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[Intervention Review]

Blood transfusion for treating malarial anaemia

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ABSTRACT

Background

Blood transfusion is used in patients with severe malarial anaemia, but risks adverse reactions, transmission of disease, and is complicated to organize in developing countries.

Objectives

This review evaluates the effects of routine blood transfusion for severe anaemia on death and adverse outcomes in malarious areas.

Search methods

We searched the Cochrane Infectious Diseases Group Specialized Register (April 2010), CENTRAL (*The Cochrane Library* Issue 2, 2010), MEDLINE (1966 to April 2010), EMBASE (1980 to April 2010), LILACS (April 2010), and reference lists of relevant articles. We contacted researchers and organizations working in the field.

Selection criteria

Randomized and quasi-randomized trials of blood transfusion compared with conservative management in malaria-associated severe anaemia.

Data collection and analysis

Trials were identified and data extracted by a single reviewer (MM) and checked by a second (HS). Inclusion criteria were applied and data were extracted independently by both reviewers.

Main results

Two randomized trials of 230 children were included. In the transfusion group, there was a non-significant tendency towards fewer deaths (RR 0.41, 95% CI 0.06 to 2.70), but a trend towards more severe adverse events (RR 8.60, 95% CI 1.11 to 66.43). In one trial by Bojang (1997a) respiratory distress was less common and hospital stay was shorter in the transfusion group (MD 1.88 days, 95% CI 2.41 to 1.35). Subsequent need for urgent blood transfusion was less common in the transfusion group (RR 0.12, 95% CI 0.02 to 0.68). Day 28 packed cell volume was less in the transfusion group (MD -1.34, 95% CI -2.57 to -0.11). There was no information on HIV or Hepatitis B virus transmission.

Authors' conclusions

There is insufficient data to be sure whether routinely giving blood to clinically stable children with severe anaemia in endemic malarious areas reduces death, or results in higher haematocrit measured at one month.

23 April 2019

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Update pending

Studies awaiting assessment

The CIDG is currently examining a new search conducted in April 2019 for potentially relevant studies. These studies have not yet been incorporated into this Cochrane Review.

PLAIN LANGUAGE SUMMARY

Blood transfusion for treating malarial anaemia

Malaria may cause anaemia. In areas where malaria is common and transmission is intense, many children are infected with the parasite, and severe anaemia can commonly cause death. Blood transfusions can be important for preventing deaths in very ill patients, although there are also some risks involved. This review was designed to assess the benefits and harms of giving a blood transfusion to all children with severe malarial anaemia but otherwise not in distress or severely unwell.

Two studies met our inclusion criteria, with a total of 230 children included in them; no studies looked at adults. There were fewer deaths in children who had blood transfusion compared with those who did not, but the numbers were small and not statistically significant. There was a trend towards more severe adverse events in the transfusion group, but a trend toward shorter hospital stay. The proportion of blood volume made up of red blood cells (haematocrit) was lower in transfused versus non-transfused children at day 28.

In conclusion, for a clinician faced with a child with severe anaemia who is otherwise stable and not distressed, there is insufficient evidence to know whether the risks of routine blood transfusion outweigh the benefit.

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BACKGROUND

Severe anaemia and cerebral malaria complicate *Plasmodium falciparum* infection, and cause most of the 1-2 million deaths caused by malaria each year (WHO 1990). In areas with stable and intense transmission of malaria, anaemia may cause more deaths than cerebral malaria (Slutsker 1994, Snow 1994).

Blood transfusion is often given to patients with severe malarial anaemia, and can be important in preventing death in very ill patients (English 1996). In other patients who are clinically stable, blood may be given simply on the basis of low haemoglobin, to prevent clinical deterioration. The other potential benefits are that it shortens recovery from anaemia, shortens hospital stay, reduces the length of follow up, and reduces the period in which patients are vulnerable as a result of their anaemic state (Bojang 1997a).

There are risks in blood transfusion: it can cause circulatory overload, transfusion reactions, and occasionally, death (Ness 1990, Garratty 1997, Goodnough 1999). There is also the risk of infection with HIV, hepatitis B or other pathogens (Greenberg 1988, Sazama 1994). Some experts recommend that patients with severe malarial anaemia who are otherwise clinically stable should be managed conservatively as haemoglobin has been shown to rise rapidly following antimalarial chemotherapy in a remarkable proportion of such cases (Pape 1989, Holzer 1993).

Conservative management corresponds with consensus guidelines for severe anaemia of any cause (ACP 1992, WHO 1989). The World Health Organization recommends that red cell transfusion is necessary only if the anaemia is associated with incipient or established cardiac failure (WHO 1989). Similarly, the American College of Physicians has recommended that blood transfusion in acute or chronic anaemia should only be given in symptomatic patients who failed to respond to other suitable resuscitative measures (ACP 1992). However some practice audit reports have shown that inappropriate blood transfusion is still common (Mozes 1989, Jager 1990, Ghali 1994).

In developing countries, blood transfusion may be further complicated by inadequate supply of donor blood, trained personnel and other basic requirements for good quality care. The potentially harmful effects of blood may be increased in these resource-poor settings since inadequate supervision of laboratory and clinical staff may increase the risk of incorrect cross matching, inadequate screening, poorly given transfusions and badly managed reactions.

The aim of this systematic review is to assess the benefits and harms of blood transfusion in severe malarial anaemia from randomised controlled trials. Since the balance of effects could vary depending on age and severity of illness, we intend to stratify the analysis by severity, and to consider sub-group analysis of children, adults and pregnant women.

OBJECTIVES

To evaluate the effect of routine blood transfusion in patients with malaria and severe anaemia on death and severe adverse events.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized and quasi-randomized controlled trials of routine blood transfusion.

Types of participants

Children or adults (irrespective of any inherited red blood cell disorders) with severe anaemia and confirmed malaria parasitaemia. Diagnosis of malaria was applied as a criterion for inclusion regardless of the species of malaria parasites.

Definition of severe anaemia: Although the most widely cited definition of severe anaemia is haematocrit < 15%, the definition of severe anaemia in reviewed literature varied from haematocrit of 13% or less (Fullerton 1962) to < 20% (Hedberg 1993). Haematocrit < 20% has been adopted as the definition for this review in order to avoid exclusion of many good trials on the basis of haematocrit cut-off points.

Inclusion of participants with inherited red cell disorders: Indications other than severe anaemia are well recognised in patients with inherited red cell disorders, notably sickle cell anaemia. Patients with those specific indicators would be expected to be excluded from trials strictly designed to determine the effects of blood transfusion in severe malarial anaemia patients who are otherwise stable. It is also possible that some good trials may not consider these disorders as criteria for exclusion. This explanation justifies the inclusion of this category of participants in the review.

Types of interventions

Intervention

Blood transfusion.

Control

Conservative management.

Types of outcome measures

Primary outcome

Death within two months.

Other outcomes

- Severe adverse events.
- Duration of stay in hospital.
- Re-admissions.
- Respiratory distress in the 1st week.
- Need for additional transfusion.
- Increase in haematocrit during follow-up.
- HIV and Hepatitis B status.

Search methods for identification of studies

We attempted to identify all relevant studies regardless of language or publication status (published, unpublished, in press, and in progress).

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We used the following search terms for all trial registers and databases: blood transfusion, haemotherapy, anaemia and malaria. The search strategy was further enlarged to include two inherited red cell disorders (sickle cell anaemia and thalassaemia) which are commonly associated with severe anaemia in many malarious areas.

We searched the Cochrane Infectious Diseases Group Specialized Register for relevant trials up to April 2010. Full details of the Cochrane Infectious Diseases Group methods and the journals hand searched are published in *The Cochrane Library* in the section on Collaborative Review Groups.

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), published in *The Cochrane Library* (Issue 2, 2010). This contains mainly reference information to randomized controlled trials and controlled clinical trials in health care.

We searched the following electronic databases using the search terms in combination with the search strategy developed by the Cochrane Collaboration and detailed in Chapter 6 of the Cochrane Handbook (Higgins 2008): MEDLINE (1966 to April 2010); African Index Medicus (1998); EMBASE (1980 to April 2010); and LILACS (La Literatura Latinoamericana y del Caribe de Informacion en Ciencias de Salud; www.bireme.br, accessed April 2010).

Organizations and individuals working in the field were contacted, and these included: Medical Research Council, The Gambia; Ifakara Centre (National Institute of Medical Research,Tanzania); Wellcome Groups (Thailand and Vietnam); World Health Organization (Child Health/TDR) and Departments of Paediatrics in malarious areas of Africa, Asia and Pacific.

The reviewers also drew on existing reviews of this topic, and checked the citations of all the trials identified by the above methods.

The review panel and external referees, were asked to check the completeness of the search strategy, and to identify any additional unpublished, ongoing and planned trials.

Data collection and analysis

Selection of studies

The inclusion criteria were independently applied to all identified studies by the two reviewers, and when in doubt the opinion of the editor was sought.

Data extraction and management

Data were extracted from the selected trials using a standard form. Data retrieved included methods, types of participants, interventions and outcome. Unpublished data, and additional data for published studies, requested from individuals or organizations, were obtained on a standard form.

Assessment of risk of bias in included studies

Study quality was assessed using the standard methods of the Cochrane Infectious Diseases Group.

Data synthesis

Anaemia severity was defined as "very severe" for haematocrit (PCV) < 12%, and "moderately severe" for haematocrit = 12-19%. Presence of signs of cardiac failure in severe anaemia was stratified as "very severe" regardless of PCV. This definition is a consensus view based on published studies and personal communication with over twenty experts.

Comparison was between transfused participants and the non-transfused controls. Estimates of effect were assessed using Risk Ratio (RR) or Mean Difference (MD) with 95% Confidence Intervals. A fixed effects model was used for meta-analysis. Where analysis showed evidence of heterogeneity of effectiveness between studies, sub-group analysis was used to explore plausible explanations, including severity of anaemia, age, co-existing morbidity (especially sickle cell anaemia) and variations in the type, speed and mode of blood transfusion.

RESULTS

Description of studies

Eligibility

A total of 42 studies were identified but only two met the inclusion criteria (see 'Characteristics of included studies'). The main reasons for exclusion were non-randomisation of blood transfusion, non-inclusion of severe anaemia as a selection criterion and location outside malarious areas (see 'Characteristics of excluded studies').

Location

The included studies were conducted in The Gambia and Tanzania. A total of 230 children aged two months to nine years with severe anaemia were included in the two trials.The detail of the characteristics of each study is shown in the Table of included studies.

Study details

Participants – both studies excluded children with PCV < 12%, haemorrhage or features of congestive cardiac failure (eg respiratory distress and gallop rhythm). One study (Holzer 1993) also excluded patients with temperature > 38 °C while the other (Bojang 1997a) excluded those with sickle cell disease or severe malnutrition. The PCV range of participants was 12-17% (Holzer 1993) and 12% to <15% (Bojang 1997a) respectively. This means that both trials exlcuded the "very severe" cases. Sickle cell anaemia patients were excluded from one trial (Bojang 1997a) while the other trial was unclear regarding the inclusion or exclusion of this category of patients.

Intervention – A total number of 118 received blood transfusion while 112 did not. Both trials used whole blood for transfusion but the volume transfused was 15ml/kg in one (Bojang 1997a) and 20ml/kg in the other trial. Non-transfused participants received oral iron supplements in one study (Bojang 1997a) and none in the other trial.

In Holzer 1993, all patients received treatment for malaria with chloroquine (25 mg/kg) followed by prophylaxis (5 mg/kg/week). In Bojang 1997a, a combination of chloroquine and sulfadoxine-pyrimethamine was used, followed by chemoprophylaxis (weekly Maloprim – dapsone+pyrimethamine) by the 28th day of follow-up in randomly selected sub-groups of transfused (19) and non-transfused (16) participants.

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Risk of bias in included studies

Both trials were randomised but the method of generation of allocation sequence was adequate in one (Holzer 1993) and unclear in the other. The adequacy of allocation concealment could not be determined in both trials. Investigators were not blinded probably due to the nature of the intervention. Studies were not analysed according to the intention-to-treat principle.

Both trials recorded high percentage of loss to follow-up. In Holzer 1993, 16 (13.8%) participants were lost to follow-up by the 8th week (10 transfused and 6 non-transfused) but mortality data was ascertained in five of them (2 transfused and 3 non-transfused). In Bojang 1997a, 26 (22.8%) participants were lost to follow-up by the 8th week (11 transfused and 15 non-transfused). Five children in the transfusion group were not transfused becaused their PCV increased while they were waiting for blood to be provided. Both studies did not give clear indication of the sources of the blood used in the trials.

Effects of interventions

Primary outcomes

Death

Combining the two trials, there were fewer deaths among transfused participants (1/118) than non-transfused patients (3/112) but the numbers were small, and the result not statistically significant (Analysis 1.1).

Severe adverse events

Bojang 1997a reported convulsions (4 patients) and coma (3 patients) following transfusion but none in the non-transfused. Holzer 1993 reported chills and fever in one transfused participant who later died.

Seven out of eight adverse events occured in one trial (Bojang 1997a), with only one event in the other. Results were not combined since the risk effect between the studies is so different (Analysis 1.2).

Number of deaths and severe adverse events were pooled. One participant (Holzer 1993), who experienced an adverse event then later died, was counted only once in this analysis. The meta-analysis showed no significant difference in risk of either death or an adverse event between transfused and non-transfused participants (RR 2.54 95% CI 0.69 to 9.34, Analysis 1.3).

Other outcomes

Duration of stay in hospital

Bojang 1997a reported duration of stay in hospital, and this was significantly longer in the non-transfused group of participants (MD 1.88, 95% CI 2.41 to 1.35, Analysis 1.4). Holzer 1993 reported a higher rate of re-admission among the non-transfused (RR 0.23, 95% CI 0.03 to 2.03, Analysis 1.5) but did not report length of stay.

Respiratory distress in the first week

The risk of developing severe respiratory distress in the follow-up period was shown by one trial (Bojang 1997a) to be significantly higher among non-transfused participants (RR 0.04, 95% CI 0.00 to 0.70, Analysis 1.6). The other trial did not report this event but identified one case of bilateral pneumonia among the non-transfused.

Need for additional transfusion

See Analysis 1.7. One trial showed that more participants in the non-transfused group (10/56) than the transfused group (0/58) needed blood transfusion in addition to their primary allocation of the intervention. The criterion for additional transfusion was 'clinical assessment' in Holzer 1993, but not stated by Bojang 1997a. In the Bojang trial, 10 children from the non-transfused arm required additional transfusion because they developed respiratory distress, and in Holzer 1993 one child from the non-transfused arm was treated with quinine and blood was transfused, but the child died soon after transfusion.

Increase in haematocrit during follow-up

In both studies, mean haematocrit at baseline in the transfusion and non-transfusion groups were similar.

The haematocrit by day 7 of follow-up reported by Bojang 1997a was significantly higher in transfused participants (MD 3.39, 95% CI 1.5 to 5.3, Analysis 1.8).

By day 28, haematocrit was significantly higher in the non-transfused participants in one study (Bojang 1997a; MD 2.10, 95% CI 3.52 to 0.68, Analysis 1.9) and was not significantly different in the other trial (Holzer 1993; MD 0.90, 95% CI 1.55 to 3.35, Analysis 1.9).

Day 56 haematocrit (Holzer 1993) showed no significant difference between transfused and non-transfused participants (MD 0.70, 95% CI -2.98 to 1.59, Analysis 1.10). The other trial did not report data on haematocrit by day 56.

Effect on Plasmodium parasitaemia

In the trial that compared blood transfusion with iron supplements (Bojang 1997a), there was no significant difference in the proportion of participants with parasitaemia on days 7 and 28 of follow-up (RR 0.97, 95% CI 0.06 to 15.06; same for both days, Analysis 1.11 and Analysis 1.12). This outcome was not pre-specified.

HIV and hepatitis B transmission

None of the trials reported the evaluation of these outcomes.

Other adverse events

No additional severe adverse events attributable to blood or the other drugs was recorded.

DISCUSSION

These studies were small, and neither study appeared to conceal allocation. The small size means we cannot be sure whether early transfusion improves survival in children with moderate malaria associated with anaemia. Loss to follow up was >10%, which could also bias the results.

The trials did not evaluate the risk of HIV or hepatitis B virus transmission which would require longer term follow up. Clearly in centres where screening is routine this is less of a risk, but these are often fatal infections.

There was also lack of information on patients with sickle cell anaemia since these were excluded from one trial (Bojang 1997a) and inadequately reported in the other.

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There is evidence from one trial that non-transfused children stayed longer in hospital than the transfused. Whether this is a result of arbitrary policies about haemoglobin level at discharge or some other clinical decision is not clear.

The mean value in haematocrit during follow-up was higher in transfused children during the first week but this did not persist. The non-transfused children had clearly higher mean haematocrit in one trial (Bojang 1997a) but lower mean haematocrit in the other trial by day 28. One of the trials (Bojang 1997a) gave iron supplements to the non-transfused while the other (Holzer 1993) gave none and this may explain the more rapid increase in the haematocrit in the former.

Blood transfusion is given for several other reasons than severe anaemia in clinical practice (Hebert 1997b, Goodnough 1999). Many of these other indications have been the subject of good clinical trials (Koshy 1988, Lorente 1993, Vichinsky 1995, Adams 1998, Yu 1998, Hebert 1999). However, these important trials do not provide an answer to the question of what the effective and safe standards should be for the use of blood transfusion for severe anaemia in malarious areas. The geographical and epidemiological relevance of this research question lies in the fact that malaria which is the leading cause of severe anaemia in endemic communities can be cured in most cases and recovery from malarial anaemia is known to be rapid following successful chemotherapy (van den Hombergh 1996, Pape 1989, WHO 1989).

The data were too limited to explore potential factors modifying effects. However, both studies were conducted in stable endemic malarious areas: the effects of malaria may be more severe in people with little immunity, so transfusion in these groups could potentially be of greater benefit.

We found no information was available on adults. Evidence in these groups are important, especially pregnant women who are also exposed to risk of significantly higher morbidity and mortality from malarial anaemia.

AUTHORS' CONCLUSIONS

Implications for practice

In children living in malarious areas with severe anaemia and no respiratory distress, there is insufficient reliable information to know whether routine administration of blood does more good than harm.

Arguments that blood transfusion helps haematocrit recovery over the subsequent weeks is not supported by evidence from one trial.

Implications for research

Larger randomized trials of blood transfusion with death as the primary outcome would be useful. The trials could also evaluate as secondary outcomes: respiratory distress and subsequent need for blood (within the first week); adverse events; increase in haematocrit (up to the 2nd month); duration of hospital stay; re-admission rate; HIV and Hepatitis B virus status (within 3-6 months). A carefully conducted large trial is likely to under-estimate the risk of HIV/HBV transmission, since greater care might be taken to avoid these infections in a trial, compared with routine practice.

Some clinicians believe that it is unethical to conduct studies on children with PCV between 12% and 17%, and believe their clinical judgement is better. We maintain that the best way of assessing this policy is to conduct a randomized controlled trial.

The reviewed trials excluded children with PCV < 12% who did not have signs of heart failure thereby losing information on this category of patients. Subsequent trials should include such patients and make room for sub-group analysis if necessary. A multicentre trial, contributing data to an individual patient data analysis, would help to explore the various factors that might modify effects. Potential sources of heterogeneity are clinical status on admission, age, pregnancy, nutritional status, presence of sickle cell trait or various forms of thalassaemia, and endemicity of malaria.

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Bojang 1997a

Methods	Randomised controlled trial, method of randomisation not specified, allocation concealment unclear
Participants	114 children aged 6 months to 9 years with malaria and severe anaemia (PCV < 15%) Exclusion criteria: PCV <12%, respiratory distress, gallop rhythm, haemorrhage, severe malnutrition or sickle cell disease
Interventions	Blood transfusion versus no blood transfusion (with oral iron) All particpicants treated with chloroquine (25 mg/kg) plus sulfadoxine-pyrimethamine (SP)
Outcomes	1. Death 2. Increase in PCV 3. Duration of stay in hospital 4. Additional need for transfusion 5. Severe adverse events 6. Respiratory distress 7. Effect on parasitaemia
Notes	Malaria microscopically confirmed by asexual parasitaemia or malaria pigments in leukocytes Excluded patients with PCV<12% or respiratory distress or other signs of cardiac failure had immediate transfusion (not randomised)

Holzer 1993

Methods	Randomised controlled trial; allocation sequence generated from table of random numbers, allocation concealment unclear
Participants	116 children aged 2 months to 6 years PVC 12-17% Temperature < 38 °C Exclusion criteria: pneumonia, signs of cardiac failure or haemorrhage
Interventions	Blood transfusion versus no blood transfusion All participants treated for malaria with chloroquine (CQ = 25 mg/kg) and mebendazole All had chemoprophylaxis with CQ (5 mg/kg/week)

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Holzer 1993 *(Continued)*

Outcomes	1. Death 2. Increase in PCV 3. Need for additional transfusion, re-admission 4. Adverse events
Notes	Microscopic confirmation of malaria not specified

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Addo-Yobo 1991	Not randomised clinical trial
Bojang 1997b	Allocation of participants to blood transfusion not randomised
Camacho 1998	Did not involve randomised trial of blood transfusion
Carson 1988	Not randomised clinical trial
Corwin 1995	Not randomised clinical trial
Craighead 1993	Not randomised clinical trial
Delzanno 1996	Not in malarious area
Dorward 1989	Not a randomised clinical trial
Elechi 1995	Not randomised clinical trial
English 1996	Participants not randomised for blood transfusion
Fullerton 1962	Not randomised clinical trial
Ghali 1994	Not randomised clinical trial
Gumodoka 1993	Not randomised clinical trial
Harrison 1971	Blood transfusion not randomised
Hebert 1997a	Not randomised clinical trial
Hebert 1999	Participants were critically ill but not all were severely anaemic; location of study is not a malarious area
Hedberg 1993	Not randomised clinical trial of blood transfusion
Jackson 1982	Not clinical trial of blood transfusion
Jager 1990	Not randomised clinical trial
Koshy 1988	Severe anaemia not inclusion criterion; not in malarious area
Lackritz 1992	Not randomised clinical trial

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Study	Reason for exclusion
Lackritz 1993	Not randomised clinical trial
Mozes 1989	Not randomised clinical trial
Pape 1989	Not randomised clinical trial
Poets 1997	Not randomised clinical trial
Poletes 1994	Not randomised clinical trial
Saxena 1993	Not randomised clinical trial
Schmutzhard 1988	Not randomised clinical trial
Slutsker 1994	Not a clinical trial
Srichaikul 1993	Not randomised clinical trial
van den Hombergh 1996	Allocation randomised for iron therapy but not for blood transfusion
Vichinsky 1995	Severe anaemia was not an inclusion criterion; not in malarious area
Vos 1994	Not randomised clinical trial
Yu 1998	Severe anaemia was not an inclusion criterion, not in malarious area
Zucker 1994	Not randomised clinical trial

DATA AND ANALYSES

Comparison 1. Blood transfusion versus no blood transfusion

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Death	2	230	Risk Ratio (M-H, Fixed, 95% CI)	0.41 [0.06, 2.70]
2 Severe adverse events	2	230	Risk Ratio (M-H, Fixed, 95% CI)	8.60 [1.11, 66.42]
3 Deaths + severe adverse events	2	230	Risk Ratio (M-H, Fixed, 95% CI)	2.54 [0.69, 9.34]
4 Duration of stay in hospital	1	114	Mean Difference (IV, Fixed, 95% CI)	-1.88 [-2.41, -1.35]
5 Re-admissions	1	116	Risk Ratio (M-H, Fixed, 95% CI)	0.23 [0.03, 2.02]
6 Respiratory distress	1	114	Risk Ratio (M-H, Fixed, 95% CI)	0.04 [0.00, 0.70]
7 Need for additional blood transfusion	2	230	Risk Ratio (M-H, Fixed, 95% CI)	0.12 [0.02, 0.68]

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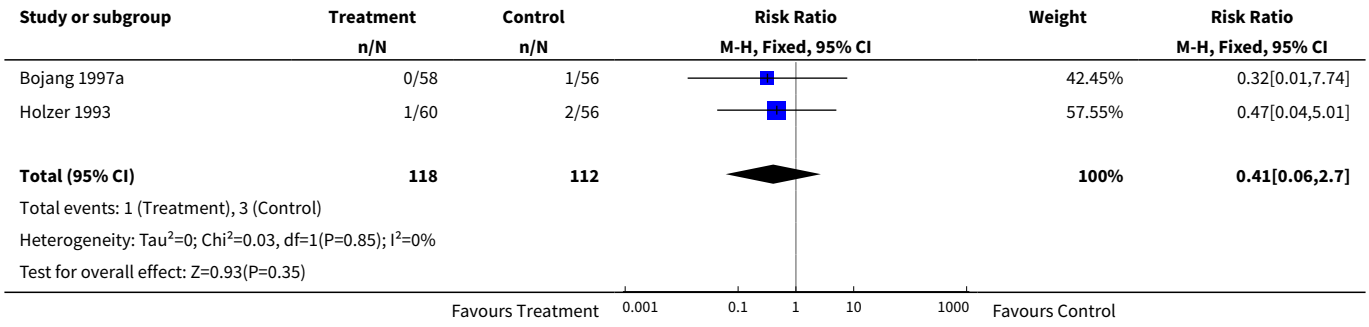
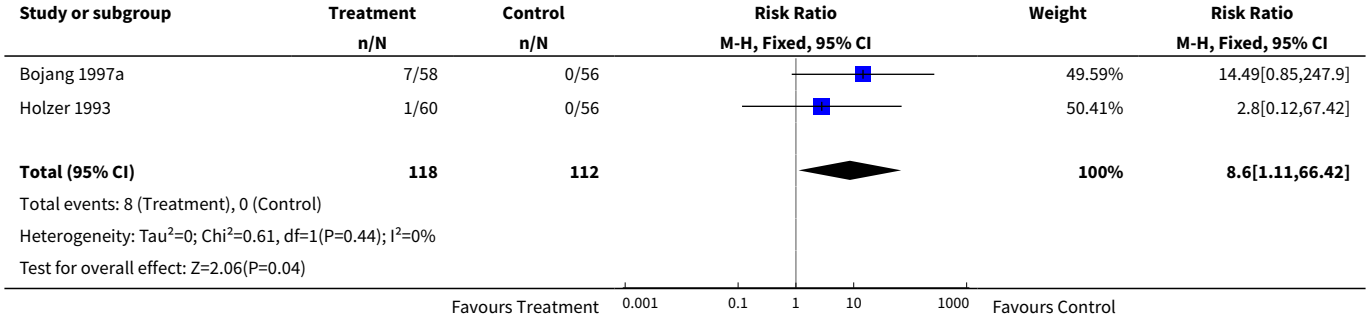
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8 Mean PCV day 7	1	102	Mean Difference (IV, Fixed, 95% CI)	3.39 [1.48, 5.30]
9 Mean PCV day 28	2	170	Mean Difference (IV, Fixed, 95% CI)	-1.34 [-2.57, -0.11]
10 Mean PCV day 56	1	90	Mean Difference (IV, Fixed, 95% CI)	-0.70 [-2.98, 1.58]
11 Effect on parasitaemia day 7	1	114	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.06, 15.06]
12 Effect on parasitaemia day 28	1	114	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.06, 15.06]

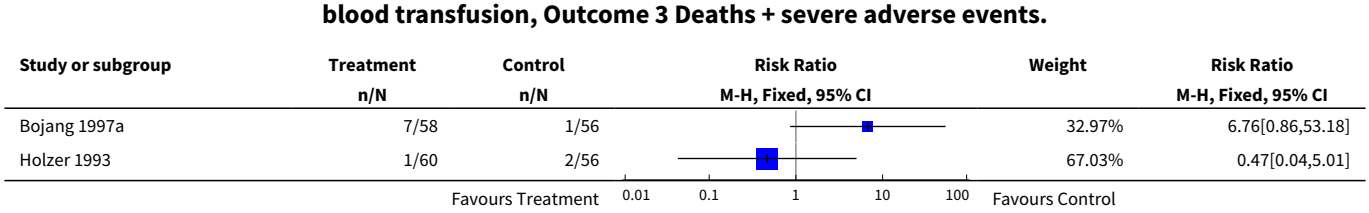
Analysis 1.1. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 1 Death.



Analysis 1.2. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 2 Severe adverse events.



Analysis 1.3. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 3 Deaths + severe adverse events.



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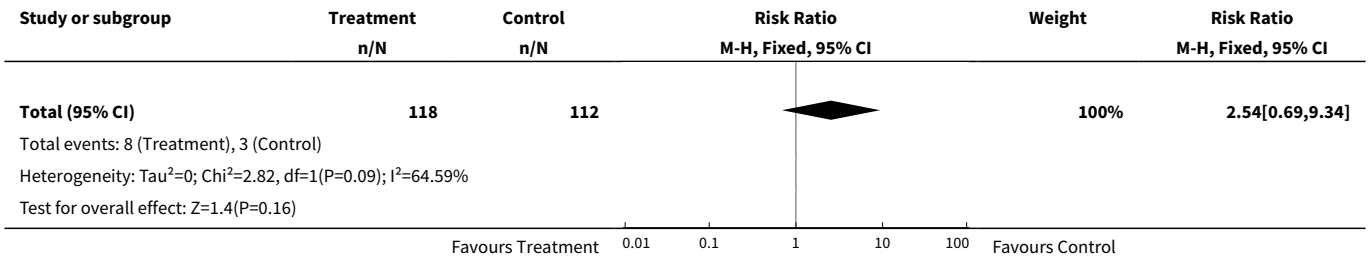
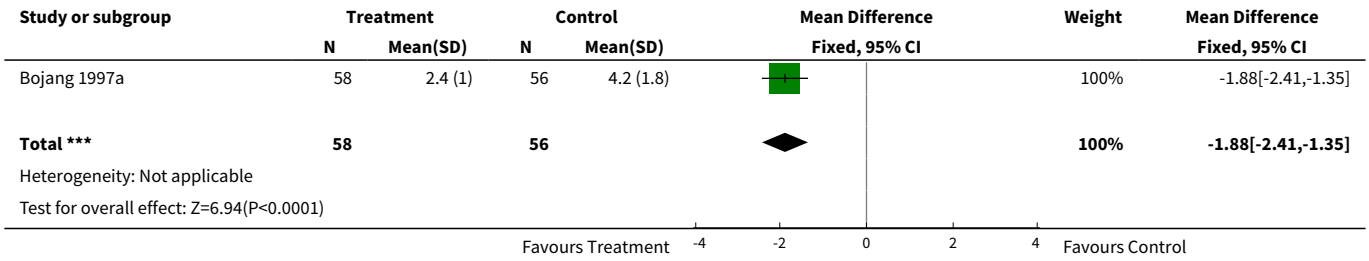
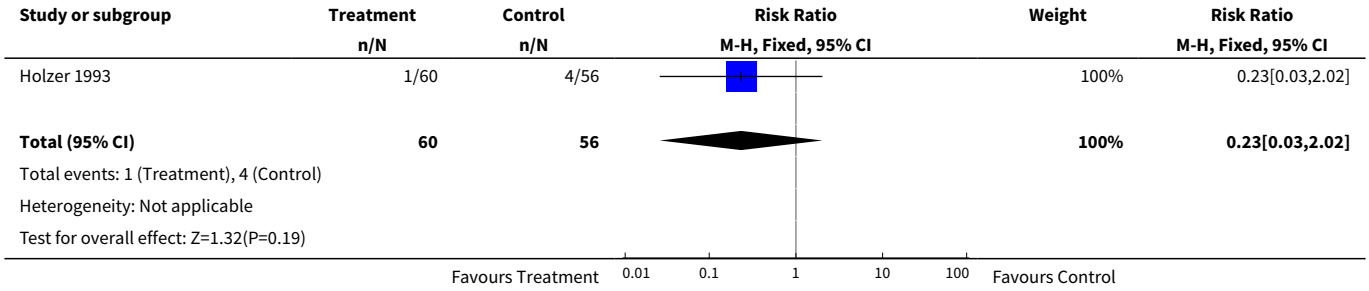


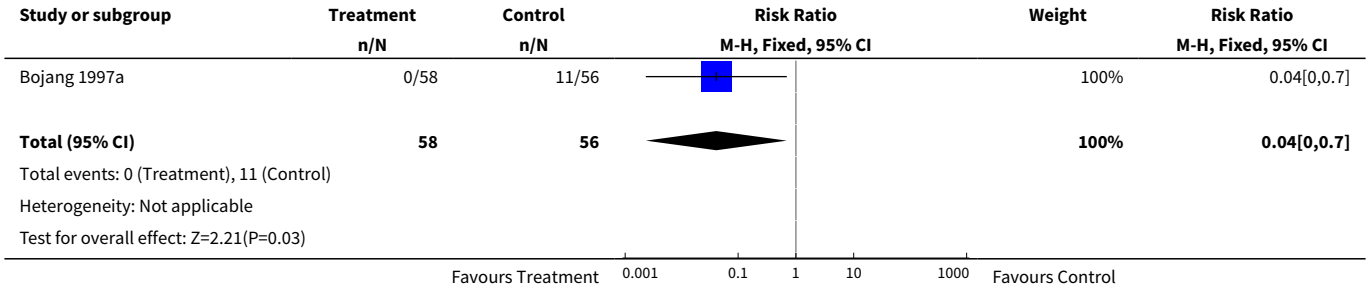
Analysis 1.4. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 4 Duration of stay in hospital.



Analysis 1.5. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 5 Re-admissions.



Analysis 1.6. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 6 Respiratory distress.



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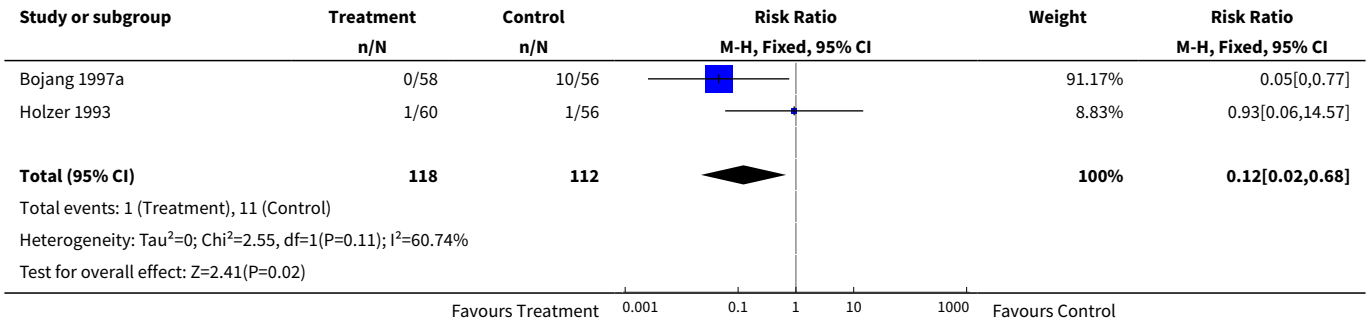
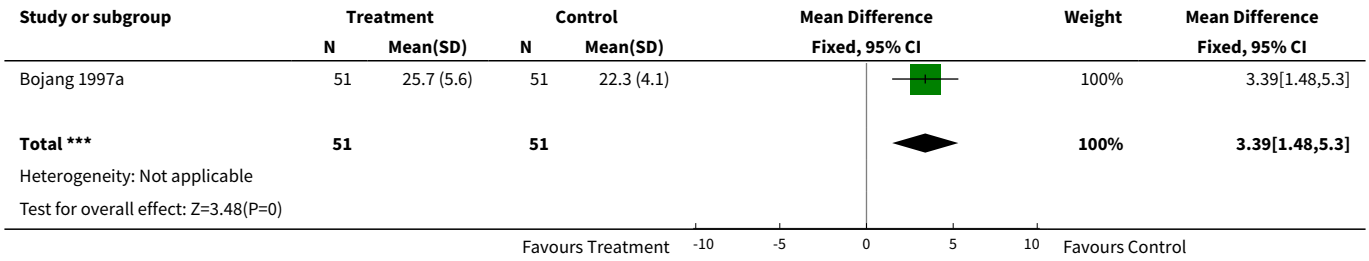
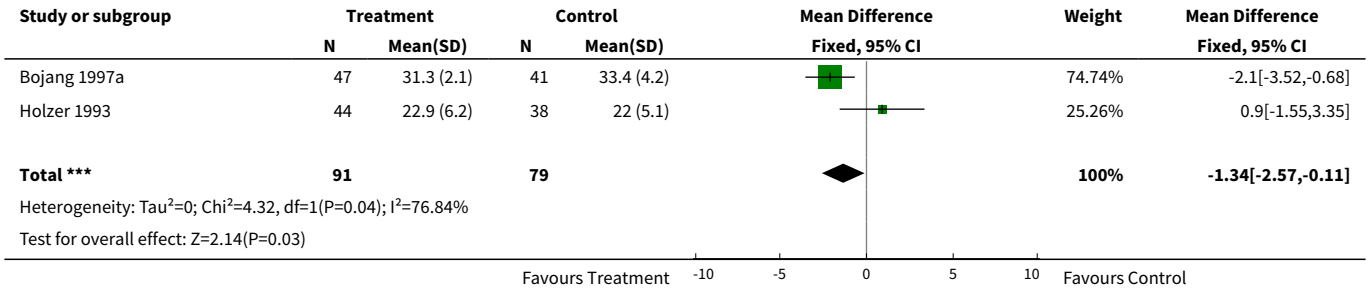
Analysis 1.7. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 7 Need for additional blood transfusion.



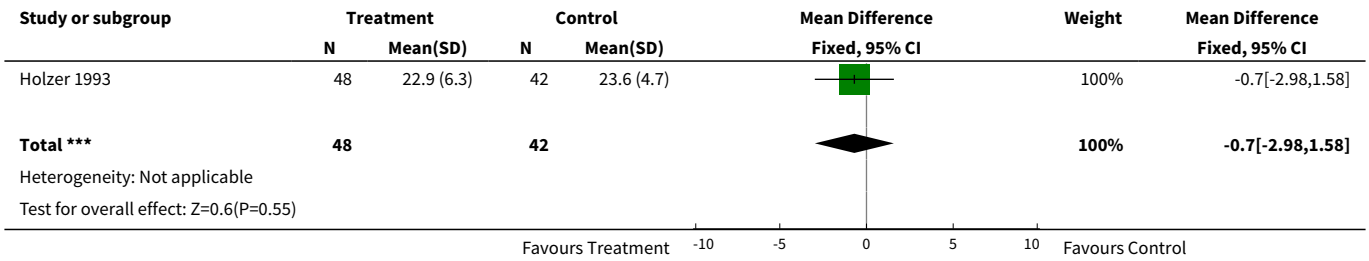
Analysis 1.8. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 8 Mean PCV day 7.



Analysis 1.9. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 9 Mean PCV day 28.



Analysis 1.10. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 10 Mean PCV day 56.



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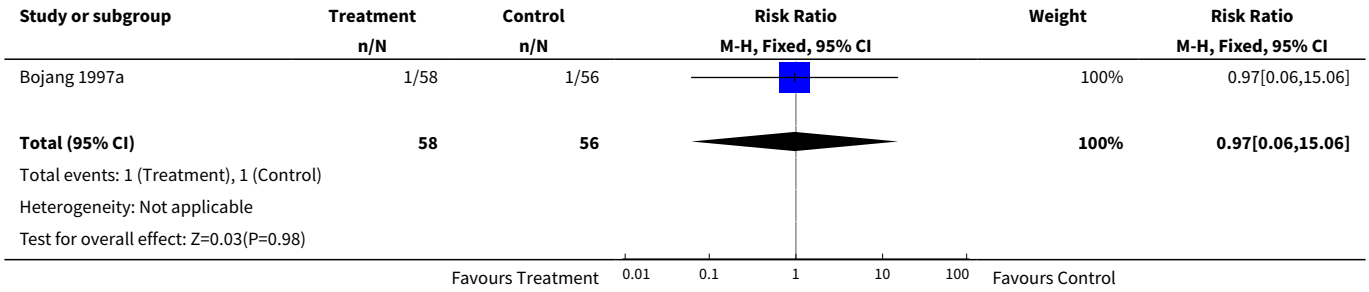
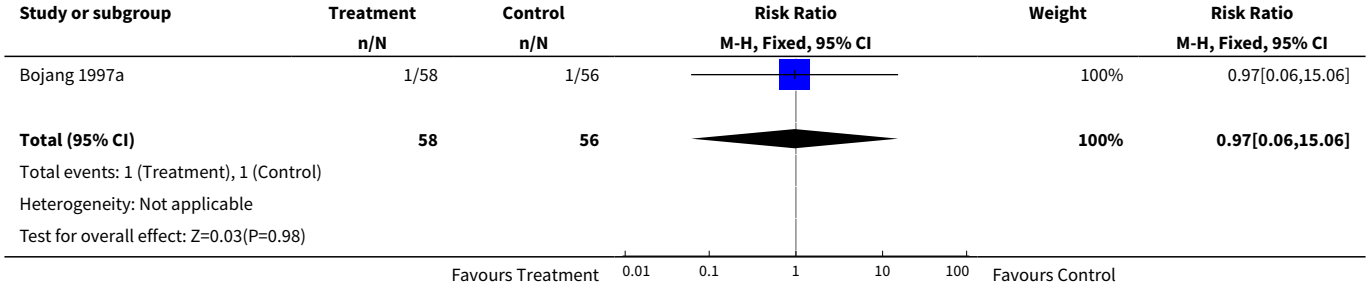
Analysis 1.11. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 11 Effect on parasitaemia day 7.



Analysis 1.12. Comparison 1 Blood transfusion versus no blood transfusion, Outcome 12 Effect on parasitaemia day 28.



WHAT'S NEW

Date	Event	Description
7 July 2010	New search has been performed	New search conducted; no new trials found.

HISTORY

Protocol first published: Issue 2, 1999
Review first published: Issue 4, 1999

Date	Event	Description
29 July 2008	Amended	Converted to new review format.
15 March 2007	New search has been performed	New studies sought but none found.

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DECLARATIONS OF INTEREST

We certify that we have no affiliations with or involvement in any organisation or entity with a direct financial interest in the subject matter of the review (e.g. employment, consultancy, stock ownership, honoraria, expert testimony).

SOURCES OF SUPPORT

Internal sources

- University of Calabar, Nigeria.

External sources

- Department for International Development, UK.
- European Commission (Directorate General XII), Belgium.
- Liverpool School of Tropical Medicine, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Blood Transfusion; Anemia [*etiology] [*therapy]; Hematocrit; Malaria [*complications]; Malaria, Falciparum [complications]; Transfusion Reaction

MeSH check words

Adult; Child; Humans

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