Renal equipment and access in the 1960s and 70s.

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Abstract

This review describes the equipment and techniques used in the pioneering day of Australia's dialysis units. Equipment included coil dialysers, gravity controlled negative pressure, Kiil plates, dialysate tanks, shunts and glass peritoneal dialysate bottles.

Key Words
dialysis, history, haemodialysis

The dialysis treatment was 14 hours, twice a week, either Monday/Thursday or Tuesday/Friday

Memories of the equipment we used

Kolff dialysis was undertaken with 'twin coil' dialysers and ranged from four hours duration to seven or eight hours. The dialysate (dry pre-weighed salts) was mixed with a paddle in a stainless steel drum installed on a mezzanine floor, and accessed by a small ladder. Gravity was used to replace the used fluid in batches. The coil dialysers were pre-filled with blood from the Blood Bank as their capacity was over a litre. Patients were wheeled to the Clinical Science Building next to the Royal Melbourne Hospital (RMH) to have dialysis. Dialysis treatments occurred under the University Department of Surgery, not the RMH. The tubing used had to be individually assembled; it was not until later that Tuta Laboratories provided us with custom made, purpose built sterilized packets of blood lines. During remote acute treatments at the Queen Elizabeth Hospital (QEH) in South Australia staff working at the bedside would slow the dialysate flow to make what was available last until the next batch was provided. Carbon dioxide (CO_2) bubbled through the Kolff bath for the pH to keep the calcium (Ca^{++}) and bicarbonate (HCO_3) in solution. Blood leaks were common, patients had hourly urea and electrolyte levels and pre and post dialysis blood cultures were taken.

In Ward 6 East, then 6 North at the RMH, we used a recirculating single pass (RSP) Travenol Kolff system which had a large 120 litre tank under the coil compartment in which the dialysate was mixed and pumped up to the coil. To remove fluid from these patients we either added powdered glucose to the bath, and/or squashed the blood line below the venous chamber with a 'gate clamp' to increase the pressure in the blood circuit. The machine had wheels, but it was not very portable.

Four nights a week in 6 North, four patients had Kiil plate dialysis using Drake Willock (DW) machines, with self proportioning chambers which measured and delivered dialysate for two Kiils. The dialysis treatment was 14 hours, twice a week, either Monday/Thursday or Tuesday/Friday. Until about 1972, all patients had arterio-venous shunts, with blood flow dependent on their blood pressure and cardiac output. A Watson Marlow three roller tubing pump was occasionally used to increase blood flow up to approximately 120mls/min. We measured the flow by injecting air into the circuit and timing it over a measured section of the blood line.

Heparin was pumped into the blood circuit using 30 ml syringe pumps (glass syringes were used prior to the availability of single use plastic disposable items). Heparin was diluted from glass bottles which had a concentration of 25,000 units per ml. Regional heparinisation was used with simultaneous infusions of protamine sulphate and heparin. Heparin was pumped into the arterial line, protamine into the venous line, just before blood returned to the patient. Patients without bleeding problems had huge doses of heparin. 'Heparin rebound' sometimes occurred. Those needing 'mini heparin' had frequent samples taken for clotting times. These samples were put into a test tube in a water bath and tilted frequently until clotted and then minimal doses of heparin were given as indicated.

A venturi pressure device was used to create negative pressure for fluid removal which constricted flow, and if this was

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insufficient, we poked the drain line further down the balcony. Patients 'slept' in weigh beds, and we checked fluid loss hourly. The concentrate was kept in 20 litre white plastic drums and the tap water used was treated only by filtration.

The Kiil plates were tilted up to about 45 degrees during the last 30 minutes of the treatment, so the patients' blood would pool by gravity to the lower end of the plates. We returned their blood by pumping air through the lines using a sphygmomanometer bulb, with a clamp at the ready to prevent air embolism. Our training included the first aid procedure, of quickly placing the patient on their side with their head lower than their body, should air get into the patients' circulation.

The Kiil plates were made of a heavy type of plastic called 'polypropylene', and we placed sheets of cellophane 'cuprophan' between them to provide the blood compartment. After each use we dismantled them, threw out the cellophane membrane and scrubbed the boards with 'safsol' leaning over into a big bath on the floor in 6 East RMH. After rinsing we rebuilt them, tightening the bolts with a torque wrench, then pressure tested and if passed, we filled the blood compartment with 4% formalin solution made from 40% formalin supplied in two litres brown glass bottles. Prior to the next use we flushed them out with saline and used clinitest tablets to check for the presence of formalin. We can still recall the pungent smell, the streaming eyes and coughing fits from inhaling the heavy vapours, and the 'dermatitis' on our hands. Our solutions were made in the pharmacy department where they reused bottles with rubber stoppers, prior to the plastic bags of saline in use today.

In the early 1970s we started using DW4015 machines which used a single delivery self proportioning unit with capillary kidneys (hollow fibre). The dialysers were Dow 3. We shortened dialysis times to nine hours each session, and the patients underwent treatment three times per week. In 1972 the first RMH patient was trained to go home on haemodialysis, using a DW4015. The Lions Club donated the dialysis machines for the first few home patients. An insulated tank was devised and a Milton Roy monitoring unit added. A few patients had this equipment at home until government funding was available. As one patient did not pass the selection committee rules (<60 years and >16 years old, with no other systemic disease such as diabetes) he had to pay the RMH $5,000, so that we could buy him the required equipment. To save his money, he sterilized his gauze in foil parcels while the Sunday roast cooked! He was 60 years old, and continued as a home haemodialysis patient, still working until his death at age 73. Patients all sat in reclining chairs for their treatment. Reuse of dialysers and lines was routine for home patients, from the beginning. The DW4215 machine followed and the 1980s saw the Cobe Centry 2 in use at the RMH.

During the 1970s many dialysers were trialed - plates were available which were compact and 'single use' (not built by staff like the Kiils); many capillary dialysers were also available; and coils became smaller in size and blood volume. Membranes became thinner, and the time on dialysis was shortened.

Peritoneal dialysis (PD) up to the early 70s had been 'stick PD'. In about 1975 Drake Willock produced a PD cycler that incorporated online reverse osmosis to treat tap water which could be mixed with concentrate. Three bottles were hung and the machine had two pumps. Home PD at the RMH began about 1975 and patients underwent treatment three nights each week for 12 hours each night. By the late 70s plastic bags meant continuous ambulatory peritoneal dialysis (CAPD) became more common. Other 'cycler' type of machines were also available

Other equipment in RMH and QEH renal units were huge celtrifuge machines used for plasma exchange and white cell collections.

'Going on' and 'coming off' packs were made up by staff, and syringes and needles were not disposable. Staff cleaned, delivered and then collected from the central sterilizing services department (CSSD) as needed in the early days of dialysis treatments.

Water treatment was introduced in the 1970s once it was realised that bone fractures, 'dialysis dementia', and worsening of anaemia, experienced by many patients was the result of excess aluminum. Alum had been added to the reservoirs to make tap water palatable and during their dialysis treatments patients were absorbing aluminium from the dialysate plus they were also getting it from the 'Alutabs' they were taking to control their phosphate levels. During this time patients were subjected to very painful bone biopsies taken from the hip, to ascertain their degree of bone disease. Early tests for parathyroid hormone (PTH) levels required the staff to run to the laboratory with the iced samples. Water treatment involving much filtering, and reverse osmosis became standard in dialysis units especially with the introduction of fluoride into Melbourne's water supply.

In 1972, Fairfield Hospital, an infectious diseases hospital, became a dialysis unit when it became apparent that Hepatitis B could be spread, possibly by blood transfusions, venous pressure monitoring (isolators for our machines were not available) or needle stick injuries. Initial equipment taken from the RMH to Fairfield Hospital was the Kolff. With the hepatitis outbreak, the Kiil plates were gamma sterilized at the Westminster Carpet Factory and came back to the RMH green! We remember staff having painful weekly gamma globulin injections to 'prevent' Hepatitis B.

Late in 1974 the RMH appointed the first machine technician. Prior to this all equipment repairs were attended by hospital electricians, plumbers or the electronic engineering department, and home installations were sometimes assisted by company representatives.

In the late 1970s equipment and staff from the RMH also went across to the Royal Children's Hospital to perform plasma exchange and haemodialysis for their patients so that the children did not have to be transferred across to the RMH for treatment.

'Acute' dialysis was also undertaken in patients who had taken drug overdoses, including alcohol as it was found to lower alcohol/drug levels quickly. We also used a type of carbon filter to treat patients who had overdosed on rat poison or panadol.

Early Access

In the early days all patients had arteriovenous shunts. Teflon tips (small, medium or rarely large tapered tubes) were sewn, one into an artery and the other into a vein. Silastic (silicon) tubing was attached to this under the skin, and the tubing then exited through the skin with a step. The two ends curved to meet and were connected with a Teflon connector. These shunts usually started at a wrist, and as the lower vessels clotted they were inserted further up the arm. Those which had been initial inserted into patients' ankles needed to be moved further up the leg when the lower leg blood vessels clotted. Larger diameter shunts called 'Thomas' shunts were inserted into the groin vessels. A 'good' arterial site often lasted for up to about six or seven months, while venous sides of the shunts often had a life of only days or weeks. Shunts clotted often and staff had to declot them with syringes and Fogarty catheters. The relatives of our home patients were trained so they could declot shunts at home, to save yet another trip to hospital. Bull dog clips were kept handy for the accidental disconnections, and for commencing treatment.

Apart from clotting, infection was a frequent complication of shunts, particularly around the exit site. Scabs often formed and we scrubbed them with 'cetrimide' prior to disinfecting the area and the shunt with 'alcoholic chlorhexidine'. Erosion of the skin over the Teflon tips also occurred.

Acute shunts were inserted and sewn straight into the vessels using metal screws for connection and rubber coated forceps for clamping.

The Brescio-Cimini arteriovenous fistula meant staff and patients learnt to 'needle' with 14 gauge needles. A few options, like plastic cannulars (after the style of trocar and cannulars), rotating heads, back eyes, side eyes were around in the beginning with fistulas. These fistulas were used as soon as needed, sometimes the day after they were constructed. The wrist of the non dominant arm was the site usually selected for the creation of the fistula. Bovine, saphenous vein and 'Omniflo' grafts were occasionally used at the forearm when the wrist site was not possible, and even in the thigh. Later 'gore-tex' became available to be used in the creation of fistulas.

The above recollections are just some of the equipment and access we recalled using in the 1960s and 70s; it was certainly an interesting time to work in the renal team.