GUIDELINES

ON ANAESTHETIC MANAGEMENT

FOR RENAL TRANSPLANT

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CONTENT

1. Introduction to Renal Transplant

Since transplant surgery began in Malaysia nearly half a decade ago, advancement in techniques, drug technology and awareness, be it in the public domain or among the medical fraternity itself, have made the field of transplant medicine becoming more of a subspecialty by itself. From early beginnings of cadaveric renal transplant, to Living Related and now, with the advancement in immuno-modulation, Living Non-Related renal transplant are made possible. As a country, we have successfully conducted the first living non-related transplant surgery 2 years ago in one of the private hospitals and was successfully replicated in Hospital Kuala Lumpur last year (2012). With this realization, it is therefore becoming more important, as anaesthesiologists, to actively participate in the process to ensure the successful completion of this procedure. In view of cost and time spent to manage a transplant case from selection to identifying potential donors to the actual procedure itself, it is imperative that a proper guideline be developed to ensure uniformity in its management based on current evidence in this field,

It is therefore the aim of this document to highlight the current issues pertaining to the anaesthetic management of a renal transplant surgery and hopefully, to ensure the successful peri-operative management of a transplanted kidney.

2. Important Considerations for the Anaesthesiologists

Management of the transplanted kidney depends on, whether it is from a **cadaveric** or a **living donor**. Transplantation from a **living donor** is done under **elective and in a more controlled environment**, whereas the

management of a **cadaveric transplant** largely revolves around the recipient and almost always occurs in less than an ideal situation.

2.1 Managing cadaveric renal transplant recipient

- Mainly revolves around the preparation of **the recipient** and their optimization.
- Potentially a **short preparation time** in which optimization of concurrent diseases need to be done. Blood works and other investigations requires urgent review and correction. Renal Replacement Therapy is to be instituted with post dialysis review of investigations.
- High induction dose of **immuno-modulative drugs** to be started.
- **'Cold ischaemic time'** (as defined as the time when the kidney is cooled with a cold perfusion solution and ends after the organ reaches physiological temperature during implantation procedures) as an estimate of a successful transplant, even though it is not always the case. The longer 'cold ischaemic time,' is usually associated with a higher incidence of delayed graft function.
- All considerations for preparations for an **emergency surgery**.
- **Acid prophylaxis** and **aspiration risks.**
- Extent of **acidosis** and adequacy of dialysis.
- **Azotaemia** and its correction.
- **Extent of Anaemia** and the degree of decompensation.
- **Cardiovascular system instability** accentuated by the administration of anaesthetics. Up to 25% of all Chronic Kidney Disease patients are at risk of having diseased coronary arteries and a full cardiovascular system work-up should be done.
- Choice of mode of **analgesic therapy.**
- **Electrolyte disturbances** namely chloride, calcium and potassium due to the fluids infused or the disease process itself.
- Type and amount of **fluids infused**
- **Hypothermia** as a result of cold perfusion

- **Hypovolaemia and Hypotension** post extraction during dialysis.
- **Thymoglobulin infusion** accentuates hypotension if given at high rates.
- **Mannitol** infusions and diuretics.
- **Methylprednisolone** infusion during anastomosis and its completion before reperfusion.
- **Reperfusion of grafted kidney.**
- **Goals of management ;**
    - **Initiation of early immunosuppressive therapy**
    - **Adequate volume** as replacement for post dialysis extraction and fasting deficit
    - **Adequate perfusion pressure**
    - Avoidance of vasopressors as far as possible
    - Achieving a short 'cold ischaemic' time as possible

2.2 Living Renal Transplant

- Considerations are for both **donor** and **recipient**.
- Surgery is done as an elective procedure either as **open or laparoscopic** donor nephrectomy.
- Preparation of both patients occurs months earlier, involving potential donor selection, optimization and assessment of both donor and the recipient's medical condition
- A few days prior to surgery, induction of immunosuppressive therapy is initiated for the recipient.

Donor

- Problems associated with **laparoscopic surgery.**
- Infusion of **mannitol** prior to warm ischaemia.
- Mode of **analgesia** either for open nephrectomy or laparoscopic.

- Amount of **fluid infusion** and maintenance of appropriate **perfusion pressure.**
- Aim for **urine output** of **more than 100ml/hour.**

Special Considerations for Laparoscopic Donor Nephrectomy

- There are concerns regarding transient **deterioration in renal function to recipient kidneys procured via laparoscopic technique.**
- Laparoscopic Donor Nephrectomy poses different problems compared to open techniques due to the **presence of pneumo-peritoneum** and subsequent **increase in intra-abdominal pressures (IAP).**
- Raised IAP was shown to **reduce renal blood flow (RBF), glomerular filtration rate (GFR) resulting in oliguria and the magnitude of this decrease is affected by IAP used, volume status and position.**
- Various studies had suggested that **collapsed venal system as a cause and vigorous fluid administration up to 2L/h was suggested.**
- **Zur Borg and colleagues (2008)** studied the effect of **different timings of fluid administrations** and found that **overnight hydration and subsequent intraoperative 13ml/kg/h crystalloid infusion**, with **6 ml/kg bolus colloid infusion before** anaesthetic **induction AND before pneumoperitoneum** resulted in **better cardiovascular parameters and improved graft function.**
- Besides volume of fluids infused, adequate perfusion pressure is paramount in the face of IAP. **A mean arterial pressure amounting to the added IAP may be required during period of pneumo-peritoneum.**
- **Use of vasopressor (Ephedrine or Phenylephrine) should be avoided as far as possible** but **may be used** as an interim measure **to treat refractory hypotension in the initial stages** of procedure**. Single bolus** will have a **duration of action of up to 10 minutes but multiple ephedrine boluses could last up to 2-3 hours.**

Recommendation

- **Overnight hydration** should be instituted at the start of fasting.
- **Caution with induction doses of propofol especially for hypertensive donors.**
- Volumes of **up to 20 ml/kg/h** is to be used intra-operatively.
- A minimum of **IAP values to be added** to of pre-operative **Mean Arterial Pressure (MAP) as Perfusion Pressure during pneumo-peritoneum.**
- Concurrent administration of **200ml of 20% mannitol** after induction of anaesthesia to finish before arterial clamping.

Recipient

- **Similar** considerations to cadaveric renal transplant **except for**:
  - A **longer preparation time** for assessment and optimization compared to cadaveric transplant.
  - Done as an **elective** procedure.
  - **Induction of immunosuppressive** therapy starts a few days prior to the actual surgery.
  - Lower risk of graft rejection due to a **short 'cold ischaemic'** time although it is not guaranteed.

3. Issues in Management

3.1 Immuno-suppressive therapy

- Immunosuppressive therapy is to be initiated in the recipient 5 days prior to surgery.
- **Induction Protocol** regimes include administration of oral Tacrolimus, Mycophenolate Mofetil, steroids and intravenous Baxilicimab (Day 0 and Day 4) for Living Transplant or from a cadaveric donor to recipients with low immunological risk.
- **Intravenous Thymoglobulin** is to be given to recipient in whom are deemed at a higher risk for graft rejection (high immunological risk). These includes;
    - Cases in whom prolonged cold ischaemic time is anticipated defined as more than 12 hours).
    - In cadaveric transplant where induction time may be short.
    - previous history of blood transfusion
    - previous pregnancy
- Immuno-suppressive plasma drug levels will be checked prior to surgery (Day 2-3 after induction). High levels may cause intraoperative hypotension and in some cases may be refractory. There may be an adverse reaction secondary to drug interactions especially with anti-hypertensive drugs. (ACE inhibitors or ACE Receptor Blockers- ARB). Hypotension may be accentuated by hypovolaemia secondary to post dialysis extraction and also anaesthetic agents.
- **Incidence of inflammatory/allergic reactions** will be reduced by administration of anti-histamine and steroids prior to surgery.
- When IV Thymoglobulin is indicated, dilution is necessary and it is to be given as an infusion over 4-6 hours through the central venous line after anaesthetic induction.

- **Hypotension** is a common side effect if thymoglobulin is delivered at a high rate.

3.2 Perioperative Fluid Management

- One of the important parameters to consider in the prevention of graft failure is the **maintenance of appropriate renal perfusion pressure**.
- In transplantation, denervation adds to a deterioration in hemodynamic auto-regulation of the kidney graft. Thus, even a mild decrease in blood pressure can further reduce renal perfusion and thereby result in repeat ischemia to the transplanted kidneys.
- Perioperative fluid management must **ensure restoration and maintenance of intravascular volume,** in order to obtain good graft function.
- Important components of intraoperative fluid therapy involves considerations on ;
    - **Avoidance of hypovolaemia**
    - **Type of fluids**
    - **Administration of Mannitol**

3.2.1 Avoidance of Hypovolaemia

- Hypovolaemia can be as a result of ;
    - Fluid extraction during dialysis
    - Preoperative fasting
- This may not be reflected by the blood pressure in an awake patient due to intact autonomic compensatory mechanisms. (Volume contracted state)
- In an anaesthetized patient however, inhibition of central control will remove auto-regulatory mechanisms and the effect of volume status will be reflected by the blood pressure (which is **linearly dependent on intravascular volume).**

- Aggressive intraoperative volume expansion is still recommended to maximize graft functional recovery (**up to 30 mL/kg/h, central venous pressure [CVP] > 15 mm Hg**), but caution must be exercised in patients with pre-existent cardiac disease or poor myocardial function. De Gasperi et al showed that a more restrictive therapy with a target **CVP of 7-9 mm Hg** also showed favourable graft function after 2 weeks **(crystalloids 2400 ± 1000 mL, 15 mL/kg/h).**
- Previously suggested haemodynamic target as aims of fluid management therapy include, **systolic blood pressure of between 130-160 mm of Hg, mean arterial pressure of > 80mmHg, CVP between 10-15 mm Hg and mean pulmonary artery pressure of 18-20 mm Hg** to optimize cardiac output and renal blood flow.
- Besides **amount of fluids** infused, **timing** of fluid administration may also be a factor. **Othman et al** described a **biphasic hydration regimen** with a maintenance of **CVP of 5 mmHg** during the **pre-ischaemic phase**, and titrating fluids to **CVP of 15 during ischaemic phase**. (about **50 ml/min** for ischaemia time less than an hour in their study). They compared this biphasic fluid regimen with a constant infusion of 10-12ml/kg/h and found a more favourable post-ischaemia haemodynamics, better graft turgidity, less tissue oedema, earlier graft function and lower serum creatinine with higher creatinine clearance at POD1 in the titrated CVP group.
- To maintain **good diuresis for donor**, generous amount of fluids need to be given. As a guide, a study by Baxter and colleagues in 2009 uses **10-20 ml/kg/hr of crystalloids**, while Othman (2010) uses **3 litres plus replacement per ml of urine loss** as supplement. Othman also administered **40 mg of frusemide** and **150 ml** of **10% Mannitol** intra-operatively before ischaemia (clamping of donor renal artery).
- **Stroke Volume Variation (SVV)** can be used as an additional guide for further fluid management. **An initial target SVV value of < 15% is**

advocated. However, **periodic revision of target SVV value need to be done with other goals of therapy in consideration.**

Recommendations

- The ideal range for the CVP and even the role of CVP have **not been clearly identified**.
- Generally, it is still recommended to have a **more liberal rather than restrictive** fluid infusion therapy to ensure adequate graft function for recipient.
- **Goals of therapy** include:
    - **CVP > 12-15 mmHg**
    - **Systolic BP** of **> 130**
    - **Mean Arterial BP** of **> 80**
    - **Total IV fluids** of **at least 30-50 ml/kg/hr**
    - **initial target SVV value of < 15%**
    - **Higher infusion rates should be given during ischaemic phase (at the time of donor clamping)**
    - **Graft turgidity as assessed by surgeon**
- Caution is exercised in recipients with cardiovascular compromise. A **lower target CVP and /or with a slower rate and total** of infusion need to be considered. A target **CVP of about 9-12 mmHg** and a **total fluids of 15- 20 /kg/hr** should be used as a guide. Regular assessment of status would need to be done intra-operatively.
- A study in **Paediatric recipients** revealed a variable and **larger fluid requirement per body weight** (30-90 ml/kg with mean of 88 ml/kg) with the younger children requiring more than the older child, especially so if from an adult donor.

3.2.2 Type of Fluids

Crystalloids

- In general, **non-potassium containing crystalloids** are the fluid of choice to be used for correction of fluid and electrolyte imbalance in renal transplant surgery, except in instances of severe hypovolaemia where colloids may be indicated.
- The use of large volume **isotonic 0.9% saline** had been associated with hyperkalemia secondary to hyperchloraemic metabolic acidosis and can lead to renal vasoconstriction and compromised flow. Comparisons between **Hartmanns solution** and isotonic saline have been done previously and it was shown that using Hartmann solution, did not cause significant hyperkalemia as previously thought.
- **Balanced crystalloid** are becoming readily available, and compared to using large volumes of isotonic saline or Hartmann alone, **may be a better option in ensuring minimal disturbance in acid base and electrolyte changes.** Hadimioglu and colleagues (2008) concluded that among the various balanced crystalloids available at the time, Plasmalyte had the best metabolic profile.
- **Potura and his Austrian group (2015)** compared an acetate-buffered balanced crystalloids solution versus 0.9% saline in patients with end stage renal disease undergoing cadaveric renal transplant on 150 patients (from 2010 to 2013).
- Their findings showed that :
    i) **no statistically significant difference in hyperkalemia** between both groups.
    ii) **higher increase in maximum chloride and chloride fluctuations in the 0.9% saline group.**

iii) **Significantly lower minimum base excess and a higher change in base excess** from start of surgery was seen in 0.9% saline group.

iv) **Higher proportion of patients** on 0.9% saline group **received catecholamines for circulatory support.**

Recommendations

- **Balanced solution** (A mixture of normal saline with either lactated or acetated Ringer's solution) may seem to be the ideal fluid for use in renal transplant surgery. Use with caution for cadaveric transplant recipients due to its potassium content in the face of potential delayed graft function.
- To avoid hyperchloraemic acidosis and hyperkalemia, a **mixture** of isotonic saline and Hartmann solution may be a better option compared to normal saline alone.
- Although the risk of significant rise in serum potassium is small, **continuous monitoring of electrolytes** is essential perioperatively whichever type of fluid is being used. (for both living and cadaveric transplant recipients)

Colloids

- There will be periods during surgery whereby a recipient is vulnerable for hypotensive episodes and may require infusion of **colloids**. Those are **after bolus intravenous anaesthetic induction** agents and after **reperfusion** of the grafted kidney.
- **Vasodilatation** after anaesthetic induction, in the face of hypovolaemia secondary to post-dialysis extraction and pre-operative fasting, may be severe so as to require colloid infusion.

- A **drop in CVP of more than 50%** can be seen even within two hours after reperfusion due to various reasons even after aggressive fluid management. This can be due to :
    - Sudden shift of 25% of cardiac output to the grafted kidney.
    - Release of mediators accumulated during ischaemia.
- Two of the synthetic colloids that have widely replaced albumin in clinical practice – dextrans and gelatins – do not seem on the whole to be preferable to albumin.
- **Medium molecular weight HES** with a low molar substitution (HES 130/0.4) was shown **not to affect the incidence of delayed graft function** (Hokema 2011) and showed **a slight advantage regarding recovery of renal function immediately after transplantation** (Wu 2010)
- VISEP trial reported a higher incidence of renal failure in septic patients when **high molecular HES** was used in doses greater than the recommended daily maximum dose.

Recommendations

- **Colloids** may be used in certain periods during transplant surgery and there are evidence to show safe use of **HES** if administered according to recommended safe daily dose (**50 ml/kg/day**).**

**** HES has been withdrawn indefinitely from the market after recommendations from the European Commission until further notice (2013)**

3.2.3 Administration of Mannitol, frusemide and Dopamine

- Studies have demonstrated **improved outcome** on grafted kidney for recipients who received adequate **hydration in combination with mannitol** compared to hydration without mannitol.
- Mannitol **improves renal haemodynamic** characteristics favouring increased flow through local prostaglandin production and a

reduction in renin release. To be effective as an osmotic diuretic, mannitol must be administered before ischaemic insult. (Before arterial clamping in donor nephrectomy)

- **For recipient**, mannitol acts through reduction of post-ischaemic endothelial cell swelling and decreases ischaemic–reperfusion injuries through scavenging of hydroxyl and other free radicals.
- The administration of **200 to 250 ml of mannitol 20%** immediately before reperfusion has been **shown to improve renal perfusion pressure**. Three randomised controlled trials showed a significant, albeit transient, reduction in acute renal failure immediately after transplantation using mannitol. However, 3 months after transplantation no difference was found in kidney function compared with patients who did not receive mannitol.
- **Two large randomised controlled trials** did not show any benefit of **frusemide** on the recovery from renal failure in patients with oliguria.
- **Two large meta-analyses** have shown a detrimental effect of **dopamine** on renal function in acute renal failure, increased mortality and a longer ICU stay.
- **Use of vasopressor (Ephedrine or Phenylephrine) should be avoided as far as possible but may be used as an interim measure to treat refractory hypotension** in the initial stages of procedure**. Single bolus** will have a **duration of action of up to 10 minutes** but **multiple ephedrine boluses could last up to 2-3 hours.**

Recommendations

- **Only mannitol** has been found to be **beneficial** for use in renal transplant surgery and 200 -250 ml of 20% mannitol are used routinely for both donor and recipient.
- **Dopamine** has not shown to be of any benefit and their use are **controversial.**

- The **effect of diuretics on renal function after transplantation requires further study.**

3.3 Perfusion Pressures

- Review of the articles, showed **no clear optimal target values** for systolic, central venous and mean arterial pressures. There was even unanswered question on the benefit of using CVP monitoring.
- **Good outcome** were shown in recipients when a target **CVP of 12 - 15mm Hg** were used in various studies. (Variable range of 5-15 were documented).
- **Minimum suggested SBP were found to be 130 mmHg during the reviews** and suggested **mean arterial pressure were 70-80 mmHg.** (Although Toth (1998) suggested that MAP < 100 mmHg and plasma volume below 45ml/kg at reperfusion are risk factors of graft failure).
- **Optimized volume therapy is essential,** but the **use of vasopressors should be considered despite the risk of vasoconstriction** in certain cases when harmful effects of low perfusion pressure outweigh the risk of renal vasoconstriction reducing graft flow. Vasopressors are to be used as an interim measure while volume loading is instituted instantaneously.
- **The use of advanced haemodynamic monitoring and its effect on outcome have not been studied but is suggested in certain patients.**
- A study on **Goal Directed Hemodynamic Management and Renal Outcome after Renal Transplant Surgery (IROR)** by a group in Munich is currently recruiting patients and are expected to be **completed by 2015**.
- As most patients have become accustomed to anaemia for some years and significant blood loss during the operation is rare, **transfusion should be performed reluctantly**; the **transfusion trigger** for these

patients is not known, but is probably **lower** than in patients without renal failure.

- Measurement of **Stroke Volume Variation (SVV) and CVP** are helpful in managing fluids for the recipient, **not just by their absolute target values, but in their actual trends dependent on other goals of therapy**. Other calculated haemodynamic variables can be derived as well (for example CO, CI, SVR, SVRI) and will aid in further fluid management.

Recommendations

- Caution with induction doses of propofol for recipients. **Titration to response is necessary to avoid excessive, protracted period of hypotension** which may compromise graft function.
  (Non-polar hypnotics have small Volume of distribution (Vd) in renal failure patients).
- **Caution with the use of vasopressors especially during the period of anastomosis.**
  (Adequate fluid loading will usually pre-empt the use of vasopressors.)
- **Appropriately guided volume loading** should be initiated early and through-out procedure. **(refer to section 3.2.1)**
- **The use of advanced haemodynamic monitoring is encouraged.**

3.4 Analgesia

- Various analgesics have been used as pain relief for both donor and recipient both systemically or regional.
- **Patient Controlled Opioids** are the most common method of postoperative analgesic technique providing satisfactory pain relief for both donor and recipient. (PCA Morphine 1mg/bolus for donor and PCA fentanyl 10mcg/bolus for recipient)

- **Epidurals** have been administered as post-operative analgesia for donor nephrectomy patients. However, segmental sympathetectomy as a result of epidural blocks has been shown to affect perfusion pressures due to uncompensated vasodilatation. This may effect kidney perfusion and the quality of graft may be in question.
- As most donor nephrectomy are done in the lateral position, infusion of epidural local anaesthetic may affect dependent segmental spinal root and in effect, may not provide adequate analgesia for the non-dependent incision site.
- **Transversus Abdominis Plane Block** or **Fascia Transversalis Block** is easier technically with the use of ultrasound and should be instituted prior to incision.
- TAP Block can be used as analgesic supplement for laparoscopic or open donor nephrectomy. A combination of classical and subcostal approach of 20 ml of 0.375% ropivacaine each are given.
- A more proximal approach to the TAP or fascia transversalis, is the **Quadratus Lumborum Block**. This block can be performed under ultrasound guidance in the lateral position, targeting abdominal and lower thoracic segmental nerves as they traverse between psoas major and the quadratus lumborum muscles. 20-30 ml of 0.375% ropivacaine (or similar strength of local anaesthetics) can be given.
- Another option is **Thoracic Paravertebral Block** of the lower thoracic segments but it is technically more difficult even with ultrasound assistance. Blocks at T7-9 with 5 ml per segment of block is used.
- **Considerations for recipients** include post dialysis coagulation profile, uraemia and qualitative platelet dysfunction.
- **NSAIDS, Paracetamol and COX inhibitors** have the potential to be nephrotoxic in post-transplant cases and should be used with caution, if at all.

- **Other options would include classical TAP Block** for post-operative analgesia for the recipient in whom 20-30 ml of local anaesthetics can be used to provide analgesia for 8-12 hours.

4. Summary: *from European Journal of Anaesthesiology September 2012*

Table 1 Preoperative assessment of patients undergoing renal transplant surgery

Risk factors	Ischaemic heart disease Diabetes mellitus Arterial hypertension
Preoperative 'work-up'	12-lead ECG Electrolytes, coagulation studies, full blood count Assessment of fluid status (last dialysis, residual excretion)

Table 2 Suitability of drugs commonly used during renal transplantation surgery

	Use	Avoid
Volatile anaesthetics	Sevoflurane Isoflurane Desflurane	Enflurane
Neuromuscular blocking drug	Cis-atracurium Atracurium	Pancuronium Sugammadex
Rapid sequence induction	Rocuronium 1.2 mg kg^{-1} Succinylcholine	
Opioids	All fentanyl analogues	Morphine
Intravenous induction agents	Propofol Thiopental	Etomidate
Diuretics	Mannitol	Furosemide

* Morphine can be used with caution

Table 3 Haemodynamic management of patients undergoing renal transplant surgery

	Use	Avoid	Special indication
Monitoring	ECG		Central venous pressure
	Non-invasive blood pressure		Invasive blood pressure
	Peripheral blood oxygen saturation		Advanced haemodynamic monitoring
Fluid therapy	Ringer's lactate	Isotonic saline	Colloids
			Blood transfusion
Vasoactive agents	Noradrenaline	Dopamine	Dobutamine

Safety profile of drugs for anaesthesia.

Neuromuscular blockers		**Inhalational agents**	
Succinylcholine	+ (K <5.5 mEq/l)	Isoflurane	+
Atracurium	+	Sevoflurane	+
Cisatracurium	+	Desflurane	+
Mivacurium	+/–	Enflurane	–
Vecuronium	+/–	**Induction agents**	
Rocuronium	+/–	Propofol	+
Pancuronium	+/–	Pentothal	+
Intra-operative opioids		**Post-operative analgesics**	
Fentanyl	+	Morphine	+
Alfentanil	+	Fentanyl	+
Sufentanil	+	Paracetamol	–
Remifentanil	+	NSAIDs	–
Morphine	–	COX-2 inhibitors	–
Meperidine	–		

COX-2, cyclo-oxygenase-2; NSAIDs, non-steroidal anti-inflammatory drugs.
+, can be used; –, cannot be used; +/– could be used.

5. Suggested Protocol for Management of Renal Transplant

5.1 Live Donor (Laparoscopic Donor Nephrectomy)

1. **Anaesthetic technique of GA with PCA morphine or GA with regional block (from TAP, Quadratus Lumborum or Paravertebral Block)**
2. **Preoperative hydration**
   100 ml/hr crystalloids starting from 2200 the night before surgery (4/2/1 formula)
3. **IV bolus colloids 5ml/kg before induction …….** *(Zu Borg 2008)*
4. **Caution with induction dose of propofol especially in hypertensive patients**
5. **Invasive haemodynamic monitoring limited to arterial line only**
6. **Start Mannitol infusion 0.5 g/kg after induction up to the time of nephrectomy**
7. **Intra-operative infusion of 20ml/kg/hr crystalloids ……** *(Baxi 2009)*
8. **Target MAP of normal or plus 20% of patient's normal**
9. **IV bolus colloids 5ml/kg before institution of pneumo-peritoneum …….** *(Zu Borg 2008)*
10. **Aim for a Perfusion Pressure to a value of IAP added to the MAP**
11. **If suggested infusion volumes are unable to improve Perfusion Pressures, low dose Dopamine infusion (1-2 ug/kg/min) should be initiated ……** (Maine Medical Centre Transplant Guidelines 2014)
12. **Aim for urine output of at least 100 ml/hr**
13. **IV Dexamethasone 8 mg**

5.2 Kidney Recipient

1. **Technique of choice will be GA with PCA fentanyl (with or without supplemental regional block from TAP, or Quadratus Lumborum Block)**
2. **IV hydrocortisone, chlorpheniramine, antibiotics and immunosuppressant will be administered from the ward**
3. **Caution with induction doses of propofol for recipients. Titration to response is necessary to avoid excessive, protracted period of hypotension**
4. **IV infusion of Thymoglobulin to be started after central line insertion (to be infused over 4-6 hours) for recipients at high immunological risk**
5. **Arterial line to be inserted. (Advanced Haemodynamic Monitoring i.e Flowtract is encouraged)**
6. **Infusion of non-potassium containing crystalloids is to be initiated**

   Goals of therapy include:

   - **CVP > 12-15 mmHg …** *(Ferris 2003)*

     (7-9 mmHg for restrictive heart … De Gasperi 2006)
   - **Systolic BP** of **> 130**
   - **Mean Arterial BP** of **> 80**
   - **Total IV fluids** of **at least 30-50 ml/kg/hr**
   - **Stroke Volume Variation of < 15%** ***(to be interpreted appropriately in combination with other parameters)***
   - **Higher infusion rates should be given during ischaemic phase (at the time of donor clamping) ……** *(Othman 2010)*
   - **Graft turgidity as assessed by surgeon**

     To run 250 ml of crystalloids initial bolus and assess

     For further boluses if required until turgidity improves
7. **Serial monitoring of acid base and electrolyte status**
8. **Mixtures of Ringers Lactate or Balanced Crystalloids may be required if worsening acidosis is seen with large volumes of saline* ….** *(O'Malley 2005, Khajavi 2008, Potura 2015)*

   Caution with potassium containing crystalloids for cadaveric recipients

9. **In refractory hypotension, not responsive to crystalloid load (especially after induction and after reperfusion) colloids may be used to optimize intravascular volume….** *(Othman 2010)*
10. **Vasopressors to be used ONLY after volume therapy has been optimized. Boluses of ephedrine or phenylephrine may be given for refractory hypotension during initial stages PRIOR to transplantation ….**(Maine Medical Centre Transplant Guidelines 2014)
11. **IV infusion of 20% Mannitol 0.5g/kg to be initiated 30 minutes prior to unclamping**
12. **IV Methylprednisolone 500mg to be infused at the start of anastomosis (over 30 minutes) and completed before arterial unclamping**
13. **Post reperfusion hypotension to be managed accordingly (based on kidney turgidity- will be communicated by urologist)**

    Depending on volume status (as per set goals of therapy- see no. 6 recipient protocol)

    or SVR/SVRI or CO/CI (if requiring vasopressors/inotrope)*

    ***Adequate volume will usually pre-empt the use of vasopressors**
14. **IV frusemide as per urologist**
15. **Total intra-operative fluid administration should be about 30-50ml/kg/hr**
16. **Aim for early extubation**

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