INTRODUCTORY NOTES

This is a transcript of a two-part article called 'Blood Transfusion in the United Kingdom' by Dr H.B.M. Lewis, former director of the Aberdeen and North-East of Scotland Blood Transfusion Service and Honorary Lecturer in Haematology at the University of Aberdeen, which was published in the April and May issues of the journal Medical Laboratory World in 1984.

I have been unsuccessful in my attempts at trying to establish who now owns the copyright for this journal (originally held by United Trade Press Ltd) and to my knowledge this article is not available via the internet. As such, this transcript is presented in this format for personal study only and must not be downloaded, copied, modified or reproduced further – it is provided here as an additional source of information relating to the history of blood transfusion.

As well as information on the work of James Blundell, the discovery of the ABO blood group system and anticoagulation, the first article presents interesting (and rarely published) background information to established historical events including the discoveries that led to the Fisher-Race Rh terminology and the organisation of the blood services in the UK prior to WW2; whilst the second article provides an insight into the organisation of the blood services in the UK during the first three decades after WW2.

BLOOD TRANSFUSION IN THE UNITED KINGDOM

Dr H. B. M. Lewis

In part 1 of this article on the development of the Blood Transfusion Services in the UK, Dr H.B.M. Lewis describes the activities of some of the early transfusers and examines the progress of blood transfusion up until the end of World War II.

The British Blood Transfusion Society at its inaugural meeting in Cambridge in 1983 decided to institute an international award to be named after Blundell; it will be given annually to anyone who has made a distinguished contribution to the development of blood transfusion. The naming of this award commemorates James Blundell, a noted physician, physiologist, and obstetrician, born in 1790; who, from 1814 to 1836 was a lecturer at Guy's and St Thomas's Hospitals; and who, in 1818, was the first to perform a human to human blood transfusion and to publish an account of his procedure.

BLUNDELL'S TRANSFUSIONS

Before Blundell gave his first human blood transfusion he had repeated Richard Lower's experiment of a century and a half earlier. At Oxford, in February 1666, under the aegis of the newly-formed Royal Society, Lower had been the first to perform a blood transfusion. In this experiment, blood from a mastiff was transfused to a smaller dog which had been bled almost to the point of death.

From one of the mastiff's cervical arteries blood was conveyed to a vein in the smaller dog through silver tubes connected to each other by a piece of cervical artery from an ox. This procedure was repeated several times until all the blood of two mastiffs had been used. At the end of the experiment Lower estimated that the

amount of blood exchanged had been equal to the total weight of the smaller dog. Yet, the smaller dog, after its exchange transfusion, appeared to be no worse for its experience.

The following year, animal blood was used to transfuse human subjects, first by Jean Denis in Paris, in June 1667, and then by Richard Lower and Edmund King in London, in November of the same year. However, after the death of one of Denis's patients in 1668, the procedure of transfusing animal blood to human patients fell, fortunately, into disrepute, even though the court at Chatelet concluded that the cause of death was that the patient's wife had been putting arsenic in his broth.

Blundell confirmed Lower's observations that a dog which had been bled almost to the point of death could be revived by a transfusion of blood from another dog. But he made the very important additional observation that is the blood of a sheep was used instead, the dog invariably died. He therefore concluded that if blood loss in human patients was to be treated by blood transfusion, human blood must be used.

For his first human blood transfusion Blundell used a syringe but he later devised other apparatus: first his 'impellor' (Figures 1 and 2), then his 'gravitator' – which clearly required a stalwart donor (Figure 3)! In the UK a little more than a century and a half later, two and a half million donations a year of human blood (each of about 430 ml) were being collected for transfusion.

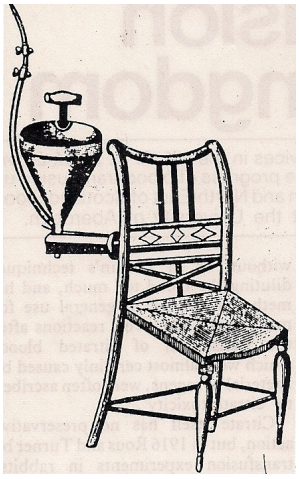

*FIGURE 1. Blundell's impellor**

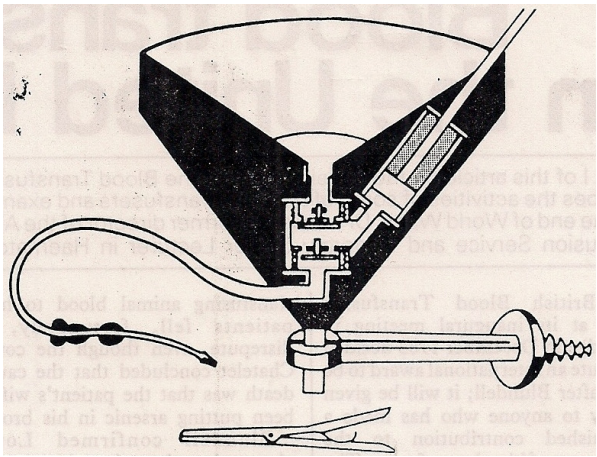

FIGURE 2. Details of Blundell's impellor

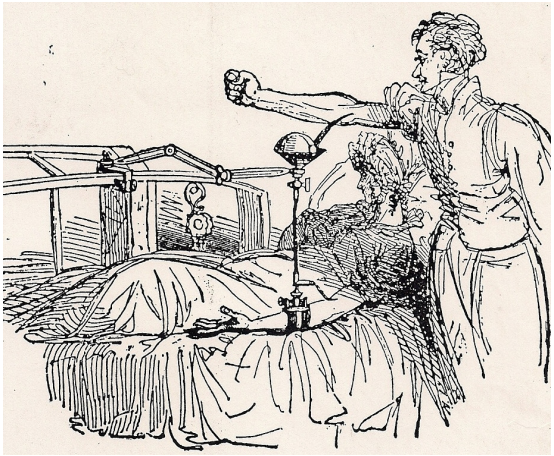

FIGURE3. Blundell transfusion using the gravitator 1829

* Figure 1 originates from Blundell's *Researches Physiological and Pathological*, published in 1821

DISCOVERY OF ABO AND THE USE OF CITRATE

However, before this expansion could take place, much had yet to be discovered in many fields. In blood transfusion, the next major advance was the discovery in 1900 by Landsteiner, working in Vienna, of the ABO blood groups; without a knowledge of these groups one in three random transfusions would be incompatible. Then, fourteen years later, four workers, independently, found that sodium citrate could be used as an anti-coagulant for blood transfusion: Hustin in Belgium (1914), Agote in Buenos Aires (1915), Lewisohn in New York (1915) and Weil also in New York (1915).

Lewisohn carefully defined experimentally the minimum dose of citrate necessary for this purpose without, as in Hustin's technique, diluting the blood too much, and his method remained in general use for many years. However, reactions after the transfusion of citrated blood, which was almost certainly caused by bacterial pyrogens, were often ascribed to 'citrate toxicity'.

Citrate itself has no preservative action, but in 1916 Rous and Turner by transfusion experiments in rabbits, showed that the addition of dextrose to citrate enabled blood to be stored for two weeks and that its transfusion after this period would prevent the development of anaemia in animals that had been previously bled. This discovery was put to practical use by Robertson in the treatment of battle casualties in France in the First World War. The donors were usually lightly wounded men or members of the Field Ambulance.

ESTABLISHMENT OF DONOR PANELS

After the war, interest in stored blood waned and did not revive until the thirties. Fresh blood was used and the donors were usually relatives or friends of the patient. However, these were not always available or suitable.

In 1921, a telephone call from King's College Hospital, London, to the Camberwell Division of the British Reds Cross Society, asking if he, Percy Lane Oliver, could find a blood donor from among his members, gave Oliver the idea of establishing a donor panel to cover all London. Oliver recruited volunteers and ran a day and night service from his own home with such success that by September 1939 the London Blood Transfusion Service, under the aegis of the British Red Cross Society, was answering calls at the rate of 6,000 a year. Thus was established the first panel of voluntary blood donors in the world.

Similar services followed elsewhere. In Edinburgh, for example, in 1929, John Copland, a dental surgeon, on learning of the death of a friend's wife who might have lived had her husband's blood been of the right group, recruited volunteers and ran a twenty-four hour service, also from his own home. By 1934 the work had expanded to a point where it could no longer be undertaken by one man, and in 1936, on the initiative of the Lord Provost of Edinburgh, a committee was formed with Charles Gumley as honorary secretary. John Copland continued as organiser with an assistant, Miss Helen White, who in 1940 was to become the Organising Secretary of the South-Eastern Region of the Scottish National Blood Transfusion Association.

FORMATION OF THE WAR-TIME SERVICES

Before the outbreak of the Second World War it had become clear that the quantity of blood that would be required in war-time would be beyond the scope of the peace-time services.

In England, on behalf of the Ministry of Health, the Medical Research Council set up four Blood Supply Depots (as they were called) on the outskirts of London. The

Army Blood Transfusion Service, based in Bristol, supplied the South-West of England. After the fall of France, the Ministry set up eight other regional centres as part of the Emergency Medical Service. The Medical Research Council extended its experimental serum drying unit and also used a grant made by the Wellcome Trustees to set up a large new drying plant in Cambridge.

In Scotland, rather different arrangements were made. At the beginning of 1939, the Department of Health set up a Blood Transfusion Committee, under the chairmanship of Sir John Fraser, Professor of Clinical Surgery in Edinburgh. After studying the use made of stored blood in the Spanish Civil War, they advised that blood banks should be established in the principle centres of population; and immediate steps were taken to set these up in Edinburgh, Glasgow, Dundee, Aberdeen and Inverness. The service would depend on volunteers, and it was decided that it would be best administered by a new voluntary body. At the invitation of the Secretary of State for Scotland, a Council was convened under the chairmanship of Lord Rosebery, and the Scottish National Blood Transfusion Association was formally constituted on the 5th March 1940. They were informed that they would receive a substantial grant from the Exchequer. When in 1943 it was decided to have two drying plants in the United Kingdom the other was established in Edinburgh.

Before the war, few clinicians had experience of blood transfusion; there were hospitals of considerable size where no blood transfusion had ever been given; and after air raids the medical staff of Transfusion Centres were often involved in giving transfusions in the surrounding hospitals. Transfusion Centres, and in particular those administered by the Medical Research Council, conducted research into many aspects of their work.

DISCOVERY OF ACD

At the SW London Supply Deport, Loutit and his colleagues investigated the effects on red cell preservation of using a mixture of the acid salt of sodium citrate (di-sodium citrate) and dextrose instead of tri-sodium citrate and dextrose, which to avoid caramelisation, had to be autoclaved apart before mixing. Using very powerful anti-A sera and the technique of differential agglutination they studied red cell survival *in vivo* and showed that acid citrate dextrose (ACD) was a much better preservative than tri-sodium citrate and dextrose. This solution was immediately adopted in the United Kingdom, and after the war it came into general use throughout the world.

UNRAVELLING RH

Simultaneously with these discoveries, others were being made in blood group serology. Before the war, and after Sir Ronald Fisher had become Galton Professor at University College, London, in 1933, he was offered funding by The Rockefeller Foundation. This he used to advance knowledge in human genetics by setting up a blood grouping laboratory. At that time only the A_1A_2BO, MN, and P groups were known. The laboratory, headed by Dr G. L. Taylor, recruited as its only other medical member Dr R. R. Race. With the approach of war, the unit was diverted to the collection of blood grouping serum and, when the war began, it moved to the Department of Pathology at Cambridge as part of the Emergency Blood Transfusion Service.

In 1943, Race was released from routine responsibilities to investigate an abnormal anti-Rh serum which had been received from Dr McCall of Stoke-on-Trent. It came from an Rh positive mother of erythroblastotic children and it agglutinated all

the Rh negative bloods with which it was tested, as well as the majority of Rh positives, 80% of bloods in all; it was later to be called anti-c. At this stage of the work two identical anti-Rh sera were received, one from Miss Boorman and Miss Dodd of the SW London Blood Supply Depot and the other from Dr C. V. Harrison of Liverpool University. They were the so-called 30% sera, later to be called anti-E. Both sera came from the Rh positive mothers of erythroblastotic children, and were almost certainly the first pure anti-Es to be discovered. In the autumn of the same year a serum was found by Professor Cappell of Dundee which agglutinated 70% of bloods and a supply of this serum was given to Race; it was later to be called anti-C.

FISHER'S PREDICTIONS

That year, Fisher had been appointed Professor of Genetics at Cambridge. When the reactions of these three sera, together with the original anti-Rh (85%) serum, had been worked out, the results were given to him one evening before dinner in a Cambridge 'pub' called 'The Bun Shop'.

At Bun Shop time the next day, Fisher returned with a solution. He predicted: a) certain reactions of Rz (CDE), which Race soon confirmed; b) that anti-e would be found, and it was, by Dr A. E. Mourant, then working at the NE London Supply Depot; and c) the existence of the very rare chromosome Ry (CdE), which was found five years later by Clara van den Bosch. As is well known, not every one of Fisher's predictions has been confirmed, but his brilliant scheme provided a basis for understanding, which has been used ever since.

MRC BLOOD GROUP RESEARCH UNIT

After the war this laboratory, under Race's directorship, became the Medical Research Council's Blood Group Research Unit, which for 29 years was housed at the Lister Institute of Preventative Medicine, at Chelsea. The Medical Research Council also set up the Blood Transfusion Research Unit, at the Royal Postgraduate Medical School, Hammersmith, under the direction of Dr, now Professor Emeritus. P. L. Mollison, which later became the Medical Research Council's Experimental Haematology Research Unit, at St Mary's Hospital.

USE OF RED CELL CONCENTRATES

One of the principle functions of the Emergency Blood Transfusion Service was the collection of plasma for pooling and drying, and it is interesting to note that the surplus of red cells thus generated stimulated the first significant use of red cell concentrates in the treatment of anaemia.

By the beginning of 1943, the Medical Research Council was drying plasma at the rate of 3500 bottles (each of 400 ml) a week, using the method developed by Greaves at Cambridge of 'high speed vertical spin-freezing'. In 1944 nearly 700,000 donations of blood were collected by the Emergency Blood Transfusion Service, a figure which was not to be reached again until ten years later.

PEACE-TIME ORGANISATION

As the war progressed, the Ministry of Health was considering a future peace-time organisation; and in its report of 1943/44 it was stated that: "As a result of the general increase in the use of blood transfusion which has taken place during the

war, it is clear that when peace returns, the demand for whole blood, plasma and serum will be very much greater than in pre-war years. The developments brought about by this war-time organisation have in fact laid the foundations of a new medical service". And soon after the end of the German war, in answer to a parliamentary question on 14th June 1945, the Minister of Health stated: "When the emergency is over, it is intended to provide a blood transfusion service on a permanent basis".

BLOOD TRANSFUSION IN THE UNITED KINGDOM

Dr H. B. M. Lewis

In part 2 of Dr H.M.B. Lewis's two-part article on the Blood Transfusion Services in the UK looks at how the Services were set up after the war and their present-day organisation and functions.

During the Second World War, the Ministry of Health had begun to consider the future peace-time transfusion service and soon after the end of the war stated that it intended to provide a permanent service as soon as the emergency was over.

The provision of a National Blood Transfusion Service in England thus became for a time the direct responsibility of the Ministry of Health. In January 1946, the Army Blood Supply Depot in Bristol, with a number of its existing staff, were taken over by the Ministry; the four London Medical Research Council depots were reduced to two and were transferred to the ministry in October. New regional centres in semi-permanent buildings were opened in Cambridge, Sheffield, Liverpool and Newcastle; plans for new premises were drawn up for centres in North London, Leeds and Oxford. A new Laboratory, the Blood Group Reference Laboratory, housed in the Lister Institute, was opened in July.

Most centres, however, continued to have accommodation difficulties; and the ministry of Health in its report for 1947 wrote: "In certain areas, particularly London, the limits of capacity of blood collection, imposed by accommodation, have almost been reached. The amounts of blood and plasma issued to hospitals will probably diminish as the dangers and limitations of transfusion are more widely appreciated".

It is east to say with hindsight that this forecast of diminishing demand proved to be incorrect. Nevertheless, this theme was to recur. Four years later it was written: "The demands made on the service during 1951 have steadily increased and it is remarkable during this year almost three times as much blood was issued to hospitals in England and Wales as in 1946. Although little of this blood was wasted in the more usual sense of the word, some of it was undoubtedly wasted in the sense that it was given to patients in whom insufficient indication for transfusion existed. The steady annual increase in demands for blood is seen not only in the United Kingdom, but in all those countries where transfusion exists. The institution of some form of control over the use of blood will become necessary if the demands increase at the present rate, for the voluntary donor panels, the source of the blood, are not of illimitable size". Thirty years later the collection of blood had trebled again (see Table 1) and blood products were being imported to make up deficiencies in supply.

INTRODUCTION OF THE NHS

With the introduction of the National Health Service in July 1948, the National Blood Transfusion Service (of England and Wales) was partly decentralised. The regional centres became part of the hospital specialist services and passed from the direct control of the Ministry of Health of that of the Regional Hospital Boards.

Other functions of the service continued to be co-ordinated and controlled centrally: the preparation and drying of plasma and the production of plasma fractions, the provision of standard transfusion equipment, the control of general publicity, and the preparation of statistics. The regional directors continued to meet under the chairmanship of the ministry's advisor on blood transfusion, Dr, now Sir, William d'A. Maycock, and by this means standards and matters of general policy were agreed.

In April 1950, the administration of the Blood Group Reference Laboratory was transferred from the Ministry to the Medical Research Council who undertook this function on the ministry's behalf.

TABLE 1:

Number of donations of blood collected in the United Kingdom (excluding donations by plasmapheresis) selected years 1949 – 1982

Year	England and Wales		Scotland		Northern Ireland	
	Donations collected (thousands	Rate per 1000 population	Donations collected (thousands	Rate per 1000 population	Donations collected (thousands	Rate per 1000 population
1949	457	10.4	43	8.4	8	5.5
1954	700	15.8	97	18.9	18	12.1
1959	958	21.1	131	25.3	28	18.8
1964	1241	26.2	164	31.5	36	24.2
1969	1484	30.6	208	40.1	46	30.9
1974	1725	35.1	231	44.4	54	36.2
1979	1942	39.4	280	54.0	67	44.7
1982	2059	42.0	297	57.2	65	43.5

Donations: each of about 430ml

Sources: England and Wales. 1949-1974: Chief Medical Officer's report for 1975, HMSO; for 1979 and 1982: DHSS, personal communication.
Scotland. 1949-79 (years from April 1 in year shown to March 31 in following year): Scottish Health Statistics, HMSO; for 1982: HQ SNBTS, personal communication.
Northern Ireland. Dr W.M. McClelland, personal communication.

Plasmapheresis: The number of donations by plasmapheresis in 1982 (200ml of plasma = one donation) would increase the total donations shown above for that year, by a little less than 2%.

Population in 1982 (millions): England and Wales 49.0, Scotland 5.2, Northern Ireland 1.5.

Automatic blood grouping using a Roche Groupamatic 360, Edgware Transfusion Centre, North London

REGIONAL ORGANISATION IN ENGLAND AND WALES

There have been few major administration changes in the NBTS since then. There are now in England 13 Regional Transfusion Centres to serve 14 Regional Health Authorities, two authorities being served by the South London Centre. The centres are located at Newcastle-upon-Tyne, Liverpool, Manchester, Leeds, Sheffield, Birmingham, Bristol, Cambridge, Oxford, Edgware, Tooting, Brentwood and Southampton. In Wales there is a Transfusion Centre at Cardiff. For logistic reasons, the area served by a centre is not necessarily the same as that of the authority which administers it; for example, North Wales is served from Liverpool, and Bath from Bristol; and comparisons based on populations must take these differences into account.

In England there are now three central laboratories: the Blood Group Reference Laboratory, now at Oxford, the Blood Products Laboratory, at Elstree, with which is associated the Plasma Fractionation Laboratory, at Oxford. Since December 1982 they have been administered by a new NHS authority: the Central Blood Laboratories Authority.

SCOTTISH NATIONAL BTS

In Scotland after the appointed day the service continued to be administered by the Scottish National Blood Transfusion Association; little administrative change was necessary, except that Flag days became a thing of the past and virtually all future funding came from the Exchequer.

A new centre at Law Hospital, Carluke, to serve the West of Scotland, was opened in 1956. By stages the other four centres were re-built and enlarged. Plasma fractionation continued to be carried out at the Regional Transfusion Centre in the Royal Infirmary, Edinburgh. Until 1974 when a new Plasma Fractionation Centre was opened in the south of the city.

In that year also, as part of the re-organisation of the NHS in Scotland, responsibility for the service was transferred from the Scottish National Blood Transfusion Association to a new health authority, the Common Services Agency for the Scottish Health Service; at about the same time a new appointment of National Medical Director was made, to co-ordinate the work of the regional centres and the Protein Fractionation Centre, and to advise the Common Services Agency and the Scottish Home and Health Department.

NORTHERN IRELAND

Northern Ireland is served by a regional centre in Belfast, which is administered by the Department of Health and Social Services. Its plasma fractionation was, until recently, carried out at the Blood Products Laboratory; to increase capacity, this work has now been transferred to the Plasma Fractionation Centre.

VARIATION OF THE FUNCTIONS OF TRANSFUSION CENTRES

Although all transfusion centres have certain basic functions in common: the recruitment and organisation of voluntary donor panels, the collection and testing of donor blood, and the provision of blood constituents (red cells, platelets, and plasma, and plasma for fractionation into numerous therapeutic substances, including Factor VIII, albumin, and a range of specific immunoglobulins), and also the supply of blood

grouping reagents, teaching and research, there are other functions that are undertaken, which differ from one centre to another.

For example, soon after the Rh blood groups were discovered by Landsteiner and Wiener in the USA in 1940, and their importance in the pathogenesis of haemolytic disease of the newborn had been recognised, transfusion centres in the UK took the initiative in starting the Rh testing of pregnant women, and their babies, as appropriate. When prevention of this disease became possible, centres added to their work the additional tests that its prevention requires.

Some centres were located within hospitals (three of the Scottish centres are, for instance, part of teaching hospitals) and undertake all the cross-matching for patients in them and the surrounding hospitals, and also other functions which elsewhere would be performed in laboratories of haematology or immunology. Many centres undertake tissue typing and the collection of HLA anti-sera; some centres carry out organ matching for transplantation. Some undertake therapeutic venesections and plasmapheresis as well as the plasmapheresis of normal donors.

When costs are being considered, these differences in function are usually not taken into account. But transfusion services do not differ in this respect from other parts of the health service, in which no-one has as yet been able to measure productivity. “The ministry”, as Sir Cyril Jones once put it in a report on the NHS to Aneurin Bevan “has no costing yardsticks at its disposal by which to judge relative efficiency or extravagance.”

In recent years, however, some of the underfunding there has been of the transfusion services is beginning to be recognised. Their expanding services now affect nearly every aspect of health care.