BLOOD BANKING ERRORS—A TWO YEAR PROSPECTIVE SURVEY

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Blood transfusion which not so long ago was a therapeutic measure prescribed by the consultant only after great consideration has today become a common therapeutic procedure prescribed by even the most junior doctor. This universal increase in the use of blood has by familarity led to the danger that the potential hazards associated with blood transfusion will not be appreciated and possibly even forgotten. Statistics from the Singapore Blood Transfusion Service show a 135% increase in the number of transfusions given over the past 10 years from a total of 7,492 transfusions given in 1955 to 17,606 transfusions given in 1965.

Twenty years ago at least one in three of the patients receiving blood had some adverse reaction attributible to the transfusion. This rate has probably been reduced to less than 5% today, Grant, 1965. Mortality from transfusion based on studies dating from 1917 to 1941 has been estimated at 1 in 1,000 - 3,000, Guynn and Reynolds, 1958. Mollison, 1962, states that mortality from blood transfusion is difficult to assess because on the one hand there is the tendency not to report mistakes and on the other there is a tendency to make blood transfusion the scape goat. However, Joseph, 1960, from statistics obtained from the Registrar General's Statistical Review of England and Wales and the United State's Bureau of Vital Statistics, estimates the current rate to be 1 death to every 250,000 to 350,000 transfusions given.

The main reason for the reduction in the dangers of blood transfusion has been the tremendous advances that have been made in the field of immunohaematology since Landsteiner first discovered the ABO blood groups in 1900. However, the safety of blood transfusion today can only be maintained if there is a highly organised transfusion service observing rigid standards of blood banking procedure and techniques coupled with an unceasing watchfulness on the part of all concerned with the collection and processing of the donor blood and with the crossmatching, issue and administration of blood to the patient.

The preparation of blood for transfusion involves the separate analysis of two unknowns —the patient's blood and donor's blood. As an added precaution, a compatibility test is carried out to observe the effects of addition of the donor's blood to the patient's under in vitro conditions. Only if this last test is negative can it be inferred that the blood to be transfused will be agreeable with the patient. The techniques employed in carrying out these tests vary from centre to centre depending on the facilities available. Whatever these may be, the techniques employed must be not only rapid to meet the emergency requests, but they must also be unfailingly accurate.

This paper reports on the operating procedures of the Singapore Blood Transfusion Service and on the results of a two year prospective survey of blood banking errors carried out during 1963 to 1965. The aim of the survey was to establish the incidence of blood banking errors and to make an analysis of the causes for the errors with a view to introducing corrective measures to prevent their recurrence.

The Singapore Blood Transfusion Service based on the Centre at the General Hospital is responsible for the collection, processing, storage and supply of blood to all hospitals in Singapore with the exception of the British Military Hospital. The performance of compatibility tests for patients in all the hospitals is carried out at the Centre in the General Hospital. Two hospitals, the Kandang Kerbau Maternity Hospital (KKMH) and the Thomson Road General Hospital (TRGH) maintain small stocks of blood in the hospital. These subcentres are managed by the Nursing Sister i/c. of Admissions or Casualty. The pilot tubes of the blood kept in these hospitals are retained in the Centre at the General Hospital for crossmatching procedures.

METHOD OF STUDY

A written report was made of any error by the person who discovered it. Before the survey was initiated it was explained to the staff that the aim of the study was an analysis of the errors and how they arose. It was stressed that the report was not to be used as a basis for personal

action against the staff. At the end of the 2 year period of survey, all the reports were analysed according to the type of error committed.

Errors were classified into technical errors—in which there has been an error in the performance or interpretation of a laboratory test, and non technical or clerical errors involving an incorrect recording of data of laboratory procedures which have been correctly performed. Included under this category were all errors occuring in the collection and labelling of blood samples taken from the patient, or in the administration of blood.

SUMMARY OF BANKING PROCEDURE

The donor at his first attendance has a preliminary blood group test carried out using known anti A and anti B sera by the slide technique. He is then issued with a blood label corresponding to his blood group. The label which has an identifying serial number is attached to the blood bottle. After donation, pilot tube specimens for laboratory tests and crossmatching are collected. The blood is stored in a separate refrigerator pending further investigation. The donor is issued with a donor certificate booklet which records his blood group. On subsequent visits the appropriate blood label is issued without any blood group tests being performed. Donors carrying booklets from other Transfusion Services are treated as new donors.

The blood collected is then submitted to a battery of rechecking tests the following day. This is carried out by a different group of technicians making use of different batches of reagents. All blood collected, irrespective of the number of donations made previously will have the ABO group rechecked by the tile method, James, 1958, using known anti A, anti B, and anti A + B (group O) sera. In addition, the sera will be tested against known group A, group B and group O cells.

All blood will be Rhesus typed with anti D sera by the papainised cell technique, Low, 1955. Those found to be Rh (D) negative will be further tested with anti CDE sera. Blood giving a positive result with this latter test will have a full genotype including a test for D^u carried out. All Rh (D) negative blood will be screened for the presence of atypical anti-bodies. Blood will only be labelled as "Rhesus Negative" if they are homozgous Rh (CDE) negative.

For all group A and group B blood, titrations of anti A and anti B titre are carried out. For group O blood a hemolysin test is carried out. Those found to have a hemolytic anti A or anti B titre of 16 or more will be labelled for "Group O patients only" and will not be issued for emergency use. The VDRL test is carried out on all blood collected. If positive, the Kahn and Wasserman reactions will be performed. Those with a positive serological reaction will be discarded. Only after completion of the above tests will the blood be transferred to the "Stock Refrigerator" ready for use.

Requests for blood for patients are made on specified forms accompanied by the blood sample from the patient in a labelled container. On receipt of a request, a search will first be made in the files for records of transfusions which the patient may have received previously. If this is not available, a transfusion record card is prepared for the patient.

The patient's blood is grouped and Rhesus typed in the same manner as described for donor blood. A compatibility test is then set up using a saline, and albumin technique at 37°C. A Coomb's crossmatch is performed as a routine in all cases. If the crossmatch shows no incompatibility an entry is made in the laboratory and patient's transfusion records. A compatibility label is then made up and attached to the bottle of blood which is now transferred to a separate refrigerator reserved for "Matched Blood" ready for despatch to the wards.

When emergency unmatched blood is requested, group O Rh (CDE) Negative blood free from haemolysin is issued for all patients except Chinese and Malays, who will be issued with group O rhesus positive blood. This is because less than 1% of Chinese and Malays are rhesus negative and it would not be economical to issue them with rhesus negative blood which is always in short supply. Urgent requests which cannot wait for the complete crossmatch have a rapid crossmatch performed in which the incubation time is reduced from the usual 60 minutes to as little as 10 minutes.

In the case of K.K.M.H. and T.R.G.H., after completion of the crossmatching tests, the compatibility labels will be despatched to the hospitals. In urgent situations, the results of the crossmatch are transmitted by telephone after which the Nursing Sister i/c. will issue the blood to the wards.

After completion of the transfusion, the details of the recipient will be recorded on the reverse of the compatibility label and returned to the Blood Transfusion Service for verification and compilation of statistics.

RESULTS

During the period of survey a total of 34,087 blood donations were received and 32,274 blood transfusions administered. A total of 78,316 crossmatches were performed during the same period.

The errors discovered during the period were analysed according to whether they were committed during the collection, and processing of the donor blood, or whether they were committed during the preparation of blood for the patient. This latter would include the collection of blood from the patient in the ward, the performance of crossmatching tests, the issue and administration of the blood to the patient. The errors were then further subdivided into whether they were technical or clerical. A summary of the errors is given below:-

I. ERRORS IN THE COLLECTION AND PROCESSING OF DONOR BLOOD

There were 37 errors in this category, 16 of which are clerical and 21 were technical.

CLERICAL: Error in identification or labelling of blood—16 examples

8 donors correctly blood grouped were issued with the wrong blood label. In 3 instances involving 6 donors there had been a switch in the blood labels issued to the donors *e.g.* two donors group A and group B were issued with blood labels group B and group A respectively.

5 donors correctly blood grouped at the preliminary screening test had compatibility labels of a different group attached to the bottled.

3 repeat donors were issued with blood labels according to the certificate booklet, the data in which were subsequently found to be incorrect.

All these errors of labelling were discovered on rechecking the blood the following day when the results of the tests showed the blood in the container to be of different group from the label it was carrying.

TECHNICAL: Error of blood typing—21 examples

8 donors initially typed as group A or B were subsequently found on rechecking to be group AB.

6 donors initially typed as group O were subsequently found on rechecking to be group A or B.

The above errors of blood typing were due to the insufficient length of time allowed for reaction to take place after addition of anti sera thus giving a false negative result. This is a recognised defect of blood typing on tiles. The possibility that some of the donors were group A_2B which is often mistaken for group B is also recognised. Another possibility is that the anti sera used were of insufficient titre and avidity.

2 donors initially typed as group A were subsequently found on rechecking to be group B. This was found to be due to an error of interpretation of results following a transposition of anti sera used.

In another instance a similar mistake occured when after ABO typing 59 donors at an outdoor session the switch in position of anti sera used was discovered as a result of which all group A donors were typed as group B and vice versa.

3 group O donors were wrongly typed as group B because of the false non specific agglutination given by the anti B sera used which was subsequently found to be contaminated.

1 donor initially typed as group AB was subsequently found on rechecking to be group B.

All these errors of blood typing with the exception of one case was discovered on rechecking the following day. The one exception was discovered when a bottle of blood labelled as group A blood was selected for crossmatch with a group A patient and incompatibility was demonstrated. This was finally shown to be because the blood was in fact group AB blood. No wrong transfusions were given as a result of these errors.

II. ERRORS IN CROSSMATCHING AND ADMINISTRATION OF BLOOD

There were 42 errors under this category, 25 of which were technical and 17 clerical.

CLERICAL ERRORS

Error in the collection of blood—8 examples.

8 errors occured in which blood for crossmatching was collected from the wrong patient or had been incorrectly labelled. The errors were discovered either because records of previous transfusions were available and showed the patient to be of a different group, or because receipt of further blood specimens from the patient at a later date showed the patient to be of a different group.

Of the 8 patients, only one patient, who was group B, received a transfusion of group Oblood before the error was discovered.

Error of identification and issue—8 examples

6 patients received transfusions of unmatched blood of the correct ABO group, due to a mix up of serial numbers *e.g.* a group B patient had a bottle of group B blood bearing serial no. B/1221 crossmatched. When blood was requested, bottle B/1121, which had not been crossmatched was issued by mistake and the transfusion given. No reactions were reported in all these transfusions.

In 2 other instances a similar mistake was made in the issue of blood but no transfusions were given.

All these errors occured in K.K.M.H. and T.R.G.H. where the results of crossmatch had been transmitted by telephone, as the patients were in urgent need of the transfusions.

Error of recording—1 example

A patient correctly typed as group B+ve. was wrongly recorded on the transfusion record as group O. Group O blood was selected for crossmatch and as no incompatibility was demonstrated the blood was issued for transfusion with no ill effects.

TECHNICAL ERRORS

Error of ABO typing—7 examples

6 patients, all subsequently shown to be group AB were originally typed as group A or B. They were matched and issued with group A or B blood respectively. 3 of the six patients received transfusions. No ill effects were reported. The errors were due to insufficient length of time allowed for action of anti sera on cells. Being group AB they did not show any incompatibility when crossmatched with group A or B blood.

1 patient originally typed as group B was found to give incompatible results when matched with a bottle of group B blood. Repeat tests on the patient's original blood specimen showed the patient to be group O. No transfusions were given.

Error of Rh typing—3 examples

Three rhesus negative patients were wrongly typed as rhesus positive. On receipt of further specimens at a latter date, they were found to be rhesus negative. In one case the error was due to a false positive agglutination due to rouleaux formation. In the other two instances, the Rh. anti sera which should have been diluted with group AB serum had been wrongly diluted with group O serum hence giving the false positive results. No transfusions were given in these three cases.

Selection of wrong blood for crossmatching—6 examples

One patient typed as group B was for no apparent reason matched with group O blood. No incompatibility was demonstrated at crossmatch.

Another patient was typed as group A but for no apparent reason group B blood was selected for crossmatch.

4 errors occured in which there was a switch or transposition in the sera used for setting up of the crossmatch for two patients, *e.g.* Two patients group A and group B were crossmatched by mistake with group B and group A blood respectively.

With the exception of the first, all the other errors were detected because of the incompatible results of the crossmatch.

No transfusions were given in all instances.

Rh. Negative patients receiving Rh. Positive blood—5 examples

4 patients (2 Chinese and 2 Malays) admitted into hospital with acute haemorrhage were given unmatched group O Rhesus positive blood as an emergency measure. The patients were subsequently discovered to be Rhesus negative. All these errors occured in K.K.M.H. and T.R.G.H. where the practice is to issue group O rhesus positive blood to all Malays and Chinese requiring emergency blood. As explained earlier, the rarity of rhesus negative group among these two races makes it uneconomical to issue as a routine rhesus blood to these cases.

1 patient, an Indian, subsequently shown to be rhesus negative was given emergency unmatched group O rhesus positive blood in a private hospital.

No immediate adverse reaction occured in all these transfusions as in all instances the patient's blood did not contain any Rhesus antibody.

KT positive blood issued for transfusion—1 example

A baby with neonatal jaundice was issued with freshly collected blood for exchange transfusion. The donor who had made 18 donations previously, had always had a negative serology. The last donation being 3 months previously. However, his latest donation was subsequently found to give a strongly positive Kahn reaction.

During the period of survey, there were only 3 instances in which patients received incompatible transfusions which could have had immediate harmful complications. They are reported in detail below:-

Case 1: was a group B patient admitted for incomplete abortion with severe haemorrhage. For no apparent reason, group A blood was selected and a crossmatch set up. No apparent incompatibility was detected in the crossmatch and the bottle of group A blood was issued for transfusion. By the time the error was discovered, the transfusion had been completed with no apparent adverse reactions. Patient subsequently received 3 further transfusions of blood of the correct group and recovered uneventfully.

Case 2: was a group O patient with Idiopathic Thrombocytopenic purpura who had undergone an emergency splenectomy.

There was in the same ward at that time another patient who had also undergone a splenectomy for portal hypertension. This patient was group A and a unit of group A blood which was issued for this patient was by mistake given to the group O patient. The patient finally died of uncontrollable haemorrhage.

Case 3: was a Gurkha soldier with spinal tuberculosis undergoing surgical operation. In May 1963 he was typed as group B and received one transfusion of matched group B blood. In August 1963 he was again typed as group B and crossmatched with group B blood. He received two units of group B blood. No incompatibility was demonstrated in all the crossmatches. All the transfusions were uneventful and no adverse reactions were noted.

In August 1964 a specimen of blood from the same patient showed the patient to be group O. Immediate investigation with repeat specimens taken from the patient confirmed the patient to be group O. It was confirmed from the Admission records that no other person with the same name, and registration number had been admitted into the hospital. Further, patient's case notes had the labels of the three units of group B blood that had been transfused earlier, thereby confirming that the patient did in fact receive the transfusions.

It is difficult to account for the mistake and for the absence of reactions or complications following the transfusions of 3 units of group B blood.

The confirmation of the patient as group O and the absence of incompatibility on crossmatching must mean that the two earlier specimens received must have been taken from the wrong patient. It is a strange coincidence that on both occasions, the blood taken was from a group B patient! The possibility of a change of blood group has to be borne in mind, but this is a rarity that has been described in cases of leukemia on a number of occasions, Race and Sanger, 1958.

INCIDENCE OF ERRORS

The total number of errors discovered during the survey and their relation to the work done is given in Table I below.

TABLE I

PROCEDURE	No. of Errors Discovered			INCIDENCE
	Technical	Clerical	Total	
Collection & Processing of blood 34,087 operations	21	16	37	1 in 921
Crossmatches performed 78,316 operations	25	17	42	1 in 1865
No. of blood transfusions given 32,274	4	15	19	1 in 1698

Table I: Showing number and incidence of errors in relation to work performed

DISCUSSION

The aim of all blood banking procedures is the supply of blood that is safe for transfusion. Towards this end the approach has always been to reduce the chance of any error remaining undetected to a minimum by having every test procedure performed at least twice by different technicians using different batches of reagents. Where the test is performed by one technician only, the results are counter checked by a second technician.

In the performance of blood group tests both the serum and cell checks are employed whenever possible and in the case of crossmatching tests, three different techniques—the saline, albumin and Coomb's technique—are employed. This would mean that any technical error commited should be discovered at the next stage and that for any incompatible blood to be issued undetected would mean that the series of counter checks has broken down and a number of consecutive errors has occured.

The same cannot be said of clerical errors where accurate and properly performed technical work can be negated by simply transfusing the correctly processed, crossmatched and labelled blood to the wrong patient or by the issue of blood of the correct group but bearing a different serial number from that which has been crossmatched. In a number of instances a combination of both technical and clerical errors have been responsible for a wrong transfusion being given.

Of the total of 79 errors recorded, 46 or 58·2% were technical errors and 33 or 41·8% were clerical. Schmidt and Kevy, 1962 found an even higher incidence of clerical errors in a survey in which 52 out of a total of 64 errors were of clerical origin. Their figures were recorded over a 21 months period during which 5,806 transfusions were given. This emphasised the need to try and reduce the clerical work involved to a minimium.

Although the number of errors occurring during the collection and processing of blood is apparently high, in all instances except one the errors were detected and corrected on rechecking of the blood the following day. The one exception was discovered when an incompatibility of crossmatch was demonstrated. In no instance did these errors result in a wrong transfusion being given. The importance of the rechecking tests cannot be over emphasised and these tests are carried out on all blood collected irrespective of the number of previous donations made.

Of the 42 errors occurring during the process of crossmatching nearly half were of clerical origin and no less than one quarter of these occurred in the ward. Not all of the 42 errors resulted in a wrong transfusion as many were detected and corrected before the issue of blood. Only 19 instances of patients receiving wrong blood were recorded, of which 3 were examples of an ABO incompatible transfusion being given. This gives an incidence of 1 incompatible transfusion for every 10,758 transfusions given. The majority of wrong transfusions did not lead to any harmful complications as they were examples of patients receiving unmatched blood of the same ABO group or group AB patients receiving group A or group B blood or group O blood being given to patients of other groups.

In the 5 instances where rhesus positive blood was given to rhesus negative patients, no immediate adverse reactions occurred as in all instances the recipients' blood did not contain any rhesus antibody.

One death associated with an incompatible transfusion was recorded during the survey. The patient who had a severe haemorrhagic condition due to thrombocytopenia, finally died of uncontrollable haemorrhage which was probably aggravated by the incompatible transfusion given. A haemorrhagic diathesis is a recognised complication following an incompatible transfusion.

The frequent occurrence of incorrect identification of patients by ward staff when collecting specimens for crossmatching has already been noted. In many instances, the availability of records of previous transfusions prevented the error from being passed undetected.

It was observed during the period of survey that errors tended to occur most frequently when the pressure of work was at a peak. Thus for example, at heavy outdoor sessions or whenever there were large numbers of donors waiting to be attended to there was a tendency for wrong blood labels to be issued to the donors and for the initial blood grouping tests to give erroneous results because of the lack of time given for the anti sera to react with the cell suspensions. In the performance of crossmatching tests, the heavy pressure of work often resulted in a high incidence of clerical errors and of errors in the performance or interpretation of tests. Thus for example, all the errors described under the heading "Selection of wrong blood for crossmatching" occurred when the lone technician on duty was harassed by the pressure of work to be

completed and with having to attend to the many telephone calls from the ward staff. This frequent distraction led to loss of concentration and to many apparently inexplicable errors being commited.

There is a limit to the number of counter-checks that can be instituted. Any additional check introduced would correspondingly increase the work load, both technical and clerical, on the already understaffed laboratory with the probability that the number of errors commited would be increased rather than decreased.

Even with an adequate system of counter-checks it is not possible to entirely eliminate mistakes because of the factor of human error or fallibility, but the number of mistakes due to human error can be reduced to a minimum if conditions are conducive to good work such as comfortable laboratory surroundings with adequate ventilation and lighting. An adequate complement of staff to avoid the necessity for long hours of duty under heavy pressure is also an essential requisite if mistakes are to be kept to a minimum.

CORRECTIVE MEASURES

Resulting from the survey the following measures were introduced:-

1. The names of all donors to be recorded on the blood labels and all staff attending to the collection of blood have been instructed to verify that the name of the donor and that on the labels agree.
2. Anti sera of greater potency to be used at the preliminary screening test and staff instructed to ensure sufficient time for anti sera and cells to react.
3. On receipt of requests for blood for patients a thorough search to be made in the files for records of past transfusions.
4. Technicians have been instructed to attend to one request at a time and not to attempt to set up crossmatches for a number of patients simultaneously.
5. All requests for unmatched emergency blood must preferably be accompanied by a specimen from the patient to enable a rapid Rh type to be performed thereby ensuring that blood of the correct Rh group is issued.
6. To obviate the necessity of having to transmit messages by telephone, a subcentre manned by qualified technicians, has been set up at the K.K.M.H. to attend to the crossmatching of blood for patients in the hospital.

SUMMARY

An analysis of the blood banking errors occuring during a 2 year period has been carried out. A total of 33 clerical and 46 technical errors were recorded with 3 instances of ABO incompatible transfusions given and one death resulting out of a total of 32,274 transfusions given. Specific corrective measures have been introduced as a result of the survey.

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