BELGIAN APPARATUS FOR ISOLATED KIDNEY PERFUSION

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This apparatus for isolated renal perfusion has been built by the mechanical engineering department of Newcastle University and is an accurate copy (apart from minor modifications) of the one in use at the Institut de Médecine, Hôpital de Bavière, Liège, Belgium. It has been developed by Professor Nizet and his co-workers, who followed on the investigations started by Brull.

Confining their studies to the dog, these workers sought to overcome the problem of progressive vasoconstriction which has long been known to occur when attempts have been made to perfuse kidneys in isolation from the body. They demonstrated that the vasoconstrictor properties of heparinised, stored blood are due to liberation by the red cells of at least two vasoconstrictor factors (Nizet et al., 1957, a and b) and these factors are detectable within five minutes of removal of the blood from the animal. Their liberation from red cells is greatly accelerated by all forms of mechanical agitation and is massive when haemolysis occurs. The vasoconstrictor factors are rapidly neutralised by the lungs (Nizet et al., 1957c) and by the liver. They can also be neutralised by the kidneys (Cuypers et al., 1961).

With this in mind Nizet and his colleagues developed their technique for perfusing isolated dog kidneys and managed to avoid renal vasoconstriction. They found it necessary to satisfy the following three experimental conditions:

1. The artificial perfusion must be done with fresh heparinised blood taken within 3 minutes from the donor animal. Within this time vasoconstrictor substances have not been liberated in sufficient quantity to cause significant renal vasoconstriction.

2. The quantity of blood used in the pump-oxygenator system must be such that the total volume of blood passes through the kidney within 2–3 minutes. In this way the vasoconstrictor agents, inevitably liberated by the red cells, are neutralised as fast as they appear. They are therefore unable to accumulate and diminish the renal blood flow. Use, from the beginning, of a limited quantity of fresh blood permits avoidance of the vicious circle.

3. In the pump-oxygenator system agitation of the blood must be reduced to a minimum in order to prevent massive liberation of vasoconstrictor agents by the red cells. All production of froth or foam must be avoided. Attention to these three conditions has led to the development of this apparatus (Cuypers, Nizet, and Baerten, 1964).

Description of apparatus

The oxygenator is made of two concentric cylinders fixed on a single base. The venous blood coming from the kidney falls on a plate which is revolving at five revolutions per minute. The rotating plate spreads the blood with one edge onto the internal surface of the external cylinder and with the other edge onto the external surface of the internal cylinder. The blood falls in this way as a thin film on the two surfaces and arrives at the bottom of the oxygenator. The lower circular space made by the two concentric cylinders constitutes the reservoir for
arterial blood. The blood is carried from here towards the kidneys by a pump of the Dale-Schuster type. The inflow and outflow of the blood pump are controlled by light leaf valves and the finger cot in its interior expands and contracts in response to hydraulic transmission from the large pump situated outside the apparatus. The frequency and volume of the pulsations can be altered over a wide range to obtain the desired blood flow. Between the pump and the kidneys there is an apparatus designed to absorb the shock of the pulsations. The pattern of the pulsations recorded with the aid of a plethysmograph

![Image](image_url)

*Fig. 1. The Belgian perfusion apparatus.*

has been found to be normal. On the arterial side of the kidneys is a mercury manometer. Sharp bends or abrupt variations in the size of the cannulae have been avoided as far as possible. The nature of the material with which the blood comes in contact has been found to have no influence on the production of vasoconstriction (Nizet et al., 1963). The kidney is supported by a plate which collects any losses of blood from the kidney and returns them to the oxygenator. At the venous side of the kidney is placed a T tube allowing direct measurement of the venous blood flow with the aid of a graduated pipette and a stop watch.

The gas mixture entering the oxygenator (95\% O₂ and 5\% CO₂) is humidified by bubbling through physiological salt solution and passed through another tube which acts as a trap for droplets of water vapour. On leaving the oxygenator the gas is passed through a third tube which collects droplets of condensation which would otherwise run back into the oxygenator and haemolyse the blood. The whole apparatus for oxygenation and perfusion is enclosed in a thermostatic bath at 38 °C.
Professor Nizet's team in Liège are using this apparatus to study fundamental aspects of renal physiology.

The apparatus, which we have found to be satisfactory and reliable, has been used in Newcastle to assess the function of kidneys subjected to various freezing procedures. It provides a means of testing the function of kidneys in almost physiological conditions for a few hours when it is not possible or desirable to re-implant the kidney into the animal. This may prove to be important in future in the assessment of human cadaveric kidneys as to their suitability for transplantation.

REFERENCES