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Effect of blood transfusion in low birthweight infants

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SUMMARY 143 fresh blood transfusions were given to 32 low birthweight babies, 28 of whom had hyaline membrane disease. The arterial or central venous pressure was raised by a blood transfusion if before transfusion the mean arterial pressure was less than 35 mmHg or if the diastolic central venous pressure was less than −0·5 mmHg. There was no effect of blood transfusion on *p*H. It therefore appears either that metabolic acidosis in hyaline membrane disease is not caused by poor peripheral perfusion or that blood transfusion does not increase peripheral blood flow in this condition. The safety of the procedure is assessed.

A low red cell mass and blood volume have been reported in association with hyaline membrane disease (Inall *et al.*, 1965; Cassady, 1966; Brown *et al.*, 1975). In addition, Usher *et al.* (1975) have presented data which suggest that a decrease in red cell mass is associated with an increase in severity of and mortality from hyaline membrane disease (HMD). It seems logical therefore, as advocated by Phibbs (1969), to augment tissue perfusion and oxygenation in HMD with small serial blood transfusions. We report our experience with this method of treatment.

Patients and methods

Observations were made on 32 babies of less than 34 weeks' gestational age (range 26–33 weeks) whose mean birthweight was 1142±296 g (range 650–2000 g). Blood was drawn from a panel of donors all of whom were screened for blood communicable diseases including cytomegalovirus. Where possible, cross-matching was performed before transfusion. When it was judged that blood transfusions were urgently required, unmatched O or unmatched blood of the same group as the baby was given. An attempt was made, depending on the availability of donors, to restrict the number of donors for each baby. 143 transfusions were given to the 32 babies. The distribution of numbers of donors and the total volume of blood/kg transfused in individual babies are shown in Tables 1 and 2 respectively.

Blood transfusions were given for hypotension (systolic arterial pressure <40 mmHg) or metabolic acidosis (−base excess >8 mmol/l), or to replace diagnostic blood loss (>10% of the estimated blood volume). Blood gases were estimated 4-hourly or less. In a few babies an intravascular Po_2 electrode provided continuous Pao_2 estimations. Continuous records of arterial pressure (17 babies) and central venous pressure (9 babies) were made using Elcomatic transducers and displayed on a Devices M 19 multichannel recorder.

Zero reference point was taken at the midpoint of the anteroposterior transthoracic diameter. For the purposes of determining the effect of blood transfusion on the blood gases and *p*H, only estimations 2 hours before or after transfusion, between which there had been no alkali therapy or adjustment of ventilator settings, were analysed. With these exclusions 78 transfusions were available for analysis from the 32 babies. For control purposes 108 pairs

Table 1 *Numbers of donors for individual babies*

No. of donors	*No. of babies*
1	12
2	8
3	3
4	2
>4	3

Note: It was not possible to determine in 4 babies the number of donors.

Table 2 *Volume of blood given to individual babies*

Volume blood transfused (ml)	*No. of babies*
0–10	8
11–20	8
21–30	5
31–40	2
41–50	4
51–60	2
>60	3

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of blood gas estimations between which no blood transfusions were given were analysed from the same babies.

For the purposes of examining the effect of blood transfusion on arterial or central venous pressure, values at 5-minute intervals were extracted from the record manually. The mean of the 5-minute values before transfusion was compared with the mean of the values for the hour after transfusion. For control purposes the mean of the hour starting 2 hours before transfusion was compared with the hour immediately before transfusion.

Results

Changes in arterial pressure during the 2 hours before transfusion appear to be random (Fig. 1). The effect

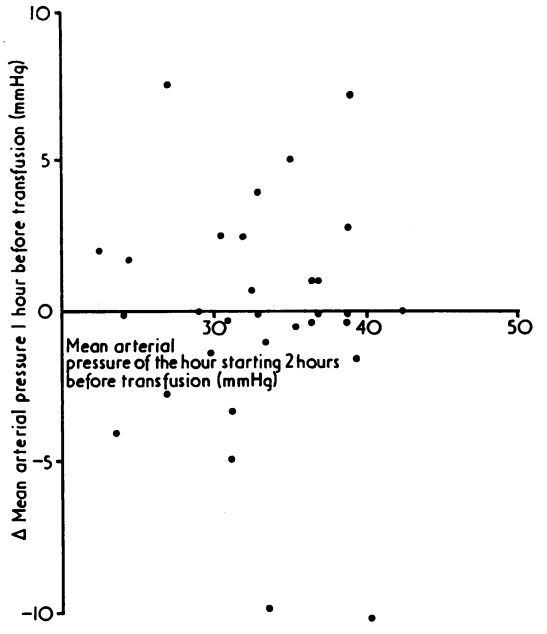

Fig. 1 *Change in mean arterial pressure 2 hours before transfusion.*

of a blood transfusion was to impose order on the random change (Fig. 2) ($P<0{\cdot}001$). It will be seen from the point at which the regression line crosses the ordinate that the effect of a blood transfusion was to raise the mean arterial pressure if it was less than 35 mmHg. Conversely, if the arterial pressure was more than 35 mmHg it appears that the effect of a blood transfusion was to lower it. Similarly, the change in diastolic central venous pressure after transfusion is shown in Fig. 3. Unlike the systolic

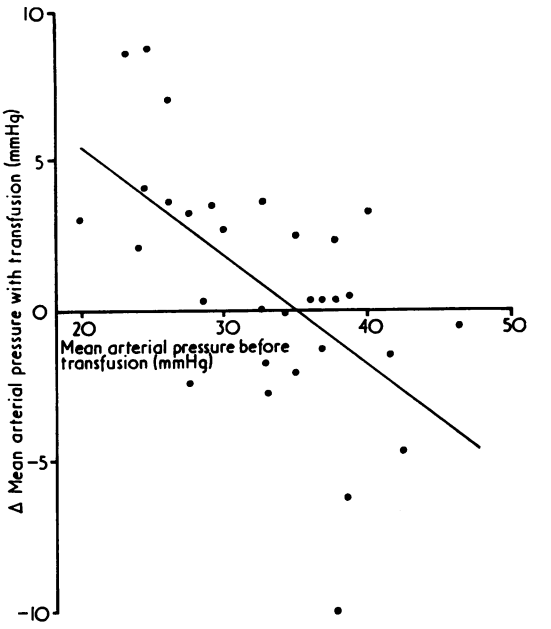

Fig. 2 *Change in arterial pressure caused by a transfusion* ($r = 0{\cdot}5$, $P<0{\cdot}001$).

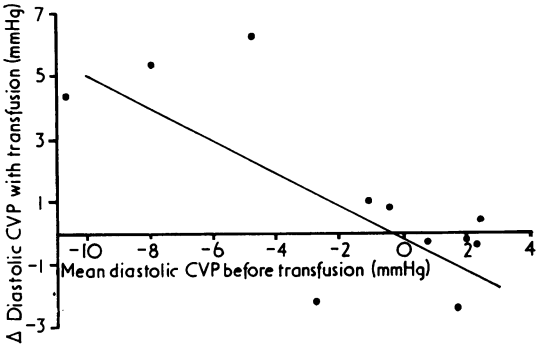

Fig. 3 *Change in diastolic central venous pressure (CVP) caused by a transfusion* ($r = 0{\cdot}74$, $P<0{\cdot}01$).

central venous pressure in which there was no clear effect of blood transfusion, a low diastolic central venous pressure ($<-0{\cdot}5$ mmHg) was raised by a blood transfusion ($P<0{\cdot}01$).

Changes in hydrogen ion concentration occurring without alkali therapy or adjustment of ventilator settings are shown in Fig. 4. It will be seen that there was a tendency for a displaced hydrogen ion concentration to return to 50 mmol/l (*p*H 7·30). Changes in hydrogen ion concentration with a blood transfusion (Fig. 5) did not differ significantly from

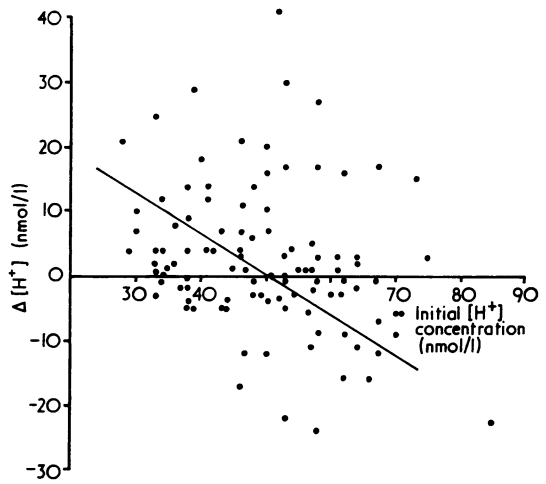

Fig. 4 *Change in hydrogen ion concentration occurring without alkali therapy or adjustment of ventilator settings* ($r = -0{\cdot}4169$, $P<0{\cdot}001$).

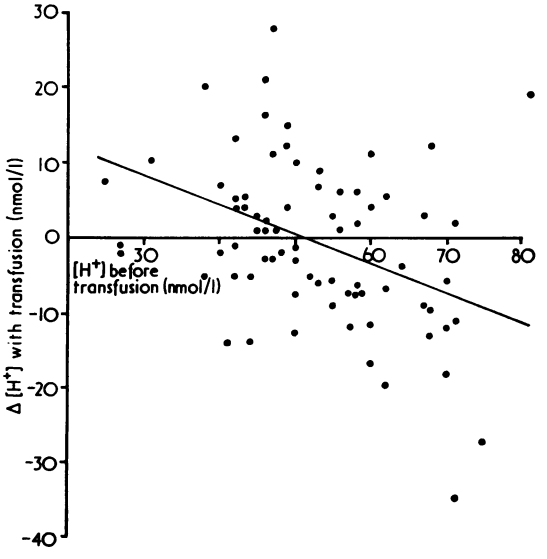

Fig. 5 *Change in hydrogen ion concentration with a transfusion* ($r = -0{\cdot}42$, $P<0{\cdot}001$).

changes effected by homoeostasis. Similarly, there was no additional effect of blood transfusion on changes in Pao_2 or $Paco_2$.

Discussion

Operation of a walking donor system has been criticized for failing to comply with the blood transfusion service requirements (Oberman, 1975). In over 200 transfusions given in our Special Care Baby Unit we have not identified any transfusion reactions or cases of graft-versus-host disease.

Although within wide limits arterial pressure appears to be maintained independently of the red cell mass or blood volume (Brown *et al.*, 1975; Robinson *et al.*, 1977), the arterial pressure if low was raised by blood transfusion. Red cell mass values were available in 12 of the babies, but could not be used to predict the response of arterial pressure to blood transfusion. This supports our suggestion made elsewhere (Robinson *et al.*, 1977), that the actual red cell mass is less important than the appropriate red cell mass for a particular baby in a particular situation. In this context, from the response of the diastolic central venous pressure to blood transfusion, it appears that the pressure of the venous system filling during diastole may be a useful indicator in the clinical situation of the adequacy of the circulating blood volume.

Our data do not support the suggestion that blood transfusion reverses metabolic acidosis. It may be argued that our failure to show an effect may be attributed to the method of analysis, but this is unlikely since with the same method we were able to show a clear effect on hydrogen ion concentration of bicarbonate and THAM administration. Another possible reason for our failure to show an effect may be that insufficient blood was given. However, we have not been able to identify an increasing effect on *p*H of subsequent blood transfusions. It appears therefore that either metabolic acidosis associated with HMD is not attributable to poor peripheral perfusion, or that blood transfusion does not increase peripheral blood flow in this condition.

It is noticeable that in the last few years we have used much less alkali than previously in the treatment of babies with HMD. This may be a consequence of more effective methods of assisted ventilation. In the 32 babies studied in this paper 28 had hyaline membrane disease but only 8 of these received any alkali therapy. Moreover, in 7 of these 8 alkali was only given within 2 hours of birth for acidosis associated with severe birth asphyxia. Thus, in giving blood transfusions with the object of increasing peripheral perfusion and combating metabolic acidosis we may have been attempting to treat a condition that was already disappearing for different reasons. In order to assess the effects of blood transfusion on metabolic acidosis we had to exclude those babies in whom some other major change in therapy had taken place over the hours of study. It might be the case that blood transfusion was only effective in terms of metabolic acidosis in those babies for whom ventilator settings had been

altered and who were therefore excluded from analysis. This seems inherently unlikely, since the ventilator settings were altered for several different reasons, for instance if a baby's clinical condition was improving as well as when it was deteriorating. However, we cannot altogether discount the possibility that metabolic acidosis already present may be reversed more rapidly with the addition of blood transfusion to effective ventilation. Only a prospective and controlled trial could answer this question.

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