatobiałkowej, spożywania preparatów kreatyny, chorób zanikowych mięśni. Czynniki te mogą istotnie wpływać na ocenę skuteczności dializoterapii, zwłaszcza stosowanej przewlekle, i prowadzić do przepisywania niedostatecznej dawki dializy. W pracy omówiono przypadki pięciorga różnych chorych, którzy wymagają intensywnego leczenia powtarzanymi hemodializami mimo stosunkowo wysokich wartości eGFR.

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INTRODUCTION

According to the KDIGO recommendations published in 2012, the absolute indications for initiation of dialysis therapy in patients with end-stage renal failure (ESRD) include at least one of such emerging symptoms as: serositis, electrolyte or acid-base imbalance, uncontrolled volume status or hypertension, pruritus, progressive cachexia refractory to dietary intervention or cognitive impairment (1). These symptoms usually occur when eGFR reaches values between 6 and 10 ml/min/1.73 m^2. In the clinical practice, the methods most frequently used for eGFR calculation are those based on creatinine serum concentration (Scr) (2). Although CKD-EPI formula is the preferred method for eGFR calculation, MDRD equation is used in the majority of laboratories (3). However, the differences be-

tween the results obtained with MDRD and CKD-EPI equations in patients with ESRD are minute.

The credibility of GFR estimation with the MDRD formula is limited. The bias may result from patient's race or ethnic origin different from the population for which the equation was prepared for. Moreover, the serum creatinine level may be inadequate due to extremely low or high muscle mass, growth, high-protein diet, administration of creatinine preparations, or muscle atrophy (4-6).

These factors may significantly influence the efficacy of dialysis sessions, especially in the view of chronic dialysis therapy, and may result in inadequate prescription of the dialysis dose (7, 8).

This paper presents five of seven cases of patients with indications for chronic dialysis therapy despite low concentrations of markers of kidney failure.

CASE 1.

Low serum creatinine concentrations in a patient with low muscle mass – a 96 year old woman with the right kidney cirrhosis and chronic kidney disease probably due to the atherosclerotic vascular nephropathy. Patient's comorbidities included: arterial hypertension, chronic coronary heart disease with a history of two acute coronary syndromes in 2007 – one of which was an NSTEMI treated with percutaneous coronary intervention with stent placement; tachycardia-bradycardia syndrome with paroxysmal atrial fibrillation and heart failure in the third stage according to the NYHA classification. The patient had been observed in the Nephrology Outpatient Clinic until March 2009 (the creatinine, urea and bicarbonate serum concentrations were 4.1 mg/dl, 95 mg/dl, and 19.8 mmol/l, respectively). As the parameters were stable the patient was diagnosed with CKD stage 5 and was referred for creation of an arteriovenous fistula. The haemodialysis therapy was introduced in June 2009 due to progression of kidney failure and worsening general condition of the patient (creatinine serum concentration 3.98 mg/dl, urea serum concentration 213 mg/dl, bicarbonate serum concentration 14.6 mmol/l). The patient was treated with intermittent dialysis sessions in a schedule 3 times a week for four hours. The dialysis dose measured with Kt/V for urea was 1.28 (table 1, mean value for 6 months of dialysis therapy). The haemodialysis therapy was complicated with an arteriovenous fistula dysfunction in 2012. The fistula was reconstructed several times with the use of PTFE. In April 2013, after another episode of arteriovenous fistula thrombosis and failure in restoring fistula patency, a tunneled, cuffed haemodialysis catheter was implanted into the right jugular vein. Next attempts for the fistula reconstruction were aborted.

During the haemodialysis therapy the patient's nutritional status maintained stable. With 149 cm height her body mass oscillated around 46 kg – BMI 18.9-22.3. Infrequently, slight oedema of lower legs was observed, while the residual diuresis remained between 1000 and 1500 ml per day on a daily dose of 5 mg of torasemide. The patient used to gain 0-3% of body mass between the dialysis sessions. During the last six months of 2015 the patient's creatinine serum concentrations fluctuated between 2.23 and 2.75 mg/dl (eGFR 14.01-20.4 ml/min/1.73 m^2), urea serum concentration was from 62 mg/dl to 121.9 mg/dl, phosphate serum concentration was between 1.38 and 1.67 mmol/l. Albumin serum concentration maintained in normal ranges – between 3.7 and 4.06 g/dl. nPCR remained on low levels – 0.49-0.8 g/kg/day. Laboratory markers of acid- base imbalance with metabolic acidosis persisted despite dialysis therapy: pH 7.23-7.39, bicarbonate concentration 18.6-27.6 mmol/l.

In September 2015 a significant increase in biochemical parameters was observed after 5 days of dialysis discontinuation (patient's creatinine serum concentration 3.78 mg/dl, eGFR 11 ml/min/1.73 m^2, urea serum concentration 135 mg/dl).

In this patient raising the dialysis dose despite low serum creatinine and urea concentrations led to an increase in BMI and albumin concentration, although nPCR levels were low. This proves that the haemodialysis therapy improved protein utilization possibly due to the decreased catabolism secondary to uremic inflammatory reaction.

Table 1. Case 1. – results of periodical predialysis laboratory tests in 2015.

	March	April	May	June	July	August
BMI	19.5	19.1	18.9	21.8	21.7	22.3
Scr mg/dl		2.94		2.23		2.75
eGFR ml/min/1.73 m^2		14.08		20.4		16
Urea pre HD mg/dl	121.9	88.3	97.2	66.4	62	68.6
Urea post HD mg/dl	66.4	27.1	31.7	15.9	28.8	28
Kt/V	0.78	1.35	1,29	1.53	1.34	1.42
HGB g/dl	11.5	12.7	10.9	10.7	11.2	
Phosphate mmol/l	1.45	1.4	1.67	1.31		1.46
Albumin g/dl		3.7				4.06
nPCR g/kg/24 h	0.74	0.76	0.8	0.63	0.49	0.75
Weight gain between dialysis sessions	2.29%	2.55%	3%	0.4%	2.08%	-0.4%

CASE 2.

Low creatinine serum concentrations in a patient with clinical symptoms of cachexia – a 72-year old patient with long-term type 2 diabetes and general arteriosclerotic vascular disease with chronic multivessel coronary artery disease. The patient was admitted to the Cardiology Department in the Priest J. Popiełuszko Bielański Hospital in Warsaw in October 2013 due to exacerbation of a chronic heart failure (NYHA III/IV, EF 25%) in the course of pneumonia. The patient had a history of a myocardial infarction with a consecutive coronary artery bypass graft in 2011 and an external iliac artery angioplasty with stent placement in 2008. During the hospitalization the patient was diagnosed with an advanced renal disease – serum creatinine, urea and albumin concentrations were 3.4 mg/dl, 105 mg/dl and 3.0 g/dl, respectively. Prior to the hospitalization the patient had never been referred to the nephrologist. The attempts of conservative treatment were ineffective, thus, the decision of initiation of the haemodialysis therapy was made. A non-tunneled haemodialysis catheter implanted through the right jugular vein was the patient's primary vascular access. During the hospitalization the patient's volume status had improved, however, biochemical renal parameters maintained elevated. The patient was referred for chronic dialysis therapy. A tunneled, cuffed haemodialysis catheter was implanted in December 2013. In February 2014 the patient's combined urea and creatinine clearance was evaluated after four days of discontinuation of haemodialysis therapy. As the result was 10 ml/min, and the nPCR was 0.79 g/kg/day, with HCO3 18.6 mmol/l we decided to continue the dialysis therapy. In March 2014 an arteriovenous fistula was created on the left forearm. In May 2015 due to the fistula dysfunction another arteriovenous fistula was formed on the left arm.

The patient has been treated with intermittent dialysis sessions in a schedule 3 times a week for four hours and the dialysis dose measured with Kt/V for urea is 1.27, that is the mean value for the last 6 months of dialysis therapy. The patient does not give consent for more intensive haemodialysis treatment (tab. 2).

The haemodialysis therapy was complicated in June 2015 with the surgically treated pertrochanteric fracture of the right femur. Moreover, the patient had symptomatic bradycardia due to the sick sinus syndrome that necessitated implantation of an artificial cardiac pacemaker (DDD). In the postoperative period a foot ulcer developed with consecutive foot phlegmon. Under surgical supervision an antibiotic therapy was introduced with a satisfactory effect and a gradual healing of the ulcer.

Currently, the patient shows clinical signs of progressive cachexia. During six months of observation the body mass had fallen from 64.5 to 56 kg (with 165 cm height). The patient has signs of excess fluid volume with ascites, feet oedema and congestion in pulmonary circulation (NYHA III). The residual diuresis is 1000 per day on a daily dose of 240 mg of furosemide. The patient gains 3-4% of body mass between the dialysis sessions. The patient's creatinine serum concentrations maintain in a range between 1.88 and 2.6 mg/dl and urea serum concentration is from 77 mg/dl to 102 mg/dl. nPCR remains on low levels – 0.63-0.88 g/kg/day. Phosphate serum concentration varies between 1.88 and 2.6 mmol/l. Albumin serum concentration is from 3.75 to 4.2 g/dl. Also, in the laboratory test findings markers of acid- base balance show signs of compensated metabolic acidosis with bicarbonate concentration: 21.5-25 mmol/l.

The predialysis biochemical markers of renal function are low and would not have been considered as an indication for dialysis therapy if they did not increase between dialysis sessions. This results probably from inadequate residual renal function despite low-protein diet. Unfortunately, the patient does not agree for more intensive haemodialysis treatment that might have prevented from further reduction in body mass and progression of cachexia.

CASE 3.

Low biochemical parameters of renal function in a patient with severe biventricular heart failure and significant weight gain between dialysis sessions – an

Table 2. Case 2. – results of periodical predialysis laboratory tests in the last six months of 2015.

	March	April	May	June	July	August
BMI	22.1	22.2	22.9	22.8	23	20.7
Scr mg/dl		2.01		1.88		2.6
eGFR ml/min/1.73 m^2		32,8		35.4		24.5
Urea pre HD mg/dl	77	74	86	88	102	97
Urea post HD mg/dl	30	29	31	31	23	27
Kt/V	1.11	1.1	1.22	1.24	1.41	1.57
HGB g/dl	11.6	11.7	10.9	11.3	10.5	10.5
Phosphate mmol/l	1.28	1.11	1.21	1.27	1.1	1.24
Albumin g/dl		4.2				3.75
nPCR g/kg/24 h	0.63	0.6	0.72	0.73	0.97	0.88
Weight gain between dialysis sessions	3.21%	3%	3.77%	3%	4.3%	0%

86-year old patient with chronic kidney disease diagnosed in February 2012 (with serum creatinine concentration 2.1 mg/dl) was admitted to the Cardiology Department in the Priest J. Popiełuszko Bielański Hospital in Warsaw in April 2015 due to the symptoms of unstable coronary artery disease. The coronary angiogram performed during the hospitalization showed multiple paramural lesions in the coronary arteries. The patient also suffered from severe mitral valve aortal valve insufficiency complicated with lung oedema and respiratory failure in July 2012. During the hospitalization in the Cardiology Department the patient had pneumonia, diarrhea associated with Clostridium difficile and urinary tract infection. Despite therapy, the patient's volume status worsened and biochemical parameters of renal function increased. Thus, a decision of initiation of haemodialysis therapy was made and the patient underwent implantation of tunneled cuffed haemodialysis catheter for a vascular access.

Since then the patient has been treated with intermittent dialysis sessions in a schedule 3 times a week for four hours and the dialysis dose measured with Kt/V for urea is 1.69, that is the mean value for the last 6 months of dialysis therapy (tab. 3). The patient general condition is moderate with signs of excess fluid volume, such as lower legs swelling, lumbar region oedema, and congestion in the pulmonary circulation. Patient's weight gain between dialysis sessions is considerable (up to 3.6% of body mass), unfortunately, he does not tolerate high ultrafiltration rate and does not agree for more intensive dialysis treatment in the form of additional dialysis sessions. The patient's residual diuresis is below 1000 ml per day on a daily dose of 240 mg of furosemide.

Despite chronic excess body fluid and low biochemical parameters of renal function patients nutritional status gradually improves (increase in BMI, serum concentrations of albumin, phosphates and nPCR).

CASE 4.

Low serum creatinine levels during haemodialysis therapy with high values of biochemical markers of renal function at qualification to dialysis treatment – a 77-year old patient with a long history of arterial hypertension and chronic kidney disease of unknown etiology diagnosed in the CKD G4 stage in 2011, under nephrological care in the Outpatient Clinic throughout the predialysis period. The patient had no other comorbidities. In March 2014 an arteriovenous fistula was created on the left forearm. Planned haemodialysis therapy was initiated in May 2014 due to the increasing values of biochemical renal parameters (serum urea concentration was 299.8 mg/dl, serum creatinine concentration was 3.18 mg/dl with eGFR 19.2 ml/min/1.73 m^2, HCO_3 20.3 mmol/l) and progressive clinical symptoms: loss of appetite, decrease in body mass, increasing values of blood pressure. A significant improvement in the patient's general condition and alleviation of symptoms occurred after initiation of dialysis therapy, and the control of blood pressure was better.

The patient has been treated with intermittent dialysis sessions in a schedule 3 times a week for four hours. The dialysis dose measured with Kt/V for urea is 1.34 – the mean value for the last 6 months of dialysis therapy. Patient's general condition remains good, stable (tab. 4). The patient's residual diuresis is 2000 ml per day on a daily dose of 240 mg of furosemide.

Patient's body mass is also stable – the weight gain ranges from 0.78 to 2.8% between dialysis sessions. In August 2015 an attempt to discontinue haemodialysis therapy was made, however, after 7 days patient's biochemical parameters significantly increased (serum urea concentration 134.5 mg/dl, serum creatinine concentration 3.46 mg/dl, combined urea and creatinine clearance was 12 ml/min). We decided to continue renal replacement therapy.

The dialysis therapy was fairly adequate. Nevertheless, the treatment cannot be aborted due to the increasing values of biochemical parameters of renal failure and low GFR estimated with combined urea and creatinine clearance.

CASE 5.

Low values of biochemical markers of kidney function and severe heart failure – a 75-year old patient

Table 3. Case 3. – results from the periodical predialysis laboratory tests performed in the last four months of 2015.

	May	June	July	August
BMI		24.2	24	24.6
Scr mg/dl		2.8		3.1
eGFR ml/min/1.73 m^2		22.01		19.11
Urea pre HD mg/dl	91.6	92	107	136
Urea post HD mg/dl		30	17	28
Kt/V		1.3	1.52	1.88
HGB g/dl	9.9	10	9.6	10
Phosphate mmol/l	1.33	1.65	1.6	1.84
Albumin g/dl	3.4			3.65
nPCR g/kg/24 h		0.78	1.09	1.26
Weight gain between dialysis sessions		1.89%	3.62%	3.35%

Table 4. Case 4. – results from periodical predialysis laboratory tests conducted in the last six months of 2015.

	March	April	May	June	July	August
BMI	23.4	23.7	23.5	23.9	23.8	23.8
Scr mg/dl		2.5		3		2.64
eGFR ml/min/1.73 m^2		24.7		20.39		23.57
Urea pre HD mg/dl	87	88	101	94	99	69
Urea post HD mg/dl	26	25	31	34	24	21
Kt/V	1.35	1.41	1.38	1.18	1.31	1.39
HGB g/dl	10.5	10.9	11.9	11.3	11.8	10.7
Phosphate mmol/l	0.96	1.11	1.04	1.04	1.17	1.02
Albumin g/dl		4.38	4.3			4.2
nPCR g/kg/24 h	0.75	0.76	0.86	0.75	0.93	0.64
Weight gain between dialysis sessions	0.78%	1.7%	2.96%	2.49%	2.96%	2.81%

has been treated for arterial hypertension since 1984. A chronic kidney disease was diagnosed in 2003. In 2006 the patient suffered from myocardial infarction that was treated with primary LAD angioplasty with a drug-eluting stent placement. Moreover, the patient was diagnosed with mitral valve insufficiency, permanent atrial fibrillation and biventricular heart failure. In April 2014 the patient underwent implantation of a cardioverter-defibrillator in the primary prophylaxis of sudden cardiac death. The patient was under a regular observation of a nephrologist in an Outpatient Clinic. Due to exacerbation of chronic heart failure and arrhythmia the patient was hospitalized several times. Moreover, in 2011 the patient was diagnosed with prostate cancer and was referred to an oncologist. A hormonal therapy was introduced under oncological supervision. In October 2014 the patient was admitted to the Nephrology Department due to the symptoms of severe biventricular heart failure (NYHA IV) with massive peripheral oedema, and congestion in the pulmonary circulation. The ejection fraction estimated in echocardiography was 26%. Serum creatinine concentration was 2.31 mg/dl. Despite administration of diuretics, neither the patient's signs of excess fluid volume, nor biochemical markers of kidney injury improved. A renal replacement therapy was introduced. After implantation of a tunneled, cuffed haemodialysis catheter through the right jugular vein haemodialysis therapy was initiated in November 2014.

The dialysis therapy brought improvement in the patient's general condition and cardiac output resulting in stabilization of circulatory system at the II level according to NYHA functional classification of heart failure.

Since November 2014 the patient has been treated with intermittent dialysis sessions in a schedule 3 times a week for four hours. The dialysis dose measured with Kt/V for urea is 1.34 that is the mean value for the periodic laboratory test findings from the last 6 months of dialysis therapy (tab. 5). Patient's general condition is fairly good with slight oedema of the lower legs. The patient's residual diuresis is 1500 ml per day on a daily dose of 360 mg of furosemide. The weight gain between dialysis sessions is considerable – up to 4.5% of body mass, that results in intensive ultrafiltration – mean 3000 ml per dialysis session.

Extreme weight gain despite abundant diuresis on high doses of diuretics necessitate continuation of haemodialysis therapy.

Table 5. Case 5. – results from periodical predialysis laboratory tests in the last six months of 2015.

	March	April	May	June	July	August
BMI	22.1	22	22	22.3	22.8	21.9
Scr mg/dl		2.35		2.38		2.69
eGFR ml/min/1.73 m^2		26,56		26.17		22.72
Urea pre HD mg/dl	111	114	128	122	145	69
Urea post HD mg/dl	35	37	43	34	45	21
Kt/V	1.35	1.37	1.31	1.52	1.34	1.39
HGB g/dl	10.2	10.7	11	10.9	11	10.7
Phosphate mmol/l	1.59	1.34	1.5	1.67	1.66	1.57
Albumin g/dl			4,1			4.1
nPCR g/kg/24 h	0.91	0.95	1.02	1.05	1.16	0.98
Weight gain between dialysis sessions	3.24%	4.59%	4.15%	3.81%	3.97%	2.98%

DISCUSSION

Patients with predialytic serum creatinine concentrations below 3 mg/dl stand for 4% of patients on haemodialysis treatment in our Haemodialysis Centre. These patients may be divided into two groups. The first group comprises patients with low creatinine concentrations due to scant muscle mass resulting from asthenic body structure or progressive cachexia. In these cases initiation of dialysis therapy improved nutritional status, prevented from further reduction of body mass and alleviated uremic symptoms. The other group includes patients with low creatinine concentrations and severe heart failure, in whom despite pharmacologic treatment residual diuresis is not sufficient to prevent form fluid overload. Symptoms in both groups result from progression of the primary disease and require continuation of renal replacement therapy.

In patients with end-stage renal failure the indications for initiation of renal replacement therapy are clinical symptoms or biochemical abnormalities characteristic for uraemia that are resistant to conservative treatment. In some patients it is necessary to begin haemodialysis therapy due to severe heart failure with excess fluid volume resistant to diuretic treatment despite eGFR above 15 ml/min. Ultrafiltration is well known to improve general condition and survival in overhydrated patients presenting with congestive heart failure resistant to diuretics (9-15). These patients require unproportionally high dialysis doses measured with Kt/V (7, 9). Furthermore, in patients with extremely low muscle mass resulting from body type or advanced cachexia, the serum creatinine concentrations remain low.

CONCLUSIONS

Consecutively, the eGFR values estimated from Scr are inadequately high in patients with cachexia and/or severe heart failure, thus these parameters do not reflect actual renal function, and to improve the nutritional status of such patients high doses of haemodialysis are required.

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