ACUTE PERITONEAL DIALYSIS IN NEWBORN BABIES

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The etiology of acute renal failure (ARF) in newborn babies is multifactorial. Their kidneys are vunerable to birth asphxia, sepsis and drug toxicity. With an increasing survival of severely premature babies it is no surprise that the incidence of ARF in this age group is increasing. This is further augmented by an increasing number of surgical procedures done in the neonatal period, cardiac surgery in particular(1-3).

In 1960, Segar *et al.*(4) for the first time successfully dialysed three newborns who were accidentally fed boric acid in the hospital. This happened eleven years after Swan and Gordon(5) performed peritoneal dialysis (PD) for the first time on a child. The procedure has since been used in an increasing number of babies and remains a method of choice inspite of the advances made in hemodialysis. This is because of its technical and medical advantages. The procedure fits with ease in the intensive care unit setting, does not require any special equipment or specially trained nurses and can be initiated at a very short notice. Peritoneal dialysis, in comparison to hemodialysis, causes minimum hemodynamic instability and is continuous in nature. The peritoneal surface area in infants is about twice that of an adult in relation to body weight(6,7). There is also an intrinsic age-related difference in peritoneal solute transfer. Esperanca *et al.*(7) reported a urea clearance of 82.8 ml/min in puppies as compared to 29 ml/min in adult dogs. They confirmed these observations in an eleven-day old infant whose urea clearance of 49.8 ml/min/70 kg was roughly twice that of an accepted normal adult value.

In another study, Elzouki *et al.*(8) reported a peritoneal dialysance value for urea and insulin 1.66 and 2.8 fold greater, respectively in puppies than adult dogs.

Indications for Peritoneal Dialysis

Acute renal failure (ARF) is a major indication for peritoneal dialysis in newborns. There is slight variation regarding criteria used by different people for dialysing such babies and although the following are widely accepted, the decision should be made on individual basis.

(i) *Oliguria:* Urine output of less than 1.0 ml/kg of body weight.

(ii) Fluid overload which may lead to hypertension, congestive cardiac failure and/or pulmonary edema.

(iii) *Azotemia:* Blood urea of more than 40 mmol/L (or 240 mg/dl).

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(iv) *Hyperkalemia:* Serum potassium more than 7.9 mEq/L.

(v) *Intractable acidosis:* Serum bicarbonate less than 12 mmol/L.

(vi) Fluid overload and pulmonary edema.

The procedure has also been used in intractable cardiac failure and salt poisoning(9), inborn errors of urea synthesis(10), maple syrup urine disease(11), lactic acidosis(12), propionic acidemia(13), hyperbilirubenemia(14) and respiratory distress syndrome(15). It can be accomplished 3 to 4 days after major abdominal surgery and a surgical drain in the peritoneal cavity may provide an easy access for the procedure(16).

Catheter Insertion

Several types of catheters and the placement techniques are reported in the literature(17-19). The most widely used is the stiff peritoneal dialysis catheter which comes in different sizes including an infant size(20). For practical purposes any of these catheters, including an adult size can be trimmed to be used in a neonate. The important thing to remember is that the distal fenestrated segment is not longer than 2 cm to ensure that all the holes are intraperitoneal. The total length of the catheter should be about 10 cm, of which approximately 5 cm remain intra-abdominal. Before the insertion of the catheter the bladder is emptied with a small catheter. The local anesthetic is injected in the midline about 1.5 cm below the umbilicus. A size 22G intravenous cannula is inserted into the peritoneal cavity and 25 ml/kg of warmed dialysate is infused to distend the abdomen. The baby should be watched for signs of cardiorespiratory distress. A small stab wound is made through the skin and subcutaneous tissue. A peritoneal dialysis catheter is inserted through the wound and is directed towards the right or left paracolic gutter. The catheter is then secured with a silk purse-string suture.

Due to an increased risk of infection it is generally recommended that the percutaneously inserted catheters should be removed after 72 hours(21). However, we use them for as long as they remain functional which sometimes is more than a week. If prolonged dialysis is anticipated, a soft neonatal size Tenckhoff's catheter is preferable. This can be introduced surgically or by peritoneoscope(22).

Dialysate Selection

A wide variety of ready made dialysate fluids are available on the market. The ones used commonly have an osmolarity of about 350 mosm/kg water and contain dextrose 1.5% or more, sodium 130-141 mEq/L, calcium 3.0-4.0 mEq/L, magnesium 1.5 mEq/L, chloride 100-103 mEq/L, bisulfate 1-2.9 mEq/L, and lactate 35 mEq/L or acetate 35-45 mEq/L.

In some newborns, particularly those with low birth weight, ARF is usually secondary to cardiovascular shock which if prolonged may also lead to lactic acidosis(23). In order to prevent worsening of lactic acidosis, such babies may be dialysed with bicarbonate rather than lactate containing fluids. Calcium must be given intravenously bacause it will precipitate if added to bicarbonate.

For emergency purposes when the appropriate type of dialysate is not available or until the supply becomes available, the fluid may be prepared in the unit under aseptic techniques. A combination of sodium bicarbonate (8.4%) 35 ml, dextrose (5.0%) 300 ml, normal saline (0.9%) 649 ml, distilled water 14 ml and magnesium

sulphate (10%) 1.8 ml will produce a solution containing dextrose 1.5%, Na 135 mEq/L, Cl 100 mEq/L, HCO_3 35 mEq/L, Mg 1.5 mEq/L and sulphate 1.5 mEq/L.

Most of the ready made dialysates don't contain potassium. If the pre-dialysis serum potassium level is more than 6 mEq/L, no KCl should be added to the fluid for the first 8 to 10 exchanges. If it is between 4-6 mEq/L, then 2 mEq/L and if it is less than 4 mEq/L then 4 mEq/L of KCl should be added to the fluid. Careful monitoring of serum potassium is necessary. In order to prevent clot formation, heparin is added to the dialysate in a concentration of 150-500 units/L. It may be used for 48 hours or longer depending on the amount of the bleeding in the peritoneal cavity.

Sepsis, which is common in newborns with ARF, can be treated with intraperitoneal administration of antibiotics. The blood level achieved by certain aminoglycosides and vancomycin is approximately the same as its concentration in the dialysate. Finer adjustment can, however, be made with the help of its blood levels. Therapeutic blood levels can be reached faster with intravenous loading dose. Commonly used antibiotics and the use recommended dosage per litre of dialysate are: gentamicin (8 mg), tobramycin (8 mg), amikacin (50 mg), penicillin (50,000 u), ampicillin (50 mg), cloxacillin (100 mg), vancomycin (30 mg), cephazolin (250 mg)(24).

Effective peritoneal dialysis depends on dialysate glucose concentration, duration of exchange, exchange volume and temperature of the dialysate. The concentration of glucose in the dialysate determines the amount of fluid that a baby will lose during dialysis and higher the glucose concentration the more the fluid loss(25). Concentration of more than 4.5% is not used because of the risk of hypovolemia, hyperglycemia and hyperosmolar coma(26). Our practice has been to start with 4.5% dextrose for 6 to 8 hours or more depending on the severity of fluid retention followed by 1.5% dextrose for continuation of dialysis. The dwell time for a dialysate in the peritoneal cavity should not be more than 30 to 45 minutes. As the patient's condition improves the dwell time can be slowly increased. Longer contact leads to reabsorption of glucose(27), particularly since neonates have a greater peritoneal surface area(6) with a greater permeability(7). This can decrease the dialysate osmolality which may lead to fluid absorption resulting in fluid overload and hyperglycemia.

The amount of dialysate that can be used for each cycle is 35-50 ml/kg. A volume of more than 50 ml/kg can lead to respiratory embarrassment whereas a volume of 25 ml/kg or less causes poor ultrafiltration(28,29). An increase in the dialysate temperature from 20° to 37°C increases the solute clearance by 30-35%.

Complications

Dialysing babies is not without risk. This can be reduced considerably if the procedure is done properly and under strict aseptic conditions. Perforation or laceration of an internal organ can occur during catheter insertion. Dialysate leak and drainage problems are not uncommon. Peritonitis should be suspected if the baby develops fever or the peritoneal fluid becomes cloudy. A white cell count of more than 50 with >50% neutrophils in the peritoneal fluid is suggestive of infection which must be confirmed by culture and sensitivity(31). If Gram staining of the peritoneal effluent reveals Gram positive bacteria,

vancomycin 30 mg/L or cloxacillin 100 mg/L or cephalothin 200 mg/L is started empirically.with the peritoneal dialysis fluid. If Gram negative bacteria are seen, gentamicin 8 mg/L can be used. If Gram staining is doubtful, then a combination of the above mentioned antibiotics offers an adequate cover. Once culture results become available only the appropriate antibiotic is continued.

Heparin is added to the peritoneal dialysis fluid for 1-3 days or until it becomes clear. The catheter must be removed if there is a fungal infection, tunnel abscess or lack of response to treatment in 4-5 days(32).

Other complications that can occur during dialysis include hypernatremia, hyper or hypokalemia, hyper or hypoglycemia. Hyperglycemia, which is not uncommon, can be effectively treated with insulin infusion. Acute changes in the blood volume can induce shock or congestive cardiac failure and pulmonary edema. This is corrected by fluid replacement in the former and the use of a dialysate with higher dextrose concentration in the latter.

Fluid and Nutritional Requirement

The fluid requirement of a baby on peritoneal dialysis is based on the following:

Insensible and stool water loss = 55 ml/kg/day(33)

Average ultrafiltration + Urine output (if any) = 35 ml/kg/day(34).

The average calorie requirement for the first month of life is 115 Kcal/kg/day. Dialysate dextrose absorption provides about 8 Kcal/kg/day. The net energy requrement, therefore, is 107 Kcal/kg/day. The protein requirement for a normal baby is 1.6 to 1.9 g/100 Kcal. Taking into consideration an average dialysate protein loss of 0.3 g/kg/day, the daily requirement is about 2.2 to 2.5 g/kg/day(35-38).

Patient Monitoring

A baby on dialysis needs excellent nursing, careful monitoring of vital signs and regular laboratory investigations. Our policy is as follows:

(i) Fluid input/output monitoring– done on 8-12 hourly basis, depending on baby's condition.

(ii) Continuous monitoring of pulse, respiration, blood pressure, oxygen saturation and temperature.

(iii) Central venous pressure monitoring in selected cases.

(iv) Daily weight record.

(v) Blood sugar estimation by Dextrostix, 4 to 6 hourly.

(vi) Levels of serum urea, electrolytes, creatinine and calcium twice daily.

(vii) Complete blood counts–once daily.

In conclusion, PD is a preferred mode of dialysis in newborn babies and in many developing countries it is the only option available. For profesionals taking care of sick newborn babies orientation with this safe and relatively easy procedure will help save many babies who otherwise face a certain death.

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