Continuous renal replacement in the developing world: is there any alternative?

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Background: Dialysis and renal-replacement therapy (RRT) through transplantation were originally developed in an effort to prolong life in patients with end-stage renal failure. However, they have since become common management practice in developed countries. In areas in the developing world where RRT has been introduced to some extent (e.g., hemodialysis and transplantation), despite the lack of effective and skilled teams, rehabilitation is commonly unsatisfactory and results are discouraging relative to costs. Patients undergoing RRT in these areas commonly experience a disproportionate amount of discomfort and suffering which cannot be balanced by the added length of life achieved. **Aim:** To lower urea elevations in patients with chronic renal failure and symptomatic uremia who were reluctant to undergo dialysis, and to achieve improved wellbeing without dialysis by the use of this novel form of RRT consisting of acacia gum supplementation and a low-protein diet. **Patients & methods**: From June 2001 to October 2005, 43 patients consisting of 29 males (69%) and 14 females (31%), with symptomatic uremia were referred for treatment due to their unwillingness to undergo dialysis. Ages ranged from 18 months to 81 years. All patients considered dialysis in their circumstance to be associated with an unacceptable degree of discomfort and suffering. No patient presented with a life-threatening uremic complication on referral. All patients were educated regarding the risks of uremia in the absence of maintenance dialysis. Only patients who attended the evaluation visits within 2–3 weeks with an acceptable degree of adherence to the therapeutic protocol were enrolled. It was thus possible to follow 11 patients for 2–16 weeks. **Results:** All 11 patients enrolled experienced amelioration of symptoms of uremia with improved general wellbeing in association with lowering of urea levels and creatinine during the period of therapy. It was possible to provide hemodialysis freedom to two patients. **Conclusion**: This is the first study reporting the use of acacia gum in adults with symptomatic uremia, and the first reporting hemodialysis freedom in patients with end-stage renal failure.

Keywords: acacia gum, hemodialysis freedom, urea lowering

Dialysis and renal-replacement therapy (RRT) through transplantation were originally developed in an effort to prolong life in patients with end-stage renal failure (ESRF). However, they have since become common management practice in developed countries. However, RRT requires an expert team consisting of at least a nephrologist, cardiovascular surgeon and urologist, in addition to a skilled nursing staff. Therefore, in many areas of the world, RRT is considered extremely expensive both in manpower and cost of treatment, with a maintenance cost far beyond those observed in other areas of medical care. In certain areas of the world, the introduction of some forms of RRT (e.g., hemodialysis and transplantation) has been associated with unsatisfactory rehabilitation and discouraging results relative to costs and patients have continued to experience a significant amount of discomfort and suffering which cannot be balanced by the added length of life achieved. This occurs due to the lack of effective and skilled teams and the lack of appropriate maintenance of dialysis units. Conversely, many patients, do not have access to any form of RRT, particularly those living far from a specialized hospital. In these areas, chronic peritoneal dialysis is generally not available. Chronic hemodialysis is available only for patients weighing over 30 kg on a limited basis. Only live donor renal transplant is available on a limited basis with a limited success [1–3]. The author is unaware of any paper reporting success in renal transplantation in Iraq.

A novel form of RRT consisting of acacia gum (AG) supplementation and a low-protein diet (LPD) has been reported to provide patients treated with intermittent peritoneal dialysis (IPD) a long period of dialysis freedom and improved wellbeing [1].

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AG, the dried gum of stem and branches of acacia trees (Senegal family leguminous) is a complex polysaccharide that is generally recognized as safe by the US FDA. It is widely used in the production of foods such as puddings, frostings, candy, beverages and chewing gum. AG is known to increase fecal nitrogen excretion and lower serum concentrations of urea and other retained metabolites in patients with chronic renal failure (CRF). Increased fecal nitrogen excretion from the ingestion of dietary fiber has also been reported in animals, normal human subjects and patients with cirrhosis [4–8]. There are no limitations to the use of AG as a food additive as the experimental evidence of safety demanded by international food safety committees has already been met [9].

The aim of this study was to lower urea elevations in patients with CRF and symptomatic uremia who were reluctant to undergo dialysis and to achieve improved wellbeing without dialysis by the use of this novel form of RRT consisting of AG supplementation and a LPD.

Patient & methods

From June 2001 to October 2005, 43 patients with symptomatic uremia, consisting of 29 males (69%) and 14 females (31%), were referred as they were reluctant to undergo dialysis, and had requested an alternative treatment option. Their ages ranged from 18 months to 81 years (mean). Of these 43 patients, 14 had chronic glomerulonephritis (GN). A presumptive diagnosis of GN was made by the presence of albuminuria or hematuria (+granular casts). Biopsy-proven focal segmental glomerulosclerosis, membranoproliferative GN and rapidly progressive GN were found respectively in these three patients. Two of these patients had systemic lupus erythematosus (SLE) and GN, and did not undergo renal biopsy. All of these patients were shown to have small kidneys (adults: renal length > 8 cm; children: >5 cm on ultrasound).

In addition, seven of the patients were recorded as having CRF caused by hereditary nephropathies and genetic syndromes including two patients with nephronophthisis, two with adult polycystic kidney disease, and one with oculocerebrorenal syndrome. Four patients presented with CRF caused by renal stone disease, seven with CRF caused by congenital abnormalities, including unilateral renal agenesis and renal hypoplasia and neurogenic bladder, one with diabetic nephropathy and one patient with bladder cancer. The cause of CRF was undetermined in nine patients. A total of 21 patients had not previosuly undergone dialysis prior to referral, 19 patients were treated with LPD and IPD, and four patients were on regular or intermittent hemodialysis (HD) including one patient treated initially with IPD. All patients considered dialysis in their particular circumstance to be associated with an unacceptable level of discomfort and suffering. On referral none of the patients had life-threatening uremic complications. However, all patients were educated regarding the risks of uremia in the absence of maintenance dialysis. Due to the special considerations to be taken into account in this geographical region, regarding the serious socioeconomic crisis and the fact that many patients would have come from remote areas, it was expected that many patients may not have been able to attend the evaluation visits or even be compliant with therapeutic protocol. Therefore, only patients who attended the next evaluation visit within 2–3 weeks with an acceptable degree of adherence to the therapeutic protocol and who had taken part in a minimal of laboratory tests of serum creatinine and blood urea were enrolled. All patients received clear written instruction regarding the protocol.

Many patients were already on a LPD and other pharmacological measures of CRF, such as iron and calcium carbonate, one-alfacalcidol supplementation, erythropoietin, antihypertensive drugs and diuretics. These dietary and pharmacological measures were reviewed and adjusted as necessary according to the clinical findings and blood levels of hemoglobin, calcium and potassium. Dietary proteins were restricted to 1 g/kg/day for patients under the age of 10 years, and 0.5 g/kg for patients over the age of 10 years with at least 50% of the total intake given as egg albumin. Protein and phosphorus restriction was primarily achieved by restricting meat, poultry, fish, milk, cheese and yogurt. Additional restrictions were made on potassium-rich foods during elevation of serum potassium above 5 mmol/l. Powder AG 1 g/kg/day (maximum 75 g) was supplied in 2–3 divided doses (diluted with the desired amount of water with or without the addition of sugar and juices) by a pharmacist. The efficacy of treatment was primarily measured by clinical improvement with amelioration of the symptoms of uremia (anorexia, vomiting, fatigability) and biochemical improvements, primarily measured by lowering of blood urea and serum creatinine.

The protocol for this research was approved by the scientific committee of the University Hospital in Al Kadhimiyia (Iraq) and conforms to the provisions laid out in the Declaration of Helsinki (as revised in Edinburgh 2000) [101].

Of the 43 patients with symptomatic uremia, it was possible to enroll 11: four with GN including two patients, each with biopsy-proven, rapidly-progressive glomerulonephritis (RPGN) and membranoproliferative GN, and one with SLE. Two patients had CRF caused by bilateral renal stone disease. The remaining four patients presented with ectopic right kidney, left renal agenesis and recurrent urinary tract infections, with biopsy-proven, infiltrative, poorly differentiated transitional cell carcinoma of bladder, biopsy-proven diabetic nephropathy (insulin-dependent), and nephronophthisis. Their ages ranged from 14–65 years (mean 41.45 years). Two of these patients were on HD and the remaining on a LPD, including one patient who underwent one PD session before referral. With exception of the patient with diabetic nephropathy, none of the patients had diabetes. Oral ingestion of AG is generally not associated with a change in blood glucose [10,11]. The energy value of AG is 14.7 ± 0.5 kJ/g, lower than the energy value of starch 17.4 ± 0.4 kJ/g [12]. AG administered to men for 3 weeks has no effect on glucose tolerance, but decreases serum cholesterol [13].

Patient 1

Patient 1 was a 17-year-old boy with biopsy-proven RPGN (endocapillary crescentic) developed ESRF despite receiving steroids and cyclophosphamide. He developed symptomatic uremia (anorexia, fatigue and tachypnea) approximately 6 months prior to referral. Laboratory tests at that time showed serum creatinine and blood urea levels of 10 mg/l and 360 mg/dl, respectively. Since that time he was receiving regular (two session/week) HD. He received more than one blood transfusion during that period. Both parents and the patient considered this form of RRT to be inconvenient and have disrupted their life and all of them experienced a significant amount of discomfort and suffering. On referral, 2 days after the last HD session, the patient had symptomatic uremia (fatigability, and mild tachypnea). He was receiving erythropoietin, parentral iron, one-alfacalcidol, calcium carbonate and frusemide. He was started on AG.

Patient 2

Patient 2 was a 53-year-old nondiabetic male with bilateral renal stone disease of unknown etiology of a few yeas duration. He underwent surgical operation for removal of the stone on the right kidney followed by several lithotripsy sessions. The patient developed symptomatic uremia with fatigabilty, anorexia, tachypnea and deterioration of the level of consciousness 23 days before referral. He underwent three HD sessions during the previous 23 days. He was living in an area far from any hospital and was therefore unable to attend more frequently to undergo regular HD. He was also on LPD and receiving iron, calcium carbonate, one-alfacalcidol and a diuretic (bumetanide). On referral, 2 days after the third HD session, he had symptomatic uremia with anorexia, fatigability and mild tachypnea. The patient then started AG.

Patient 3

Patient 3 was a 48-year-old women with symptomatic uremia (fatigability, anorexia and pruritus). Laboratory tests confirmed hemoglobin (Hb) levels of 7.6 g/l, serum creatinine 6.9 mg/l, blood urea 189.5 mg/l, serum potassium 4.7 mmol/l and serum sodium 140 mmol/l. Renal ultrasound showed an ectopic right kidney, in the right lumber region at the level of the iliac crest, with a small kidneys size: right kidney (6.8 × 2.6cm) with smooth renal outline with hyperechoic thin parenchyma (7 mm), and the left kidney (6.8 × 2.9 cm) with smooth outline with hyperechoic parenchyma (1 cm). No stone or hydronephrosis was present. The patient was referred as she refused dialysis. On referral, she was on a LPD, iron and calcium supplementation. She was only able to receive 50 g AG/day.

Patient 4

Patient 4 was a 39-year-old man with chronic GN and symptomatic uremia (anorexia, fatigability and pruritus). He was on a LPD, iron, and calcium. One-alfacalcidol was added due to persistent hypocalcemia. He underwent one PD session before referral. On referral, laboratory tests showed serum creatinine: 5.1 mg/dl; creatinine clearance: 2.23 ml/min/1.72 m^2; blood urea 157 mg/l; serum calcium 7.8 mg/l and serum potassium 4.7 mmol/l.

Patient 5

Patient 5 was a 65-year-old male with biopsy-proven infiltrative, poorly-differentiated transitional-cell carcinoma of bladder. He presented initially with hematuria, frequency, dysuria and dribbling. He was treated with radiotherapy. On referral he has symptomatic uremia (anorexia, fatigue, vomiting and pruritus) and had lost at least 20 kg of weight. Renal ultrasound showed bilateral hydronephrosis, left kidney and large mass in the bladder. Laboratory tests confirmed

serum creatinine: 11.6 mg/l and blood urea: 238 mg/dl. He received pyridoxine 100 mg by intramuscular injection and oral domperidone to control vomiting.

Patient 6

Patient 6 was a 30-year-old female with left renal agenesis and recurrent urinary tract infections presenting with symptomatic uremia (anorexia and fatigability). Laboratory tests showed Hb: 6.5 g/l; serum creatinine: 8 mg/l and blood urea: 204 mg/dl. On referral, the patient was on a LPD, iron and calcium. She received AG 50 mg/dl.

Patient 7

Patient 7 was a 57-year-old female with SLE and GN who presented with symptomatic uremia (anorexia, fatigue, pruritus and mild tachypnea) of several weeks duration. She was not receiving specific treatment for SLE nephritis. Laboratory tests showed serum creatinine: 2.5 mg/l; blood urea 162 mg/l and serum calcium 8 mg/dl.

Patient 8

Patient 8 was a 14-year-old female with biopsy-proven membranoproliferative GN who presented initially 6 years previous with edema hematuria and oliguria. She progressed to CRF despite long-term alternate-day prednisone. On referral she had symptomatic uremia (anorexia, fatigue, tachypnea). She was also complaining of headache attributed to severe hypertension (190/120 mmHg). She was already on a LPD, diuretic, iron and potassium supplementation. Laboratory tests showed urinalysis (albuminuria 3 pluses by dipstick method, full-field red blood cell count, pus cell 6-/HPF, and granular casts). Laboratory tests showed serum creatinine: 2.1 mg/l; blood urea: 132 mg/l and serum potassium: 5.5 mmol/l. Prednisone was stopped and hypertension was controlled with enalapril and losartan.

Patient 9

Patient 9 was a 60-year-old male with CRF caused by bilateral renal stone disease presenting with symptomatic uremia (anorexia, fatigue, vomiting and tachypnea). Laboratory tests showed Hb: 11.8 g/l; serum creatinine: 6.2 mg/l, blood urea: 208 mg/l; serum calcium: 11 mg/l and serum potassium: 6 mmol/dl. He received pyridoxine 100 mg (intramuscular injection) once-daily for 3 days and oral domperidone 10 mg three times daily for 3 days to control nausea and vomiting.

Patient 10

Patient 10 was a 38-year-old male with insulin-dependent diabetes mellitus of approximately 20 years duration and biopsy-proven diabetic nephropathy. He subjected to retinal laser therapy before 1 month. He presented with symptomatic uremia (anorexia, nausea vomiting and tachypnea). He had severe hypertension blood pressure 190/120 mmHg despite treatment with enalapril 40 mg daily and frusemide 40 mg daily. Laboratory tests showed Hb: 10 g/day; blood sugar: 110 mg/l; serum creatinine; 6.8 mg/l; blood urea; 151 mg and serum potassium: 5 mmol/l.

Blood pressure was controlled using slow-release nifedipine 40 mg daily in two divided dose. The patient received pyridoxine 100 mg (intramuscular injection) once-daily for 3 days and oral domperidone 10 mg three-times daily for 3 days to control nausea and vomiting.

Patient 11

Patient 11 was a 35-year-old female with hereditary nephropathy (nephronophthisis) who presented with symptomatic uremia (anorexia, nausea fatigability). There was no history of hematuria, edema, renal colic or urinary tract infection). Her younger brother died at the age of 24 years from uremia after a number of dialysis sessions. Of her eight siblings (four girls, four boys) only the present patient developed CRF. Blood pressure was 150/100 mmHg. Laboratory tests showed urinalysis was normal; Hb: 8.8 g/l(28%); serum creatinine: 5.2 mg/l; blood urea: 158 mg/dl; serum potassium: 6.3 mmol/l. Renal ultrasound showed small kidneys. Treatment included a LPD, AG 50–60 g daily, calcium carbonate, iron, erthropietin, one-alfacalcidol and losartan 50 mg/day.

Results

Patient 1

After 2 weeks from the start of this form of RRT, patient 1 was symptom-free and reported improved wellbeing and that much more comfort had been experienced since the onset of uremia. **Table 1** shows the effect of this form of RRT on serum creatinine and blood urea. The values of serum calcium and potassium are expected to be greater with other therapies (one-alfacalcidol, eryrthropoeitin, diuretic). The family traveled outside the country for and the boy stopped AG therapy, but continued on LPD. After 2 weeks he presented again with symptomatic uremia. Laboratory tests showed blood urea: 182 mg/l;

serum creatinine: 9 mg/dl; Hb: 5 mg/dl and serum calcium 5.2g/dl. Both parents decided to continue their child on this form of RRT rather than returning to regular HD.

Patient 2

At 10 days after the start of AG, patient 2 experienced a marked improvement in uremic symptoms as well as improved wellbeing. **Table 1** shows serum creatinine and blood urea levels pre- and post-HD, and after AG therapy.

Patient 3

After 2 weeks from the initiation of the AG, patient 3 experienced an improvement in uremic symptoms and general wellbeing and laboratory tests confirmed Hb: 9.2 g/l; serum creatinine: 5.1 mg/l; blood urea: 126 mg/l; serum potassiu: 5.1 mmol/l. The patient was followed for 2 months during which time urea levels ranged from between 100 and 120 mg/dl.

Patient 4

After 3 weeks of therapy, patient 4 experienced a marked improvement in uremic symptoms and improved wellbeing. Laboratory tests showed serum creatinine: 2.0 mg/dl and bood urea: 78 mg/dl. The patient was followed for approximately 6 months with urea levels remaining below 100 mg/dl. **Table 1** shows serum creatinine, blood urea levels pre- and post-PD, and after AG therapy. At times, the patient experienced abdominal distension and mild abdominal pain that was relieved by three doses of domperidone 10 mg before the administration of AG.

Patient 5

After 3 weeks of therapy, the patient experienced a marked improvement in uremic symptoms and improved wellbeing. Laboratory tests showed: serum creatinine 2.47 mg/l, blood urea 72 mg/dl. This weight increased from 45–49 kg without the development of edema at 7 weeks after therapy. He was followed for 10 weeks, during which time he was symptom-free and urea levels remained below 60 mg/dl.

Patient 6

After 2 weeks, patient 6 experienced amelioration of the uremic symptoms. Laboratory tests showed Hb: 8.2; serum creatinine: 7.8 mg/l, blood urea: 178 mg/dl, serum Ca: 7.9 mg/dl, serum phosohorus: 5.5 mg/dl. The patient did not attend the next follow-up visit. The authors were informed at a later date through her family that she remained symptom-free while on therapy. However, the patient died less than a month after renal transplantation.

Patient 7

After 8 weeks, patient 7 was completely free from uremic symptoms. **Table 1** shows the effect of this form of RRT on serum creatinine and blood urea.

Patient 8

After 2 weeks she experienced disappearance of uremic symptoms with marked improvement in general wellbeing and relief of headache with control of hypertension. Laboratory tests showed serum creatinine: 1.3 mg/dl and blood urea 50 mg/dl. The girl was compliant with therapeutic protocol for about 6 weeks. During this period she remained symptom-free. She died within 1 month of stopping therapy after undergoing 2 sessions of IPD.

Patient 9

After 4 weeks, patient 9 experienced disappearance of uremic symptoms with marked improvement in general wellbeing. Laboratory tests demonstrated serum creatinine: 3.8 mg/dl and blood urea: 112 mg/dl. The patient was followed for 8 weeks.

Patient 10

After 4 weeks, patient 10 experienced disappearance of the uremic symptoms with marked improvement in general wellbeing. Laboratory tests demonstrated serum creatinine: 4.7 mg/dl and blood urea: 97 mg/dl. The patient was followed for 12 weeks.

Patient 11

After 14 days patient 11 was symptom-free. Laboratory tests showed Hb: 10.8 g/l; serum creatinine: 1.8 mg/l; blood urea: 87 mg/dl and seum potassium: 3.7 mmol/l. The patient was followed for 16 weeks.

Discussion

Dialysis and transplantation (RRT), originally developed to forestall death in patients with ESRF, have become standard management practice in developed countries. In the USA, which has the highest incident of patients treated with RRT in the world [14,15], the annual cost of medical care for patients undergoing chronic dialysis is estimated at US$50,000 [102]. However, of the

Table 1. Renal-replacement therapy on serum creatinine and blood urea.

	Serum creatinine mg/dl	Blood urea mg/dl
Patient 1		
Post-hemodialysis (range)	2.7–5.5	82–112
Start of therapy	4.5	151
After 2 weeks	3	118
After 6 weeks	7.2	110
After 10 weeks	7.5	103
2 weeks after stopping acacia gum	9.2	225
Patient 2		
Pre-hemodialysis 1	12.9	260
Post-hemodialysis 1	7.6	180
Pre-hemodialysis 2	7.3	200
Post-hemodialysis 2	6.8	165
Pre-hemodialysis 3	10	286
Post-hemodialysis 3	6	170
10 days after the start of acacia gum	6	126
Patient 3		
Start of therapy	6.9	189.5
After 2 weeks	5.1	126
Patient 4		
Preperitoneal dialysis	7.4	227
Postperitoneal dialysis	4.9	137
Start of therapy	5.1	157
After 2 weeks	2.1	78
Patient 5		
Start of therapy	11.6	238
After 3 weeks	2.47	72
After 7 weeks	8.7	48
Patient 6		
Start of therapy	8	204
After 2 weeks	7.8	178
Patient 7		
Start of therapy	2.5	162
After 2 weeks	2.3	93.6
After 4 weeks	1.7	76.2
After 6 weeks	1.6	68
After 8 weeks	1.1	48
Patient 8		
Start of therapy	2.1	132
After 2 weeks	1.3	50 mg
Patient 9		
Start of therapy	6.2	208
After 4 weeks	3.8	112
After 8 weeks	4	118
Patient 10		
Start of therapy	6.8	151
At 4 weeks	4.7	97

Table 1. Renal-replacement therapy on serum creatinine and blood urea (cont.).

Patient 11		
Start of therapy	5.2	158
After 14 days	1.8	87
After 4 weeks	1.6	76
After 8 weeks	1.5	66
After 16 weeks	1.5	47

more than 450,000 patients with ESRF, over 79,000 patients died in 2004 [16]. This high mortality rate resulted in patients with ESRF discussing their end-of-life wishes with their family and staff irrespective of their cultural background [17].

Dialysis patients lead a highly abnormal life. Patients undergoing various forms of maintenance dialysis are tethered to a machine to an extent unprecedented in the history of medical technology. All dialysis patients find themselves abjectly dependent on a procedure, medical facility and medical personnel. Approximately one of every 500 dialysis patients commits suicide. A larger number unsuccessfully suicide on one or more occasions [18,19].

In areas where RRT has been introduced to some extent (e.g., hemodialysis and transplantation) despite the lack of effective and skilled teams, rehabilitation is commonly unsatisfactory and results are discouraging relative to costs. Patients undergoing RRT in these areas commonly experience a disproportionate amount of discomfort and suffering which cannot be balanced by the added length of life achieved [1–3].

Conclusions & expert commentary

The study evaluated 43 patients with symptomatic uremia were reluctant to undergo dialysis; however, of these, it was possible to enroll only ten. All patients were on a LPD with the exception of the two patients on HD. The initiation of AG was associated with amelioration of the uremic symptoms and improved general wellbeing as long as they were compliant with therapeutic protocol. However the most significant finding in this study is the achievement of HD freedom in two of these patients, both of whom had a vascular access, but they considered HD to be associated with a significant amount of discomfort and suffering and they were not satisfied with the quality of life associated with this treatment. Two patients who did not comply with our therapeutic protocol died, one during treatment with IPD and one within a month of renal transplantation.

The use of this novel form of RRT has been reported previously in children with ESRF to have freedom from dialysis for 1 year in association with improved general wellbeing [1]. However the use of AG supplementation has not been previously reported in adult patients with

Highlights

- Dialysis patients lead a highly abnormal life. Patients undergoing various forms of maintenance dialysis are tethered to a machine to an extent unprecedented in the history of medical technology. All dialysis patients find themselves abjectly dependent on a procedure, medical facility and medical personnel. Approximately 1 in every 500 dialysis patients commits suicide. A larger number unsuccessfully attempted suicide on one or more occasions.
- In some areas of the world, the introduction of some forms of renal-replacement therapy (e.g., hemodialysis and transplantation) is associated with unsatisfactory rehabilitation and discouraging results relative to costs and patients continued to experience a significant amount of discomfort and suffering which cannot be balanced by the added length of life achieved. This problem results from the lack of effective and skilled teams and the lack of appropriate maintenance of dialysis units.
- Acacia gum is known to increase fecal nitrogen excretion and lower serum concentrations of urea and other retained metabolites in chronic renal failure patients. Increased fecal nitrogen excretion from the ingestion of dietary fiber has also been reported in animals, normal human subjects and patients with cirrhosis.
- There are no limitations to the use of AG as a food additive as the experimental evidence of safety demanded by the international food safety has already been met.
- This is the first study reporting the use of AG in adults with symptomatic uremia, and the first study reporting hemodialysis freedom in patients with end-stage renal failure.

symptomatic uremia. The children in the previous report who were provided with dialysis freedom were on IPD. In the present study, two of the patients in two different age groups, 17 years and 53 years ,were on HD before enrollment, both experienced HD freedom in association with improved general wellbeing. This is the first study reporting the use of AG in adults with symptomatic uremia, and the first study reporting HD freedom in patients with ESRF.

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