CHAPTER 3
Immediate postoperative monitoring

CHAPTER 3.1 Perioperative volume and blood pressure management and concomitant medications

Burkhard Tönshoff & Jens H. Westhoff

Heidelberg University, Medical Faculty Heidelberg, Department of Paediatrics I, University Children's Hospital, Heidelberg, Germany

ORCIDs:
Burkhard Tönshoff: https://orcid.org/0000-0002-6598-6910
Jens H. Westhoff: https://orcid.org/0000-0002-9837-9383

1 Perioperative volume and blood pressure management

The difference in size between an adult kidney and a child's body must be taken into account after surgery. This is particularly true in young children. After transplantation of an adult donor kidney, the intravascular volume of a paediatric recipient can increase by up to 20%, meaning that the circulating blood volume must be replenished by administering infusion solutions. A paediatric haemodialysis catheter, or a central venous line in older children, is usually placed preoperatively into the internal jugular vein and, less commonly, into the subclavian vein. The purpose of this is to: monitor central venous pressure; ensure rapid and safe fluid administration; enable the administration of catecholaminergic drugs; and allow for renal replacement therapy in case of delayed graft function. Young transplant recipients usually require an arterial line for invasive arterial blood pressure measurement.

During surgical preparation, balanced isotonic crystalloid solutions and 5% human albumin are used for fluid replacement. The initial target value for central venous pressure is 5–10 mmHg. During preparation of the renal vascular anastomoses, however, higher values of 10–14 mmHg are targeted by administering balanced crystalloid solutions, 5% human albumin and red blood cell concentrate, if necessary (haematocrit target: 25–30%). Please note that patients with pre-existing cardiomyopathy may require different values. To achieve a mean arterial blood pressure of 70–80 mmHg during the preparation of vascular

Published in: Tönshoff & Pape (eds.), Management of the paediatric kidney transplant recipient. Heidelberg: heiBOOKS 2026, pp. 75–79. DOI: https://doi.org/10.11588/heibooks.1732.c25443

anastomoses, catecholaminergic drugs may be required. During reperfusion of the transplanted kidney, particularly in young children, it is essential to closely monitor and maintain stable arterial blood pressure and central venous pressure. Furosemide is administered continuously in this phase of surgery. Following reperfusion, the mean arterial pressure should be maintained above 80 mmHg. The fluid requirement following reperfusion is 4–6 ml per kg of body weight per hour, and this should be adapted according to diuresis. Depending on thrombophilic risk, unfractionated heparin can be administered either before abdominal wall closure or six hours after reperfusion (see Chpater 3.2).

For recipients weighing less than 20 kg, a higher volume supply is mandatory, and the risk of cardiovascular instability following reperfusion of an adult donor kidney must be considered.

General recommendations for perioperative fluid management:

- Fluid intake = excretion plus perspiratio insensibilis (400 mL/m² body surface area per day).
- In case of polyuria (> 2000 mL/m² per day): Replacement with two/thirds balanced isotonic crystalloid solution (e.g., STEROFUNDIN ISO), one third glucose 5%, or in case of hyperglycaemia, a pure balanced isotonic solution; switch to a semi-isotonic solution after a few days.
- In case of oliguria (< 1 ml/kg per hour): Replace with a solution of 2/3 sodium chloride 0.9% and 1/3 glucose 5%.
- Replace drainage fluid with a balanced isotonic solution and 5% albumin at a ratio of 1:1.
- Body weight should be 5–10% above the "dry weight" achieved during dialysis. Note: many patients are overhydrated before transplantation.
- Target central venous pressure: 5–7 mmHg. Target systolic blood pressure: 100–140 mmHg.
- Initially, check urine output hourly and replace accordingly.
- Check body weight twice daily.
- Check serum chemistry twice daily.
- In case of primary graft dysfunction: Perform a Doppler ultrasound of the renal allograft vessels within the first hour post-transplant to rule out vascular thrombosis.
- If primary graft dysfunction persists, repeat the Doppler ultrasound of the renal allograft vessels daily.
- Maintain haemoglobin concentration above 8 g/dL. If necessary, transfuse CMV-negative blood using a leukocyte filter.

- Maintain plasma total protein concentration above 50 g/L and albumin concentration above 30 g/L.

Specific recommendations for young children under 6 years of age who have received a kidney from an adult donor (aged over 15 years):

- Children weighing less than 20 kg require a particularly high volume of fluids. During preparation, administer 10–20 ml/kg of balanced crystalloids and 5% albumin (10–20 mL/kg) per hour. Aim for a central venous pressure of 7–10 mmHg at this stage.
- During placement of the vascular anastomoses (approx. 30 min) and before opening the aortic clamp, administer crystalloid volume (see above) and, if necessary, administration of erythrocyte concentrates to achieve a target central venous pressure of > 10–14 mmHg and a target haematocrit of 25–30% (caveat: patients with pre-existing cardiomyopathy).
- In consultation with the transplant surgeon, administer heparin 10 IU/kg before clamping the aorta and anastomosing the renal artery.
- Target mean arterial blood pressure of > 80 mmHg in this phase; catecholamines are usually required to achieve this goal (give Akrinor®; in case of prolonged hypotension, give noradrenaline/suprarenin at a starting dose 0.1 µg/kg body weight per minute). Perfusors must be pre-run at the time of declamping.
- Close communication with the surgeon is required for gradual opening of the aortic clamp.
- After opening the anastomosis, there is a risk of a sharp drop in blood pressure and central venous pressure, particularly in young children, due to the redistribution of the blood volume into the transplanted adult kidney. Maintaining haemodynamics at the above levels is particularly critical in this phase (note: avoid warm ischaemia; do not tolerate drops in blood pressure). A drop in central venous pressure of up to 50% can be expected for up to 2 hours after declamping.
- Initial fluid requirements: 4–6 ml/kg per hour Sterofundin ISO, then adjusted according to diuresis. In the case of primary graft function, there will be a high fluid requirement of up to 70% of body weight.
- In the first 24 hours post-transplant, aim for a central venous pressure of 7–10 mmHg and a mean arterial blood pressure of > 80 mmHg.
- Continuation of catecholamine therapy and recording of circulatory parameters is also mandatory during transport from the operating theatre to the intensive care unit.

- After 48 hours, polyuria decreases as the adult kidney adapts to the child's circulation.

Following surgery, the patient is monitored in the Paediatric Intensive Care Unit (PICU) for at least 24 hours. Initially, there are hourly checks of central venous and blood pressure, as well as precise fluid balance facilitated by urine drainage through a suprapubic bladder catheter. Postoperative ventilation may sometimes be necessary for a few hours due to the high fluid load during surgery, particularly in young children. If the operation goes smoothly, the patient is extubated immediately afterwards.

If a child's own kidneys still have good residual diuresis, total diuresis is not a reliable indicator of successful kidney transplantation. Therefore, to better assess and continuously monitor the diuresis of the kidney transplant, it is recommended that the transplanted kidney be selectively splinted with a single-J catheter for about 1 week.

Following a kidney transplant from a deceased donor, cold ischaemic time (during which the organ is transported without blood supply and kept on ice) often leads to acute tubular damage. This can initially cause anuria, followed by "forced polyuria" and considerable water and electrolyte losses. If the transplanted kidney fails to function properly for an extended period, dialysis therapy may be required. This can be performed as peritoneal dialysis using an intraperitoneal indwelling catheter (Tenckhoff catheter), or as haemodialysis using a Shaldon catheter. This complication occurs in around 10% of patients, particularly if the ischaemia time is prolonged and the quality of the organ is poor.

2 Concomitant medications

In most centres, furosemide is administered postoperatively as a continuous intravenous infusion, depending on diuresis. Low-dose furosemide (1–3 mg/kg/day) also has a tubuloprotective effect. The dose is tapered depending on the clinical course after 1–3 days and switched to oral administration. Furosemide is discontinued in the event of anuria for more than 24 hours or polyuria. Some centres recommend the calcium channel blocker diltiazem (dose: 1 mg/kg/day intravenously or orally for the first 10 days post-transplant) for tubuloprotection.

After the anastomosis is opened, acidic valences are often released from the transplanted kidney. The resulting metabolic acidosis inhibits the kidney's

immediate functional uptake. Buffering with 8.4% sodium bicarbonate is then required. Perioperative antibiotic prophylaxis with a broad-spectrum antibiotic, such as ceftriaxone, is also administered. Antifungal prophylaxis with oral nystatin is recommended for the duration of the antibiotic prophylaxis. Specific prophylaxis against cytomegalovirus (CMV) and Pneumocystis jirovecii is described in chapters 7.1 and 7.4. The recommended anticoagulation is described in chapter 3.2.

Ulcer prophylaxis is also recommended, for example in younger children with esomeprazole, at the following dosages: patients aged 1–11 years with a body weight of 10–20 kg: 10 mg/day; with a body weight of > 20 kg: 20 mg/day; patients aged 12–18 years: 20–40 mg/day or in older children with pantoprazol (20–40 mg/day). If there are no gastrointestinal symptoms, esomeprazole should be stopped two weeks post-transplant.

References

Tönshoff B, Becker JU, Pape L. Nierentransplantation, pp. 243–74. In: Nierenerkrankungen im Kindes- und Jugendalter, Dötsch J, Weber LT (Hrsg.), Springer Berlin, 2024