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The Incidence and Pathophysiology of the Obesity Paradox: Should Peritoneal Dialysis and Kidney Transplant Be Offered to Patients with Obesity and End-Stage Renal Disease?

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Abstract

Purpose of Review—To educate nephrologists and primary-care physicians about the incidence, pathophysiology, and survival benefits of the obesity paradox in end-stage renal disease (ESRD). This review also discusses the future of kidney transplant and peritoneal dialysis in obese dialysis patients.

Recent Findings—Obesity paradox in ESRD was first reported three decades ago, and since then, there have been several epidemiological studies that confirmed the phenomenon. Regardless of the anthropometric indices used to define obesity in ESRD patients, these markers serve to predict the dialysis patient's survival. The pathophysiology of obesity paradox tends to be multifactorial. Recent cohort studies demonstrated a survival benefit in all race and ethnic groups, but Hispanics and blacks experienced increased survival rates when compared to non-Hispanic whites. Obese dialysis patients should be offered peritoneal dialysis, especially if they are new to dialysis and have an adequate renal residual function. Several studies have shown that the benefit of receiving kidney transplant in obese patients exceeds the risks. The robotic-assisted kidney transplant (RAKT) procedure is the latest innovation that could offer hope for obese dialysis patients who have been denied or are waiting for kidney transplant.

Summary—The obesity paradox phenomenon in ESRD is a unique illustration of survival benefit in a population that has a high overall annual mortality. Peritoneal dialysis should be encouraged for obese patients who have preserved residual renal function. Kidney transplant centers should encourage RAKT utilization in obese dialysis patients instead of denying them a kidney transplant.

Keywords

Obesity paradox in ESRD; Malnutrition-inflammation complex syndrome; Peritoneal dialysis in obesity; Robotic assisted kidney transplant

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Conflict of Interest The authors declare no conflicts of interest relevant to this manuscript.

Compliance with Ethical Standards

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Introduction

In the USA, as well as in most industrialized countries throughout the world, the mean body weight of the population is on the rise, which is associated with many comorbid conditions, such as cardiovascular disease (CVD), hypertension, type 2 diabetes, metabolic syndrome, dyslipidemia, and psychosocial problems. These chronic conditions will likely result in an increase in the number of obese patients on dialysis. Patients with end-stage renal disease (ESRD) who receive maintenance dialysis therapy have a significantly higher annual mortality than those without ESRD, about 20% in the USA and 10–15% in Europe [1]. Cardiovascular disease is the leading cause of death in patients with advanced chronic kidney disease (CKD) and ESRD [2]. Mortality and hospitalization risks are extremely high during the first months of a patient's transition to dialysis, and the annual death rate may approach 30–40% [3].

An increasing number of epidemiologic studies based on analyses of large samples of dialysis patients and national databases have reported paradoxical inverse associations between obesity and mortality, a phenomenon referred to as "reverse epidemiology" or "obesity paradox" [4]. In these reports, a higher BMI in dialysis patients was associated with improved survival [4], whereas a lower BMI was associated with higher mortality [5–7]. This obesity paradox phenomenon has contributed greatly to the growing confusion among nephrologists whether or not to treat obesity in dialysis patients. Further, it created a dilemma in transplant centers as to whether to deny transplants to obese patients on pretransplant waiting lists, or to recommend weight loss programs or bariatric surgery before including them on such lists.

There is strong evidence regarding the relative survival benefit of kidney transplantation in obese patients on dialysis. This issue was addressed by an analysis of incident dialysis patients in the USA between 1995 and 1999. This study reported that kidney transplantation in obese patients (BMI ≥ 30 kg/m^2) was associated with a significant reduction (61%) in risk of death compared to continued treatment with dialysis. However, a survival advantage for transplanted morbidly obese patients with BMI ≥ 41 kg/m^2 was not demonstrated [8•]. Efforts by physicians to better understand the existence, etiology, and components of the obesity paradox in obese dialysis patients remain of paramount importance for improving their survival.

Definitions of Anthropometric Indices

Weight in kilograms divided by the square of height in meters (BMI) is one of the most reliable anthropometric indices used for large epidemiological studies for the prevention and treatment of obesity. The World Health Organization (WHO) defines normal weight as a BMI of 18.50–24.99 kg/m^2, overweight as a BMI of ≥ 25–29.99 kg/m^2, and obesity as a BMI ≥ 30 kg/m^2 [9]. However, the normal weight range varies according to racial background and ethnicity. Several authors have questioned the accuracy of BMI for prediction of outcomes in pre-dialysis and dialysis patients or in post-transplant subjects [10, 11, 12••]. Agarwal et al. [10] used air displacement plethysmography (ADP) in dialysis patients to estimate body mass and found a survival advantage in patients with normal or

increased muscle mass. Pastorino et al. have shown that waist circumference and waist/hip ratio (WHR) were better predictors of cardiovascular death than BMI in ESRD patients [12••]. In a prospective study, Kovesdy et al. analyzed in the association of BMI and waist circumference (WC) in kidney transplant recipients and found that WC appeared to be a better prognostic marker in obesity paradox [13].

Incidence of the Obesity Paradox in Different Populations

The first report of the obesity paradox in ESRD patients was published in 1982 from the Diaphane collaborative study group in France. This study included a cohort of 1453 young and mostly nondiabetic hemodialysis patients followed between 1972 and 1978 in 33 French dialysis centers. The report revealed an interesting observation; there was no increase in mortality among high-BMI dialysis patients [14]. The prospective Dialysis Outcomes and Practice Patterns Study (DOPPS) allowed for comparison of the demographics, BMI, and mortality rates of 9714 maintained hemodialysis patients (MHD) in the USA and Europe from 1996 to 2000. A multivariate survival analysis was used to evaluate the relationship between BMI and mortality in maintained hemodialysis (MHD) subpopulations defined by continent, race (black and white), gender, severity of illness score based on albumin concentration, age (< 45, 45–64, ≥ 65), smoking, and diabetic status. DOPPS revealed a lower relative mortality risk with increasing BMI. A BMI < 20 was associated with the highest relative mortality risk. This observational study showed that there was a survival benefit for healthy overweight patients (BMI 25–29.9 kg/m^2) and a greater benefit for obese patients (BMI > 30). Also, young (< 45 years old) MHD patients with low comorbidity, overweight, and obesity were not associated with decreased survival [15•].

Another interesting point is whether or not the obesity paradox exists or differs by race and ethnicity in ESRD patients. Using the US Renal Data System (USRDS), Glanton et al. performed an historical cohort study on 151,027 patients initiated on ESRD therapy who had never been transplanted. The study explored the association of various comorbidities present at the time of dialysis initiation with the presence of obesity as well as the association of obesity with patient survival. The authors found that obese patients with a BMI > 30 kg/m^2 had an unadjusted 2-year survival rate of 68%, compared with a rate of 58% for nonobese MHD patients. This complex relationship was stronger in African Americans than whites. In addition, subgroup analysis suggested that obesity in MHD is associated with an increased risk of infectious death in women [16••].

A retrospective cohort study conducted by Ricks et al. from 2001 to 2007 tested the hypothesis that minority (black and Hispanic) MHD patients had a greater survival rate than non-Hispanic whites. In this cohort of 109,605 MHD patients (including 39,090 blacks, 17,417 Hispanics and 53,089 non-Hispanic whites) a higher BMI was associated with greater survival in all racial/ethnic groups. Hispanic and black MHD patients had higher survival rates than non-Hispanic whites across all BMI categories. Surprisingly, Hispanics in the ≥ 40 kg/m^2 category had a lower death-hazard ratio compared to non-Hispanic whites in the BMI 23 to < 25 group. While the obesity paradox occurred in all subgroups, black MHD patients had the largest reduction in death related to increasing BMI [17].

In contrast, Wong et al. [18] and Johansen et al. [19] have shown that Asian patients do not benefit from survival advantages at higher BMIs. A study of 20,818 MHD patients in South Korea from 2001 to 2009 and 20,000 matched MHD patients in the USA (10,000 whites and 10,000 blacks) from 2001 to 2006 demonstrated that Asian patients showed a trend toward higher mortality in the higher BMI categories. However, Park et al. compared the association of mortality with obesity in Caucasians, African Americans, and Asians. BMI and serum Cr were used as surrogates of obesity and muscle mass, respectively. In the matched cohort (n = 10,000) in each of the three races, mortality risks were lower across higher BMI and serum Cr levels. This cohort study confirmed that race does not modify the obesity paradox phenomenon [20••].

The obesity paradox is not restricted to patients with ESRD. Chronic heart failure patients [21], the geriatric population [22], and patients with rheumatoid arthritis [23], HID/AIDS [24], and cancer [25] also exhibit the obesity paradox. This review will analyze the underlying and prevailing conditions that are present in obese patients that may cause this risk factor reversal.

Pathophysiology of the Obesity Paradox in ESRD

Several hypotheses have been proposed to explain the obesity paradox in patients with ESRD and other chronic conditions. The leading hypothesis refers to the protective properties of obesity against protein-energy malnutrition (PEM) and the persistent activation of inflammatory cytokines, forming what is known as malnutrition-inflammation complex syndrome (MICS) [26•]. PEM is defined as a state in which the protein reservoir is depleted, with or without fat depletion or a state of worsening functional capacity caused by an imbalance in nutritional intake relative to nutritional demands [26•]. Several epidemiologic studies reveal a strong association between PEM in chronic dialysis patients with diminished quality of life and higher risk of mortality [7, 27]. The prevalence of PEM varies depending on many factors: among the three major considerations are the patient's nutritional status prior to the initiation of dialysis, the patient's limited protein and energy intake after dialysis has been initiated, and the presence of acute and chronic illnesses.

Inflammation can be classified as acute or chronic phase [28]. Many studies reveal that ESRD patients maintained on dialysis have high levels of inflammatory markers. The prevalence was shown to be higher in the North American and European dialysis populations than in Asian dialysis populations [29–31]. High levels of inflammatory markers such as CRP, IL-6, and tumor necrosis factor α have been observed in anorexic dialysis patients and were hypothesized to potentiate the malnutrition-inflammation complex syndrome (MICS), resulting in further loss of appetite, loss of muscle mass, cardiovascular disease, and mortality [32–36]. The adipose tissue mass in obese patients may stabilize MICS and prevent further persistent inflammation. In part, this could explain the high mortality in low BMI dialysis patients. It is hypothesized that the low adipose tissue mass of malnourished dialysis patients is unable to halt the progression of MICS, thereby leading to faster rates of wasting, sarcopenia, and cachexia [37]. There are several examples, including anorexia caused by uremic toxins, cardiovascular disease, sepsis, and life-threatening

infection [38], in which PEM and the chronic inflammatory state potentiate MICS and act as a catalyst to cause faster mortality in dialysis patients.

Obesity may also provide physiological benefits for dialysis patients suffering from heart failure and volume overload. In a large cohort of 1203 patients characterized with advanced heart failure based on NYHA functional class, overweight patients were noted to have lower left ventricular end diastolic dimension (LVEDD) indices and a higher rate of oxygen consumption that was actually lower when corrected for weight. The hemodynamic variables revealed higher cardiac output, blood pressure, and higher right atrial pressure, but no significant increases in pulmonary capillary wedge pressure (PCWP) or cardiac index.

Obesity was associated with short-term hemodynamic stability and proved a survival benefit among overweight patients at the 1 and 2-year follow-up but not at 5 years [39]. Further, hemodialysis is associated with significant reductions in myocardial blood flow, stress-induced myocardial stunning, and regional wall motion abnormalities. It is also hypothesized that obesity provides better diffusion and ultrafiltration by preventing intra-dialytic hypotension and myocardial stunning [40].

In general, obesity is associated with high lipid and lipoprotein concentrations [41], and it is assumed that serum lipoproteins are able to modulate inflammatory immune function caused by catabolic states in chronic dialysis patients. Lipoprotein binds and detoxifies endotoxins, limiting progression to an inflammatory state [42].

One hypothesis to explain the obesity paradox centers on so-called competing risks for survival. A competing risk is defined as an event that either prevents the occurrence of the event of interest or modifies the chance that this event might occur in the near future. This theory could explain why lower BMI is associated with higher mortality. For instance, in an obese hypertensive dialysis patient who also suffers from other comorbidities, being obese and hypertensive could compete with other comorbidities to provide a short-term benefit, allowing the patient to receive hemodialysis and survive [4].

Selection bias, which is also called “incidence- prevalence” bias, is defined as the incidence of patients who survive their comorbidities to be included in a cross-sectional study. For example, only a small percent of CKD patients progress to ESRD [43]. Kalantar-Zadeh et al. argue that those who have survived to become ESRD patients might be “exceptional individuals” because they survived traditional risk factors and were further selected to enter the cross-sectional studies [4].

The Obesity Paradox and Survival in Hemodialysis Patients

Previous studies that have extrapolated 30 years of findings on the general ESRD population have shown that targeting conventional risk factors, such as hyperlipidemia, hypertension, obesity, hyperphosphatemia, secondary hyperparathyroidism, anemia, vitamin D deficiency, and dialysis dose has not improved the clinical outcomes of these patients [44–49]. In a study that included more than 400,000 dialysis patients, Johansen et al. found that overweight, obese, and even extremely obese hemodialysis patients have an increased rate of 2-year survival after adjusting for confounding factors. This increased survival applied

to white, African American, and Hispanic patients, but not to patients of Asian origin [50]. Noori et al. [51] found that fat mass (FM) and lean body mass (LBM) were associated with greater survival in women, whereas only FM was linearly associated with greater survival in both sexes. In contrast, other authors have shown a direct relation between large waist circumference (an index of abdominal obesity) and increased risk of all cause and cardiovascular mortality, and concluded that patients with a large waist circumference and low BMI had the highest risk of overall and CV mortality [52]. Marcelli et al. have observed that using BMI in hemodialysis patients does not offer good information about body composition and could be misleading when analyzing survival. They concluded that LBM and FM allow a broader perspective and better understanding of the obesity paradox [53••].

In a study of 50,000 MHD patients, Kalanthar Zadeh et al. [54•] evaluated the relationship between gaining dry weight by increasing muscle mass and survival benefit. The authors of the study used serum creatinine concentration as a surrogate for estimating muscle mass. They concluded that patients who gained weight and had an increase in serum creatinine concentration had the best survival rate. Moreover, those who lost weight but had increases in serum creatinine concentration exhibited a better survival rates than those who gained weight but had a decrease in creatinine levels. Another large study found that a decline in serum creatinine over time was a stronger predictor of poor outcome than weight loss [55]. In a retrospective study, Sakao et al. [56] use serum creatinine in hemodialysis patients to analyze the risk of mortality. They concluded that high BMI alone did not predict 1-year mortality; however, when they used serum creatinine to further stratify patients, they noticed that lower serum creatinine was associated with higher mortality and strokes regardless of the gender.

The Netherlands cooperative study [57] on the adequacy of dialysis investigated whether BMI and mortality in dialysis patients differ between younger and older dialysis patients. They concluded that younger obese patients (BMI > 30 kg/m^2 and age < 65 years) on hemodialysis had a 2-fold increased mortality rate than younger hemodialysis patients with a normal BMI. But older obese dialysis patients (BMI > 30 kg/m^2 and age > 65 years) had mortality rates similar to those of older dialysis patients with a normal BMI. These data were confirmed by a large retrospective study [58] which concluded that the obesity paradox benefit was noted in all ages but the benefits were more established in hemodialysis patients who were younger than 65 years of age.

In conclusion, there is strong evidence supporting the obesity paradox in hemodialysis patients regardless of age, gender, race, and how obesity was defined. Nephrologists and primary-care providers should also pay close attention to their dialysis patients' weight, BMI, serum creatinine levels, FM, LBM and waist circumference over time.

Obesity in Peritoneal Dialysis (PD)

The obesity paradox in PD patients has not been well studied. There are many "myths" about PD, one of which is that PD should not be offered to obese patients because they have less solute clearance and worse outcomes than nonobese patients [59]. In general,

PD prescription is based on clearance, ultrafiltration, and metabolic requirements. The term adequacy in PD (Kt/V) is often used to reflect clearance and quality of dialysis. In a study by Nolph et al., the authors concluded that patients with large weights but no residual renal function would be unable to achieve adequate solute clearance on PD (total weekly Kt/V ≥ 1;7) [60]. However, patients who are new to PD still have some residual renal function (RRF) and this will help larger patients achieve their adequacy targets.

Utilization of a cycler to perform the exchanges allows for many more rapid exchanges, which also may help increase solute clearance for patients with higher peritoneal membrane transport status. When taking these factors into account, larger patients would likely be able to achieve their adequacy targets.

In a more recent study, Ananthkrishnan et al. studied a cohort of 43 patients who started PD at weights greater than 90 kg who were matched with patients < 90 kg. The authors found no difference in weekly Kt/V between groups [61]. In a cohort study of over 15,500 PD patients, Obi et al. found that although peritoneal Kt/V decreased in the various BMI categories (< 20, 20 to < 25, 25 to < 30, 30 to < 35, 35 to < 4, and ≥ 40 kg/m^2), renal Kt/V remained the same because total Kt/V did decrease, but even patients in the highest BMI category were able to maintain adequacy given the renal input. The available information suggests that obese patients can be adequately managed on PD, particularly when renal residual function is present.

Similar to patients on HD, obese patients on PD may also have a survival advantage. The cohort study mentioned previously showed that PD patients with BMI < 35 kg/m^2 had lower mortality than those with BMI < 35 kg/m2 on HD, and that obese patients with BMI ≥ 35 kg/m^2 on PD had similar outcomes to those on HD [62]. Another large, retrospective cohort study of over 400,000 patients evaluated mortality outcomes in patients who were underweight, overweight, or obese and found that patients who were overweight or obese and initiated PD had lower mortality rates than when overweight or obese patients initiated HD [63•]. A prospective study in India evaluated outcomes in incident PD patients with diabetes in four BMI groups, obese (≥ 25 kg/m^2), overweight (23–24.9 kg/m^2), normal (18.5–22.9 kg/m^2), and underweight (≤ 18.5 kg/m^2). The underweight group had the highest mortality, though the obese group had a higher risk of peritonitis [64]. Many of these studies evaluated patients by their BMI categories, which can vary for different reasons, such as muscle mass. Jin et al. evaluated 84 patients, 57.1% of whom had an abdominal circumference of > 90 cm in men, and > 80 cm in women. After a median follow-up of 53.2 months and there was no significant difference in mortality between groups. Thus, PD patients with large abdominal circumference have outcomes similar to those with smaller abdomens [65•]. However, increasing waist circumference after initiation of PD is associated with worse outcomes [66]. This is seen in nondialysis and HD patients as well.

In summary, obese patients are able to achieve adequate dialysis clearance (weekly Kt/V > 1.7), especially when they are new to dialysis, and they still have residual renal function. Obese patients on PD have equivalent or better outcomes compared to obese patients on HD. There is a paucity of prospective data on these patients, as many obese patients are

not offered PD. With the paradigm shift to home-dialysis therapies, more obese patients will likely be initiated on PD in the near future.

Obesity Paradox and Kidney Transplant Survival

The obesity paradox in ESRD patients is a unique illustration of the survival benefit of obesity in a population that already has a high annual mortality rate. As discussed in the previous section, dialysis patients with a low BMI have a worse survival rate than obese dialysis patients. For the majority of patients on dialysis, kidney transplant offers a better quality of life, increased survival benefit, and greater life expectancy, regardless of their BMI, age, race, or diabetes status [67]. The American Society of Transplantation, Kidney Disease: Improving Global Outcomes (KDIGO) and other international guidelines have discordant recommendations regarding transplanting obese dialysis patients. The BMI cutoff selections were based on a retrospective analysis conducted by Holley et al. from 1986 to 1988. There were increases in unfavorable outcomes, including mortality from CVD, delayed graft function (DGF), 1-year graft survival and postoperative complications (wound complications, intensive care unit admission, reintubations, and new-onset diabetes) after kidney transplant in obese dialysis patients [68]. Other studies also showed a higher rate of anastomotic and perinephric complications, such as lymphocele and hematoma in obese transplant recipients [69, 70].

The obesity paradox phenomenon in ESRD patients has raised an ethical dilemma regarding the pros and cons of transplanting obese patients with a BMI > 35 kg/m^2, knowing that survival and quality of life would improve tremendously post transplantation. The majority of kidney transplant centers in the USA exclude obese patients with a BMI > 35 kg/m^2 and refer them to weight loss programs and consideration for gastric bypass [71••]. The acceptable BMI for kidney transplant candidates can vary across US transplant centers. Transplant centers are essentially graded based on the expected survival of recipients and grafts at 1 and 3 years post-transplant, and post-transplant complications, such as recipient death or high graft loss rate, must be reported and usually result in citations. Citations could result in serious regulatory penalties, heavy financial burden, loss of Medicare participation, exclusion of private payer agreements and program closure [72, 73]. These considerations militate against transplanting obese patients with ESRD.

On a positive note, in a 2011 survey, 23% of US kidney transplant recipients were classified as obese (BMI 30–34.9), 9.4% were morbidly obese (BMI 35–39.9), and 2.1% were very morbidly obese (BMI ≥ 40 kg/m^2) [72]. Often studies show survival benefits in transplanting dialysis patients with a BMI > 35 kg/m^2. For example, a study published in 2003 showed a remarkable 61% reduction of death in kidney transplant patients with a BMI ≥ 30 kg/m^2. This survival benefit was identical to that of patients with normal BMI, but this benefit was not seen in patients with BMI ≥ 41 kg/m^2 [74•]. A later study showed that a higher pretransplant BMI and larger muscle mass (reflected by 24-h urine creatinine excretion) were associated with better post-transplant patient and graft survival [75]. Another observational study demonstrated a survival benefit in transplanting obese dialysis patients, regardless of age and diabetes status. However, the survival benefit was lower in patients with BMI ≥ 40 kg/m^2 especially in black patients [76].

Robotic-assisted kidney transplants (RAKTs) are the latest innovation and future hope for obese dialysis patients who are currently waiting for kidney transplant. The first RAKT in an obese dialysis patient, performed in 2009, involved transplantation of a deceased-donor kidney into a 29-year-old woman with a BMI of 41 kg/m^2. The transplanted kidney had immediate function, no surgical site infection, and no perioperative complications [77]. In 2013, the same transplant group at the University of Illinois published a prospective cohort study of 39 obese patients who underwent RAKT. The BMI in the robotic group was 42.6 ± 7.8 kg/m^2 compared to retrospective obese patients with an average BMI 38.1 ± 5.4 kg/m^2 who underwent open kidney transplant. The control group had eight patients with wound complications (28.6%) compared to one patient in the robotic group (3.6%). The reported complication in the robotic group was a small subcutaneous hematoma with superficial wound dehiscence. There were no differences in serum creatinine or graft survival between both treatment groups at 6-month follow-up period [78•].

A recent comprehensive review comparing adult living donor kidney transplant recipients with a BMI of > 40 kg/m^2 receiving either RAKT or open kidney transplant was performed using the United Network of Organ Sharing registry from 2009 to 2014. The results confirmed similar renal function over 3-year follow-up period, and similar graft survival rates at 1 year in both treatment groups [79••].

Conclusions

With a rise in the obese population worldwide, nephrologists and care-givers for dialysis patients should be aware of the obesity paradox phenomenon in ESRD. Contrary to popular belief, high BMI in dialysis patients has been associated with improved survival compared to lower BMI. The majority of epidemiological studies showed that obesity paradox in ESRD could be beneficial in all races, gender, and ages, but these benefits seem to be more obvious in blacks and Hispanics and less in Asian population. Survival benefit in obesity paradox could be seen in both hemodialysis and peritoneal dialysis patients. The majority of US kidney transplant centers use a BMI > 35 kg/m^2 cutoff to exclude dialysis patients from being considered for transplantation. Instead, these patients are referred to weight loss programs. Recommending weight loss programs to obese dialysis patients instead of listing them for kidney transplants has created an ethical dilemma regarding survival benefit. RAKT could offer future hope for many obese dialysis patients with a BMI > 35 kg/m^2. It is not clear how many programs in the USA offer RAKT to their patients.

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Paper Summary

- Reverse epidemiology, or the obesity paradox phenomenon, has been confirmed in many epidemiologic studies for three decades
- High BMI in dialysis patients has been associated with improved survival, whereas lower BMI has been associated with higher mortality.
- The obesity paradox has been demonstrated in all races and ages but seems to be more prominent in blacks and Hispanics and less in Asians
- The pathophysiology of the obesity paradox is multifactorial. The leading hypothesis refers to the protective properties of obesity against both protein-energy malnutrition (PEM) and the persistent activation of inflammatory cytokines.
- Increased survival associated with the obesity paradox has been shown in both hemodialysis and peritoneal dialysis patients.
- Strong evidence supports the link between the survival benefit and the obesity paradox in hemodialysis patients, regardless of age, gender, race, and the definition of obesity.
- Obese dialysis patients on hemodialysis or peritoneal dialysis should not be denied kidney transplants based on BMI alone. The advantage of receiving a kidney transplant exceeds the risks.
- Robotic-assisted kidney transplants (RAKTs) might offer future hope for obese dialysis patients who are currently waiting to be listed for kidney transplantation.