

THE PROFESSIONAL NURSE IN THE CELL SUPPORT UNIT

LUCILLE WOOD

SRN, CRM, Chief Professional Nurse.

***JOHN D M RICHARDS**

M.D., F.R.C.P. (Edin.), Consultant

PETER JACOBS

MD, PhD., F.C.P.(S.A.), F.A.C.P., F.R.C. Path. (U.K.) Professor and Head

**The University of Cape Town Leukaemia Centre and the Department of Haematology,
Groote Schuur Hospital, Observatory
and**

***The Department of Haematology, University College Hospital, London.**

OPSOMMING

'n Goed-opgeleide verpleegkundige is die sentrale figuur in 'n Selondersteunings-eenheid.

So 'n eenheid bestaan uit gesofistikeerde bloedsel-afskeiers waarvan elk voltyds deur 'n verpleegkundige beman word. Die apparaat kan gebruik word om wit-bloedselle (leukopherese), of plaatjies (plaatjiepherese) te versamel, om plasma af te skei (plasmapherese) of vir rooibloedseluitruiling. Gesamentlik staan die verskillende tegnieke bekend as apherese.

Die rol van die verpleegkundige tydens apherese val in twee kategorieë. Eerstens moet sy die masjien bedien en enige nuwe-effekte of komplikasies by die pasiënt onmiddellik herken en dienoreenkomstig optree. Tweedens het sy 'n belangrike rol by die werwing van skenkers. Meeste skenkers word deur andere saamgebring maar dit impliseer dat daar 'n gelukkige atmosfeer in die eenheid moet heers en dat die personeel bekwaam moet wees.

Die eise wat in hierdie eenheid vir die veiligheid van skenkers en pasiënte gestel word beklemtoon die rol van die verpleegkundige as 'n gelyke vennoot van die geneesheer in die lewering van moderne gesondheidsorg.

These may be of different types but the one used at Groote Schuur Hospital (figure 1) is the NCI-IBM 2997 model which uses disposable pre-sterilised plastic tubing and a separation band (figure 2) which is assembled, inserted into the machine and all air flushed out with physiological saline. The machine function, integrity of the tubing, and the alarm systems are tested before the subject is started on the procedure.

Each cell separator is operated by one full-time professional nurse who never leaves her station at any stage during the procedure. The machine can be used for different purposes including white cell collection, known as leucopheresis, platelet harvesting, known as plateletpheresis, plasma exchange or plasmapheresis, and red cell exchange. The different techniques are collectively known as apheresis.

The Cell Support Unit is ideally an integral part of the Department of Haematology, where it fulfils the function of providing white cells and platelets for the leukaemia and transplantation programme, collections of haematopoietic stem cells for bone marrow grafting, and a wide range of emergency procedures not only for haematology patients but for those in the remainder of the hospital.

THE NURSE — A CENTRAL FIGURE

The well-trained nurse is the central figure in the efficient operation of the Cell Support Unit. This individual is responsible for the safety of those undergoing the procedures, whether they be volunteer donors or patients and has as a prerequisite thorough training and competence in intensive nursing care.

To this basic requirement must be added a minimum of three months in an accredited training centre to become familiar with the

operation of the cell separator in order that malfunction of the instrument and complications arising in donor or patient may be recognised immediately and appropriate corrective steps taken. This new breed of professional nurse reflects in part the introduction of sophisticated technology and in part the increasing role played by nurses at the forefront of health care.

THE UNIT

The Cell Support Unit consists of expensive sophisticated machines called blood fraction separators.

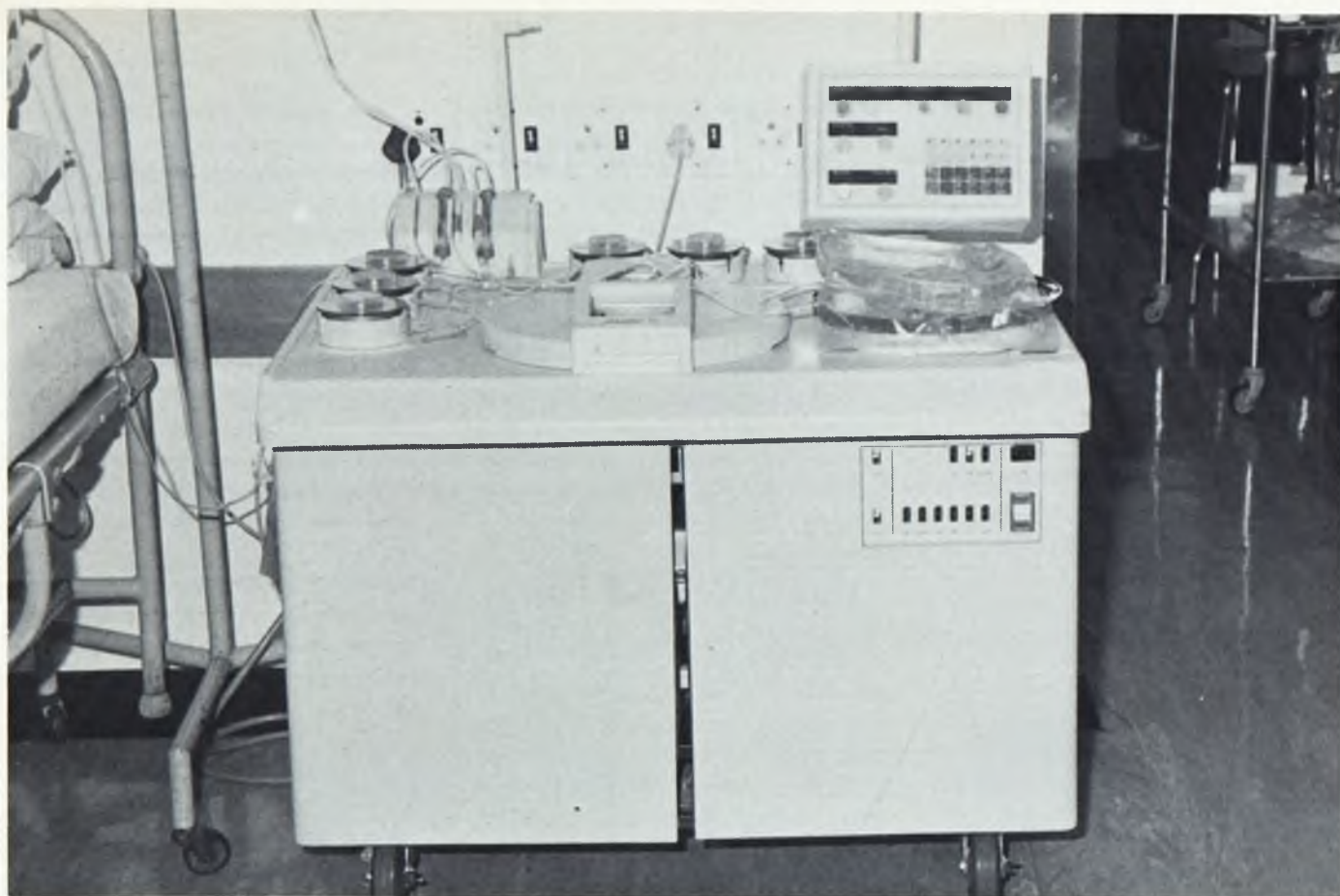


Fig. 1 Blood fraction separator.

These include replacement of abnormal red cells in patients with sickle cell disease during crisis, plasma exchange for life-threatening antibody-mediated diseases such as myasthenia gravis and Goodpasture syndrome, or removal of immune complexes in rapidly progressive glomerulonephritis.

After the introduction and development of separators in university departments, they are being slowly introduced into blood transfusion services for more efficient collection of platelets; here as well, the professional nurse should be in control of the procedure.

APHERESIS TECHNIQUES

The technique is relatively simple. Intravenous cannulae are introduced into the brachial vein in the forearm. Blood enters the specially designed band in the machine where it is separated into components based on differences in their specific gravities by means of circumferential centrifugation. Any of the components can then be selectively removed by means of roller

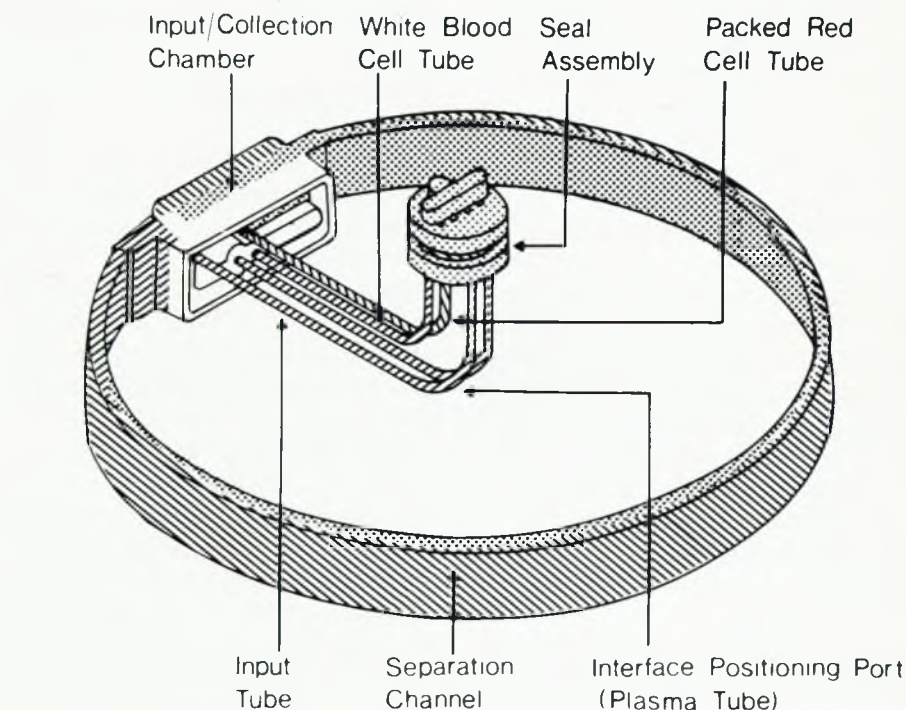


Fig. 2 Separation band.

pumps and the remaining blood returned to donor or patient by intravenous infusion into the opposite arm. In exchange procedures, large volumes of red cells or plasma can be separated and discarded and blood volume and composition retained by appropriate infusion into the return line.

Many safety devices are incorporated into the equipment to minimise hazards to the subject arising from instrument dysfunction. No technology, however, can safely be left to operate without continuous supervision by a highly trained and thoroughly experienced nursing sister.

Leucopheresis

Leucopheresis is the collection of white cells and with appropriate adjustment in technique this may be largely lymphocytes or, more usually, predominantly granulocytes.

Lymphocyte depletion may be used as a form of immunosuppressive therapy and is being investigated in the treatment of autoimmune and immunologically-mediated diseases. Granulocyte transfusion plays a vital role in patients with neutropenia, as seen in severe acute aplastic anaemia, following bone marrow transplantation, and after cytotoxic chemotherapy in leukaemic patients.

In each of these situations the peripheral blood granulocyte count should be less than $0.5 \times 10^9/\ell$, the patient to have a sustained fever greater than 38.5°C , and having failed to respond to adequate courses of appropriate intravenous antibiotic therapy for 48 hours. Once granulocyte transfusions are commenced, they are continued until the count is greater than $0.5 \times 10^9/\ell$, the infection controlled, and the temperature normal for 48 hours.

The procedure time for white cell collection is approximately two hours and depends upon the donor's white cell count. It is useful to administer 48 mg of methylprednisolone six to eight hours before commencing the collection to raise the white cell count. Under these circumstances, a 250 ml volume will contain between 2 and 4×10^{10} granulocytes which are morphologically and functionally normal.

During the procedure a concentrated citrate solution is infused as an anticoagulant in the ratio of 13:1 to the whole blood to ensure that clotting does not occur once blood is in the machine. A sedimenting agent in the form of 500 ml of hydroxyethyl starch is also added to the blood in the separator to improve granulocyte separation. The donors are always ABO and Rh group compatible with the recipients.

Plateletpheresis

Plateletpheresis is undertaken for bleeding when the platelet count is below $20 \times 10^9/\ell$, particularly following chemotherapy for cancer. It is important that donors do not take any tablets containing aspirin or other antiplatelet drugs prior to donation since, although the numbers may be normal, their function may be suboptimal.

A similar situation is found in patients with myeloproliferative syndrome and when such individuals require surgery additional platelets may be needed despite normal numbers.

The procedure time is ninety minutes to collect 250 ml of plasma containing between 3 and 5×10^{11} platelets. It is useful, following platelet infusion, to monitor the rise in platelet count which should be approximately $50 \times 10^{10}/\ell/\text{m}^2$ for a single such pack and indications for further infusions can be gauged by documenting platelet survival. The latter measurement is simply carried out by twice daily platelet counts.

Plasmapheresis

Plasmapheresis refers to the separation and removal of plasma and its replacement with an appropriate fluid which may be either fresh, frozen plasma, fractionated serum, or plasmalyte B and albumin. A practical exchange is approximately four litres but will vary with the individual's plasma volume.

Flow rates between 30 and 50 ml/minute are achieved using acid citrate dextrose as an anticoagulant at a ratio of approximately 1:11 with the blood. Specimens are collected before and after the procedure to monitor the white cell count differential, platelet count, biochemical profile, and changes in clotting factor. Serum samples are stored to measure the level of the product removed, such as cholesterol, antibodies or immunoglobulin.

A wide variety of indications exist for plasma exchange. Firstly, the hyperviscosity syndromes, as in Waldenström's macroglobulinaemia, in multiple myeloma, and in cryoglobulinaemias where abnormal

proteins are precipitated in the cold.

Secondly are antibody-related diseases where the procedure is carried out in conjunction with immunosuppressive therapy using prednisone, cyclophosphamide, or azathioprine and aimed at removing the antibody giving rise to the disease. Examples would include Goodpasture syndrome where renal failure and haemoptysis characterise the clinical syndrome, myasthenia gravis where weakness and paralysis are prominent clinical findings, and less frequently in haemophilia associated with antibodies to factor VIII, in diabetes with anti-insulin antibodies, in rhesus sensitisation where anti-D causes haemolytic disease of the newborn, and in both immune thrombocytopenia and haemolytic anaemia.

Similarly, immune complexes formed between foreign antigen and antibody may produce life-threatening symptoms in systemic lupus erythematosus and fulminating glomerulonephritis.

Thirdly there is a group of miscellaneous conditions where plasma exchange may be used to remove poisons or drugs taken in overdose, removal of biologically active substances in hypercholesterolaemia, in liver disease, porphyria, thyrotoxic crisis, and even to remove blood group antibodies where incompatibility exists between donor and recipient prior to bone marrow transplantation.

Other indications

Continuous-flow red cell exchange is an efficient and practical way of removing abnormal haemoglobin (HbS) in patients with sickle cell anaemia and replacing this with normal adult haemoglobin (HbA). This may be done prophylactically where patients require surgery or therapeutically when patients present with sickle cell crises.

In addition, therapeutic leucopheresis may be done where very high white cell counts may interfere with blood flow, as in acute and chronic leukaemia, while platelets may be removed by means of therapeutic plateletpheresis in individuals at risk from thrombotic episodes due to thrombocythaemia.

ROLE OF THE NURSE

In all of these sophisticated and relatively complex techniques, the role played by the professional nurse cannot be overstated and falls into two broad groups. Firstly, the thorough competence with all aspects of machine operation including the recognition of hazards and complications associated with the procedures. Secondly, the important role of donor recruitment.

Machine operation and patient observation

Hazards may be associated with the machine. Thus, air embolism may result from incorrect priming, extracorporeal clotting may reflect insufficient anticoagulant, while haemolysis may be due to a failure to recognise abnormal pressure changes occurring in the circuit.

Anticoagulants, particularly the acid citrate dextrose solution used in the procedures, may lead to side effects including citrate toxicity in which reduction of ionized calcium, due to binding, produces symptoms. The latter may be slight with numbness and tingling in the lips and around the mouth or the extremities, while priapism may be embarrassing. Failure to immediately recognise and correct citrate overdosage may lead to more severe side effects such as nausea and vomiting, substernal chest pain with changes in the electrocardiograph, and even cardiac arrest. While correction is easy and involves reduction in flow rate, failure to obtain immediate reversal may require the intravenous administration of 10 ml of 10 % calcium gluconate over the course of 10 minutes.

The sedimenting agent, hydroxyethyl starch, may result in urticaria, skin irritation with no visible changes which may last for many days, or headache due to plasma expansion. The replacement fluid, particularly when this is fresh, frozen plasma, may cause allergic reactions, fever, chills, urticaria, and hypotension.

Finally, the individual undergoing the procedure may present difficulties because of poor venous

access, or anxiety, usually during the first procedure. This can be overcome by a confident operator, reassurance to the patient, and careful step-by-step explanation.

Syncopy or fainting may occur. Haematoma may occur at the site of intravenous cannulation, particularly in the hands of inexperienced or poor operators and, similarly, blood may infiltrate the return site.

In each of these situations it is imperative that the professional nurse be able to recognise and separate anxiety from changes in plasma calcium level due to citrate intoxication or dilutional effects. Only experience will help the nurse to recognise more severe reactions that may occur during the course of these procedures and which may correlate with the underlying disease.

It is completely unacceptable to have a sister nominally present or in charge of such a unit. The only arrangement appropriate for an academic institution is to have a senior member of the nursing faculty positively and directly in charge of all aspects of the procedure and responsible for the supervision and in-service training of her more junior staff.

Donor recruitment

Neither should the question of donor recruitment, which lies within the ambit of the professional nurse, be underestimated. While in many situations families of patients come forward as volunteer donors, the demands of a busy unit require considerable support from the community and this can be elicited most efficiently by word of mouth in which one donor brings friends. To be efficient, such a system implies a happy unit competently staffed and with which the donor panel clearly identifies. Additional sources of donor recruitment are the media including the press, radio, television, and illustrated short talks to large firms and factories.

Donor selection itself is important since each individual establishes a personal relationship with the nursing staff of the Cell Support Unit. It is the moral responsibility of the staff to fully explain the pro-

cedure to all donors, including the use of drugs, and then to obtain fully informed consent.

Initial screening includes blood and rhesus grouping, screening for hepatitis, malaria, and venereal disease, and excluding underlying serious illness. Donor age is not critical, lying anywhere between 18 and 55 years. A suitably large panel, meticulous control of rotation and a philosophy never to store products but to collect components only as the specific need arises will mean that donors are used about once every four months for white cell collections but monthly for platelet donation. Following bone marrow grafting, the donor may undergo apheresis daily for five days to collect haematopoietic stem cells.

CONCLUSION

It is concluded that the professional nurse plays a vital role in the Cell Support Unit. The services range from collection of white cells and platelets through continuous-flow red cell, white cell, and platelet exchange to plasmapheresis. In each of the procedures sophisticated equipment with numerous fail-safe devices is used.

Nevertheless, it remains the cardinal principle that safety rests solely on the shoulders of the professional nurse in charge of the procedure. Only thorough familiarity with every aspect of the instrument and the procedure is compatible with patient safety and there is no excuse for leaving an instrument unattended at any stage of its operation. These prerequisites for donor and patient safety emphasise the everexpanding role of the professional nurse as an equal partner with the doctor in delivery of modern health care services.

ACKNOWLEDGEMENTS

The cell support system was established at Groote Schuur Hospital by the Department of Hospital Services with the support of the Teaching Hospitals Central Advisory Committee. We record our appreciation for encouragement and strong continuous support from both bodies and we acknowledge with pleasure the role played by dedicated and outstanding nursing staff. We thank the Medical Superintendent of Groote Schuur Hospital for permission to publish.