Cochrane
Library

Cochrane Database of Systematic Reviews

Umbilical artery catheters in the newborn: effects of position of the catheter tip (Review)

Barrington KJ

Barrington KJ.

Umbilical artery catheters in the newborn: effects of position of the catheter tip.

Cochrane Database of Systematic Reviews 1999, Issue 1. Art. No.: CD000505.

DOI: [10.1002/14651858.CD000505](https://doi.org/10.1002/14651858.CD000505).

www.cochranelibrary.com

Umbilical artery catheters in the newborn: effects of position of the catheter tip (Review)

Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

WILEY

TABLE OF CONTENTS

HEADER	1
ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
BACKGROUND	3
OBJECTIVES	3
METHODS	3
RESULTS	4
DISCUSSION	6
AUTHORS' CONCLUSIONS	7
ACKNOWLEDGEMENTS	7
REFERENCES	8
CHARACTERISTICS OF STUDIES	8
DATA AND ANALYSES	12
Analysis 1.1. Comparison 1 High catheter position compared with low position, Outcome 1 Clinical vascular compromise.	13
Analysis 1.2. Comparison 1 High catheter position compared with low position, Outcome 2 Death or occurrence of intraventricular hemorrhage.	13
Analysis 1.3. Comparison 1 High catheter position compared with low position, Outcome 3 Death.	14
Analysis 1.4. Comparison 1 High catheter position compared with low position, Outcome 4 Intraventricular hemorrhage.	14
Analysis 1.5. Comparison 1 High catheter position compared with low position, Outcome 5 Necrotising enterocolitis.	14
Analysis 1.6. Comparison 1 High catheter position compared with low position, Outcome 6 Aortic thrombosis.	15
Analysis 1.7. Comparison 1 High catheter position compared with low position, Outcome 7 Hypertension.	15
Analysis 1.8. Comparison 1 High catheter position compared with low position, Outcome 8 Hematuria.	15
WHAT'S NEW	16
HISTORY	16
CONTRIBUTIONS OF AUTHORS	16
DECLARATIONS OF INTEREST	16
INDEX TERMS	16

[Intervention Review]

Umbilical artery catheters in the newborn: effects of position of the catheter tip

Keith J Barrington¹¹Department of Pediatrics, CHU Ste-Justine, Montreal, Canada

Contact address: Keith J Barrington, Department of Pediatrics, CHU Ste-Justine, 3175 Cote Ste Catherine, Montreal, Quebec, H3T 1C5, Canada. keith.barrington@umontreal.ca.

Editorial group: Cochrane Neonatal Group

Publication status and date: New search for studies and content updated (no change to conclusions), published in Issue 1, 2010.

Citation: Barrington KJ. Umbilical artery catheters in the newborn: effects of position of the catheter tip. *Cochrane Database of Systematic Reviews* 1999, Issue 1. Art. No.: CD000505. DOI: [10.1002/14651858.CD000505](https://doi.org/10.1002/14651858.CD000505).

Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

ABSTRACT

Background

Umbilical arterial catheters (UACs) are among the most commonly used monitoring methodologies in neonatal intensive care. There seems to be significant variance between neonatal intensive care units in exactly how these catheters are used. This variance involves heparin dosing, catheter materials and catheter design and positioning of the catheter.

Objectives

To determine whether the position of the tip of an umbilical arterial catheter influences the frequency of ischemic events, aortic thrombosis, intraventricular hemorrhage, mortality or necrotising enterocolitis in newborn infants.

Search methods

Randomized and quasi-randomized controlled trials of umbilical catheterization use were obtained using the standard search methods of the Cochrane Neonatal Review Group. *The Cochrane Library*, MEDLINE (search via PubMed), CINAHL and EMBASE were searched from 1999 to 2009.

Selection criteria

Randomized trials in newborn infants of any birthweight or gestation.

Comparison of high catheter placement with the tip above the diaphragm to a lower position just above the aortic bifurcation. End points included ischemic events, aortic thrombosis, necrotising enterocolitis, intraventricular hemorrhage, hypertension, hematuria or death.

Data collection and analysis

Five randomized controlled trials and one alternate assignment study had sufficiently detailed data to allow interpretation.

Main results

High placed umbilical artery catheters are associated with a lower incidence of clinical vascular complications, without an increase in any adverse sequelae. Intraventricular hemorrhage rates, death and necrotising enterocolitis are not more frequent with high compared to low catheters.

Authors' conclusions

There appears to be no evidence to support the use of low placed umbilical artery catheters. High catheters should be used exclusively.

PLAIN LANGUAGE SUMMARY

Umbilical artery catheters in the newborn: effects of position of the catheter tip

High positioning of umbilical artery catheters in babies in neonatal intensive care leads to fewer complications than low positioning. The umbilical artery catheters (tubes) (UACs) commonly used in neonatal intensive care to monitor babies, can sometimes cause them problems. They can be used with different accompanying doses of the drug heparin, and different catheter materials and design. The catheter can also be placed in a low or high position. This review found that high catheter positions led to fewer complications, and reduced the need for replacement and re-insertion of catheters.

BACKGROUND

Description of the condition

Umbilical arterial catheters (UACs) are among the most commonly used monitoring methodologies in neonatal intensive care. There seems to be significant variance between neonatal intensive care units in exactly how these catheters are used. This variance involves heparin dosing, catheter materials and catheter design and positioning of the catheter. Immediately after insertion of a UAC, local vascular compromise is frequently evident, usually in the form of blue or white toes, but occasionally with more severe and extensive ischemic manifestations. Aortic thrombi and renal ischemia have also been described. Some epidemiologic and case control studies have also shown that use of umbilical artery catheterisation is statistically associated with the later development of necrotizing enterocolitis. In order to minimize these morbidities, some aspects of the use of UACs have been assessed in randomized control trials.

Description of the intervention

This systematic overview analyses data regarding comparisons of 'high' and 'low' catheter positions. High positioned catheters are usually placed so that the tip is in the descending aorta above the level of the diaphragm and below the left subclavian artery. Low positioned catheters are usually placed so that the tip is above the aortic bifurcation and below the renal arteries.

How the intervention might work

Although it may seem self-evident that a shorter length of catheter in the aorta would cause fewer problems, other considerations such as the turbulence of blood flow around the catheter tip and the effects on flow dynamics of flushing the catheter after blood drawing complicate the picture. Evidence from randomized controlled trials is therefore required to clarify the benefits and risks of catheter position.

Why it is important to do this review

This review updates the existing review "Umbilical artery catheters in the newborn: effects of position of the catheter tip" published in the Cochrane Database of Systematic Reviews (Barrington 1999).

OBJECTIVES

To determine whether the position of the tip of an umbilical arterial catheter (UAC) influences mortality, necrotising enterocolitis, intraventricular hemorrhage, aortic thrombosis, or clinically recognized ischemic phenomena in neonates requiring UACs.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized and quasi randomized clinical trials were selected.

Types of participants

Newborn infants, both preterm and term. Entry criterion was usually simply the 'need' for a catheter, as defined by the attending medical staff.

Types of interventions

Variation in the placement position attempted for the umbilical artery catheter. Comparison of high versus low positioned catheters.

Types of outcome measures

1. Clinical vascular compromise, including blanching or cyanosis of the feet or toes;
2. necrotising enterocolitis;
3. intraventricular hemorrhage;
4. death;
5. aortic thrombosis;
6. hypertension;
7. hematuria.

Search methods for identification of studies

The standard search methods of the Cochrane Neonatal Review Group were used.

Electronic searches

Randomized and quasi-randomized controlled trials of umbilical catheterization use were obtained from the following sources:1. MEDLINE Search using Melvyl Medline Plus and the keyword headings 'Umbilic#', 'Catheter#' and subject heading 'Infant, Newborn'.

The bibliography cited in each publication obtained was searched in order to identify additional relevant articles.

The original search was completed in November 1997. The search was updated in November 1998.

The search was updated in April 2009:

The Cochrane Library, MEDLINE (search via PubMed), CINAHL and EMBASE were searched from 1999 to 2009.

Search terms: umbilic* AND catheter. Limits: human, newborn infant and clinical trial. No language restrictions were applied.

Searching other resources

Randomized and quasi randomized controlled trials of umbilical catheterization use were obtained from searching the following other resources:

1. Effective Care of the Newborn Infant, edited by JC Sinclair and MB Bracken;
2. Search of personal data files.

Clinical trials registries were also searched for ongoing or recently completed trials (clinicaltrials.gov; controlled-trials.com; and who.int/ictpr)

Data collection and analysis

The standard methods of the Cochrane Neonatal Review Group Guidelines were employed.

Selection of studies

Reports were first reviewed to determine whether there was a concurrent control group, and discarded if not. The method of assignment to control and intervention groups was then

determined and if not random or quasi random, then the trial was discarded.

Data extraction and management

The review author extracted, assessed and coded all data for each study using a form that was designed specifically for this review. For each study, final data was entered into RevMan by the review author (KB).

Assessment of risk of bias in included studies

The standard method of the Cochrane Neonatal Review Group were employed. Each identified trial was assessed for methodological quality with respect to a) masking of allocation b) masking of intervention c) completeness of follow-up d) masking of outcome assessment. This information is included in the Characteristics of Included Studies Table.

For the update in 2009, the risk of bias table was completed in order to address the following questions:

1. Sequence generation: Was the allocation sequence adequately generated?
2. Allocation concealment: Was allocation adequately concealed?
3. Blinding of participants, personnel and outcome assessors: Was knowledge of the allocated intervention adequately prevented during the study? At study entry? At the time of outcome assessment?
4. Incomplete outcome data: Were incomplete outcome data adequately addressed?
5. Selective outcome reporting: Are reports of the study free of suggestion of selective outcome reporting?
6. Other sources of bias: Was the study apparently free of other problems that could put it at a high risk of bias?

Measures of treatment effect

Statistical analyses was performed using Review Manager software. For categorical outcomes, estimates for relative risk and risk difference were calculated. For outcomes measured on a continuous scale, estimates for weighted mean difference were calculated. 95% confidence intervals were used.

Assessment of heterogeneity

Heterogeneity between trials was evaluated by inspecting the forest plots and quantifying the impact of heterogeneity using the I-squared statistic. A fixed effects model for meta-analysis.

Data synthesis

If multiple trials were found and meta-analysis was judged to be appropriate, the analysis would be done using Review Manager software (RevMan 5). All meta-analyses were to be done using the fixed effect model.

Subgroup analysis and investigation of heterogeneity

If data was available, subgroup analysis based on gestational age or birth weight were planned

RESULTS

Description of studies

The original search strategy retrieved 12 trials investigating catheter position, catheter materials or heparin use. The updated searches, the latest being in March 2007 revealed no new randomized controlled trials comparing high to low catheter position.

Seven trials of varying methodological quality have examined the effects of catheter positioning on clinical outcomes. One of these trials ([Henry abstract](#)) was reported only as an abstract and insufficient data were presented to enter into the meta-analysis. This trial has therefore been excluded.

[Harris 1978](#) studied 36 infants, both term and preterm, who required umbilical artery catheterisation. Infants were allocated alternately to high or low catheter groups. The primary outcome variable is not stated, but data were recorded for a number of complications, clinical ischemic compromise of the limbs, necrotising enterocolitis and death. The timing of ascertainment of these outcomes is uncertain. Death appears to have been ascertained until the time of discharge; the one occurrence of necrotizing enterocolitis noted in the paper occurred after the catheter was removed.

[Kempley 1993](#) performed a randomised single center trial in 308 term and preterm infants. Randomisation was stratified by birth weight and either end hole or side-hole (oxygen electrode tipped) catheters were used. Outcome variables were primarily necrotising enterocolitis, and secondarily clinical vascular compromise, hypertension, hematuria, and duration of catheter usability. All were ascertained until discharge from hospital. Necrotising enterocolitis was defined using a standard definition. Hematuria was defined as 'macroscopic hematuria'. In a separate publication they reported Doppler ultrasound findings in a subgroup of the infants, n = 69 ([Kempley 1993](#), citation #2).

[Mokrohisky 1978](#) randomly assigned 73 term and preterm infants to high compared to low catheter positioning. Outcome variables were clinical vascular compromise, hypertension, necrotising enterocolitis, sepsis, aortic thrombosis on aortography at catheter removal, and hematuria. The duration of surveillance for these outcome variables is not detailed. Hypertension and necrotising enterocolitis were not defined. Although surveillance for hematuria was carried out, the results are not presented.

[Stork 1984](#) reported in abstract form a trial of high versus low catheter position. The major outcome variable was the occurrence of hypertension, others being the occurrence of clinical vascular compromise of the legs and necrotising enterocolitis. The abstract reported the outcome for the 'first 182 infants analyzed'. No further reports from this study were found. Study infants were both term and preterm, and umbilical catheterisation was clinically required. Blood pressure was recorded for a maximum of 30 days. Both oxygen electrode tipped catheters and plain end-hole catheters were used. Hypertension was defined as a mean arterial pressure greater than 70 mmHg for three days. Definition of necrotising enterocolitis was not given.

The Umbilical Artery Catheter Trial Study Group ([UACTSG 1992](#)) studied 970 preterm infants in a multi-center randomized trial.

Infants of between 500 and 1500 grams birth weight were entered using a masked, blocked, birth weight stratified, randomization scheme. Only 3.5 Fr catheters were used but there is no note of whether these were end-hole, side-hole or either; heparinisation was also not standardised. The major outcome criterion was the combined incidence of intraventricular hemorrhage (grade 2 to 4) and death during the first five days of life. The sample size was initially determined by standard methods to be 724, with the hypothesis being a reduction in the combined rate of death or intraventricular hemorrhage from 24.6% to 16%. The sample size was actually increased after an interim analysis showed a suspicion that one of the randomization strata may have an increase in the major outcome variable. Other outcome variables recorded were clinical ischemic phenomena, sepsis, seizures, and necrotizing enterocolitis during the first five days of life. Data were also recorded to 120 days or hospital discharge but are not presented in the text; they are currently being sought from the authors.

Wesstrom's trial ([Wesstrom 1979](#)) was designed to randomly assign infants requiring umbilical catheter placement to one of four groups, high end hole, high side hole, low end hole or low side hole catheter. Sixty-two infants were studied. After the first 15 months the side hole groups were dropped, presumably because of the high incidence of aortic thrombosis and for the final four months randomization was to high or low end hole catheters only. The end hole catheter used was an 'Argyle' umbilical catheter, the side hole catheter was an Argyle feeding tube. Most catheters were 5 Fr size. The major outcome variable was aortic thrombosis; this was determined either by angiography at the time of removal of the catheter or at autopsy. Clinically apparent sequelae were said to be recorded, but are not clearly described.

Risk of bias in included studies

Apart from Harris's study ([Harris 1978](#); alternate assignment) the included trials were all randomized. Randomization method was clearly described only in the [UACTSG 1992](#) report and appears to have been appropriate. The remaining trials simply state that randomization was performed or give insufficient detail. None of the studies was blinded.

Clinically important endpoints were analyzed in all studies. The major end point in many of the studies was clinical ischemic phenomena in the legs. This was sometimes, but not consistently, defined by being severe enough to require catheter removal. Long term follow up is not available for any of the published controlled trials.

[Harris 1978](#)

Masking of allocation: Alternate assignment, not masked.

Masking of intervention: Not attempted.

Completeness of follow up: Yes.

Masking of outcome: No.

Other comments: No hypothesis stated, no sample size determination or power analysis.

[Kempley 1992](#)

Masking of allocation: Uncertain, methods not described.

Masking of intervention: No.

Completeness of followup: Yes.

Masking of outcome: No.

Other comments: Hypothesised a 2 fold increase in necrotising enterocolitis rates and a sample size of 200 infants. Reason for exceeding sample size not given.

[Mokrohisky 1978](#)

Masking of allocation: Uncertain ('assigned from a random-number table').

Masking of intervention: No.

Completeness of follow up: Yes.

Masking of outcome: No.

Other comments: No hypothesis, or sample size determinations are described.

[Stork 1984](#)

Masking of allocation: Not certain from the abstract.

Masking of intervention: Again not described from the abstract, presumably an unmasked study.

Completeness of follow up: Uncertain.

Masking of outcome: No.

[UACTSG 1992](#)

Masking of allocation: Yes, opaque, sequentially numbered envelopes, allocation centrally co-ordinated.

Masking of intervention: No.

Completeness of follow up: Yes, all infants appear to be accounted for.

Masking of outcome: No.

Other comments: Sample size increased after interim analysis showed a potential for an adverse outcome in one of the weight strata. Most outcomes reported only for the first five days of life, even though necrotising enterocolitis, for example, often presents after this time.

[Wesstrom 1979](#)

Masking of allocation: No details of the allocation procedure are reported.

Masking of intervention: Not attempted.

Completeness of follow up: Outcomes for all subjects are reported.

Masking of outcome: No.

Other comments: The reason for dropping the side hole groups was not clearly described. No details of the randomization process are given. There is no hypothesis described and no sample size calculations are given.

Effects of interventions

HIGH CATHETER POSITION COMPARED WITH LOW CATHETER POSITION (Comparison 1):

Clinical vascular compromise (Outcome 1.01):

The studies of catheter position have all demonstrated that clinical ischemic phenomena are significantly less common with high catheter position (typical RR 0.53, 95% CI 0.44 to 0.63). This result was consistent between studies with individual relative risks for the studies ranging from 0.25 to 0.60. For all of the individual trials, except for [Stork 1984](#), this was a statistically significant result.

Death or occurrence of intraventricular hemorrhage (Outcome 1.02):

The combined outcome of death or intraventricular hemorrhage was reported in only one trial ([UACTSG 1992](#)) and was not significantly affected, RR 1.12; 95% CI 0.89, 1.39. Similarly, intraventricular hemorrhage alone was reported only in this trial and was not significantly affected, RR 0.99; 95% CI 0.74, 1.32 (**Outcome 1.04**).

Death (Outcome 1.03):

Death rates were reported by five of the trials. All gave a relative risk close to 1.0 and none were significantly different between high and low catheter positions. Relative risk varied between 1.00 and 1.21, with an overall RR of 1.11; 95% CI 0.88, 1.40.

Necrotising enterocolitis (Outcome 1.05):

The frequency of necrotising enterocolitis was determined in five trials. The diagnostic criteria for necrotising enterocolitis are not stated in several of the studies. However, there does appear to be homogeneity between studies with all of the studies having widely overlapping confidence intervals. This was a fairly rare outcome with an overall incidence of 3.9% with high catheters and 2.9% with low catheters. Relative risks range from 1.1 to 3.0 with none of the individual studies showing a significant effect of catheter position. The overall relative risk is 1.34; 95% CI 0.79, 2.25.

The [UACTSG 1992](#) study reported necrotising enterocolitis incidence until five days of age. However, this is a complication which often presents after five days of age, and it is certainly feasible that the position of catheter placement could affect microvascular perfusion of the bowel and lead to an ischemic injury which may present somewhat later. The other studies appear to have documented necrotising enterocolitis rates until discharge, although this is not absolutely clear for two of the studies ([Stork 1984](#); [Mokrohisky 1978](#)). The [UACTSG 1992](#) did collect data on necrotising enterocolitis rates until discharge, and reported that the incidence "did not differ by level of catheter placement", but no data are given. Analyzing the data on necrotising enterocolitis either with or without the [UACTSG 1992](#) five day data does not change the conclusion that catheter position does not have a statistically significant effect. The relative risk for necrotising enterocolitis prior to five days of age is 1.22; (95% CI 0.53, 2.80) and for necrotising enterocolitis before discharge is 1.42 (95% 0.73, 2.78).

Duration of catheter usage is probably significantly improved with high catheter position, although this result was only clearly described in one study (Kempley 1993) and no standard deviation is given to allow analysis. The authors reported a median duration of catheter use of 105 hours (ranging from 1-978) with high catheters and 79 hours (range 2 - 709) with the low catheter position.

Aortic thrombosis (Outcome 1.06):

[Mokrohisky 1978](#) reported a 91% incidence of aortic thrombosis on aortography performed at catheter removal in 23 infants from their study of 73 neonates. However, the relative frequency in the two groups (high versus low catheter placement) was not noted in the main article. I obtained supplemental data on file with the National Auxiliary Publications Service. This documented the results of aortography at catheter removal and showed that nine of nine infants with high catheters had documented clots compared to 12 out of 14 infants with low catheters (RR 1.17; 95% CI 0.94, 1.44). The subgroup of infants who had angiography in [Mokrohisky 1978](#) was selected, it appears, on the basis of whether parental consent could be obtained. It is, therefore, unclear whether these infants are representative of the groups as a whole. For example, it is possible that parents whose infants had clinical signs of thrombosis would be more likely to consent. The data from Mokrohisky therefore should probably be considered to be less reliable, and have not been entered into the analysis.

Aortic thrombosis was also noted by [Wesstrom 1979](#). The result of this study showed, in contrast, a lower incidence of aortic

thrombosis with high catheters (RR 0.31, 95% CI 0.11, 0.86). All of the infants in Wesstrom's study had angiography.

Hypertension (Outcome 1.07) and Hematuria (Outcome 1.08):

Hypertension and hematuria also do not seem to differ between catheter positions, but have been reported in only three (Kempley 1993, [Mokrohisky 1978](#), [Stork 1984](#)) and one (Kempley 1993) studies respectively. Hypertension was not defined in the same way in each of the studies. In Kempley 1993 it was defined by the need for treatment; in [Mokrohisky 1978](#) it was not defined in the publication, and in [Stork 1984](#) it was defined as a mean blood pressure greater than or equal to 70 for three or more days. Both Kempley and Mokrohisky reported a very low incidence, whereas Stork reported that 10% of their infants were hypertensive. None of the studies suggested a significant effect of catheter position and overall the relative risk, 0.75, was non-significant, 95% CI 0.34, 1.67. Hematuria was reported only by Kempley 1993 and was referred to as 'macroscopic hematuria'. It was not different between groups, RR 0.45, 95% CI 0.08, 2.42.

DISCUSSION

Although there is not a statistically significant effect of catheter position on the frequency of necrotising enterocolitis, there remains a possibility that there is clinically important effect. This effect, we can say with 95% confidence, would lie between a 21% relative risk reduction in the incidence of necrotising enterocolitis and a 125% relative risk increase. Given the reported incidence of this complication in these studies, of 3.9% with high catheters and 2.9% with low catheters, it is unlikely that another trial to prove that there is truly a difference in the incidence of necrotising enterocolitis will ever be performed.

Many of the analyzed complications may be of little long term significance. It could, for example, be questioned whether having blue toes for a few hours is of much real import. More important are questions of whether catheter position influences the frequency of renal injury, bowel injury or spinal cord injury. Death and intraventricular hemorrhage rates and, as mentioned above, necrotizing enterocolitis rates are not affected by catheter position. Hypertension appears to be of equal frequency with high catheters compared to low catheters. Hematuria appears to be more common with low catheters but, as stated, has not been well reported. Spinal cord injury has been reported in the randomized trials only once ([Kempley 1992](#)) in an infant with a low catheter. Other major complications which clearly are of long term importance include an infant with intestinal necrosis due to thrombosis of the superior mesenteric and coeliac arteries who had a high, side hole catheter in place ([Kempley 1992](#)).

Long term follow up has not been reported from any of the RCTs. Wesstrom reported follow up of 79 infants which appears to have included some of the babies from his controlled trial. One infant with an aortic thrombosis had a calf diameter discrepancy; one infant with a femoral artery thrombosis had a tibial length discrepancy.

Seibert's observational study, mentioned above, followed up 10 of the infants with aortic thrombi ([Seibert 1991](#)) and found leg size discrepancies and significantly increased blood pressure.

The available information indicates, in summary, that clinical vascular compromise is decreased in frequency with high catheter

position, that there may be a reduction in the frequency of aortic thrombosis with high catheter position and that other complications are not affected.

Further data from the two studies published as abstracts ([Stork 1984](#), [Henry abstract](#)) and the outcome data at discharge of the [UACTSG 1992](#) trial may modify these conclusions. In particular, the effect of catheter position on aortic thrombosis could be affected by the Henry study which is of sufficient size to substantially affect this outcome. Similarly, the data on incidence of necrotising enterocolitis ascertained until discharge in the very large [UACTSG 1992](#) trial are needed in order to assess more precisely the effect of catheter position on this outcome. The principal investigators of these trials are being contacted and, if the requested data are retrievable, they will be incorporated in future updates of this review.

AUTHORS' CONCLUSIONS

Implications for practice

High umbilical artery catheter positioning is supported by the literature. Using high catheter positions will lead to fewer clinically obvious ischemic complications, probably a reduced incidence of

aortic thrombosis, and a longer duration of catheter usability. The incidence of serious complications is not affected.

Implications for research

There appear to be no controlled studies regarding whether the composition of fluids (other than heparinization) infused through the catheter affects complications. One observational study ([Seibert 1987](#)) suggested that presence of calcium in the infusate significantly increased the risk of thrombosis with low lying catheters.

Further studies of umbilical catheter usage in the newborn should analyze the effects of giving parenteral nutrition, calcium, antibiotics, or drugs through the catheter.

ACKNOWLEDGEMENTS

The Cochrane Neonatal Review Group has been funded in part with Federal funds from the Eunice Kennedy Shriver National Institute of Child Health and Human Development National Institutes of Health, Department of Health and Human Services, USA, under Contract No. HHSN267200603418C.

REFERENCES

References to studies included in this review

Harris 1978 {published data only}

Harris M, Little G. Umbilical artery catheters: High, low, or no. *Journal of Perinatal Medicine* 1978;**6**:15-21.

Kempley 1992 {published data only}

Kempley ST, Bennett S, Loftus BG, et al. Randomized trial of umbilical arterial catheter position: Clinical outcome. *Acta Paediatrica* 1993;**82**:173-6.

Kempley ST, Gamsu HR. Randomised trial of umbilical arterial catheter position: Doppler ultrasound findings. *Archives of Disease in Childhood* 1992;**67**:855-9.

Mokrohisky 1978 {published data only}

Mokrohisky ST, Levine RL, Blumhagen JD, et al. Low positioning of umbilical-artery catheters increases associated complications in newborn infants. *New England Journal of Medicine* 1978;**299**:561-4.

Stork 1984 {published data only}

Stork EK, Carol WA, Kleigman RM, Fanaroff AA. Neonatal hypertension appears unrelated to aortic catheter position. *Pediatric Research* 1984;**18**:321A.

UACTSG 1992 {published data only}

Malloy MH, Cutter GR. The association of heparin exposure with intraventricular hemorrhage among very low birth weight infants. *Journal of Perinatology* 1995;**15**:185-91.

Umbilical Artery Catheter Trial Study Group. Relationship of intraventricular hemorrhage or death with the level of umbilical artery catheter placement: A multicenter randomized clinical trial. *Pediatrics* 1992;**90**:881-7.

Wesstrom 1979 {published data only}

Wesstrom G, Finnstrom O, Stenport G. Umbilical artery catheterization in newborns. I Thrombosis in relation to

catheter type and position. *Acta Paediatrica Scandinavica* 1979;**68**:575-81.

References to studies excluded from this review

Henry abstract {published data only}

Henry M, Harrinson D, O'Malley K, Harvey K, Koza D, Nielsen HC. Umbilical artery catheter (UAC) position and aortic thrombus (AT): A randomized trial. *Pediatric Research* 1991;**29**:257A.

Additional references

Seibert 1987

Seibert JJ, Taylor BJ, Williamson SL, Williams BJ, Szabo JS, Corbitt SL. Sonographic detection of neonatal umbilical artery thrombosis. *American Journal of Roentgenology* 1987;**148**:965-8.

Seibert 1991

Seibert JJ, Northington FJ, Miers JF, Taylor BJ. Aortic thrombosis after umbilical artery catheterization in neonates: prevalence of complications on long term follow up. *American Journal of Roentgenology* 1991;**156**:567-9.

References to other published versions of this review

Barrington 1997

Barrington KJ. Umbilical artery catheters: catheter position. *Cochrane Database of Systematic Reviews* 1997, Issue 4. [DOI: [10.1002/14651858.CD000505](https://doi.org/10.1002/14651858.CD000505)]

Barrington 1999

Barrington KJ. Umbilical artery catheters in the newborn: effects of position of the catheter tip. *Cochrane Database of Systematic Reviews* 1999, Issue 1. [DOI: [10.1002/14651858.CD000505](https://doi.org/10.1002/14651858.CD000505)]

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Harris 1978

Methods	Alternate assignment study. Masking of allocation; No. Masking of intervention; No. Completeness of followup; Yes. Masking of outcome; No.
Participants	36 term and preterm newborn infants requiring umbilical catheterisation.
Interventions	high or low catheter position.
Outcomes	"Complications" used as the primary outcome variable, which included clinical vascular compromise or necrotising enterocolitis. The timing of ascertainment of these outcomes is uncertain.
Notes	End hole catheters used, heparin at 0.2 units/mL in the infusate.

Harris 1978 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	Masking of allocation: Alternate assignment, not masked.
Blinding? All outcomes	High risk	Masking of intervention: Not attempted. Masking of outcome: No.
Incomplete outcome data addressed? All outcomes	Low risk	Completeness of follow-up: Yes.
Free of other bias?	Unclear risk	Other comments: No hypothesis stated, no sample size determination or power analysis.

Kempley 1992

Methods	Randomized study. Masking of allocation; Uncertain. Masking of intervention; No. Completeness of followup; Yes. Masking of outcome; No.	
Participants	308 newborn infants term and preterm stratified by birth weight requiring UAC placement.	
Interventions	Randomized to either high or low catheter position.	
Outcomes	Primary outcome was confirmed necrotising enterocolitis, secondary outcomes were clinical vascular compromise, all outcomes were recorded until discharge from hospital.	
Notes	both end hole and side hole catheters were used.	

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	Masking of allocation: Uncertain, methods not described.
Blinding? All outcomes	High risk	Masking of intervention: No. Masking of outcome: No.
Incomplete outcome data addressed? All outcomes	Low risk	Completeness of follow-up: Yes.
Free of other bias?	Unclear risk	Other comments: Hypothesised a 2 fold increase in necrotising enterocolitis rates and a sample size of 200 infants. Reason for exceeding sample size not given.

Mokrohisky 1978

Methods	Randomized single center study.Masking of allocation;Uncertain. Masking of intervention;No. Completeness of follow up; Yes. Masking of outcome; No.	
---------	---	--

Mokrohisky 1978 (Continued)

Participants	73 newborn infants requiring UAC placement.
Interventions	High or low catheter position.
Outcomes	Incidence of "complications", a combination of necrotising enterocolitis, blanching of feet and other clinical vascular compromise, hypertension and catheter clotting. Also investigated aortic thrombi by aortography. The time of ascertainment of these outcomes is not clearly described.
Notes	Only end hole catheters used, heparin used at 2 units/mL in the flush solution, apparently not in the infusate. Incidence of aortic thrombi not reported by assigned group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Masking of allocation: Uncertain ('assigned from a random-number table').
Allocation concealment?	Unclear risk	Masking of allocation: Uncertain ('assigned from a random-number table').
Blinding? All outcomes	High risk	Masking of intervention: No. Masking of outcome: No.
Incomplete outcome data addressed? All outcomes	Low risk	Completeness of follow-up: Yes.
Free of other bias?	Unclear risk	Other comments: No hypothesis, or sample size determinations are described.

Stork 1984

Methods	Single center randomized study. Masking of allocation; Uncertain. Masking of intervention; No. Completeness of followup; Uncertain. Masking of Outcome; No.
Participants	182 infants both term or preterm.
Interventions	High or Low positioned umbilical artery catheters.
Outcomes	Hypertension in the first 30 days of life, clinical vascular compromise of leg, necrotising enterocolitis.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Masking of allocation: Not certain from the abstract.
Allocation concealment?	Unclear risk	Masking of allocation: Not certain from the abstract.
Blinding? All outcomes	High risk	Masking of intervention: Again not described from the abstract, presumably an unmasked study.

Stork 1984 (Continued)

Masking of outcome: No.

Incomplete outcome data addressed? All outcomes	Unclear risk	Completeness of follow up: Uncertain.
--	--------------	---------------------------------------

UACTSG 1992

Methods	Randomized multicenter study Masking of allocation; Yes. Masking of intervention; No. Completeness of follow up; Yes. Masking of Outcome; No.
Participants	970 preterm infants. stratified by birth weight.
Interventions	Catheter placed either high or low.
Outcomes	Primary outcome was the combined incidence of death or intraventricular hemorrhage during the first 5 days of life. Clinical vascular complications and necrotising enterocolitis during the first 5 days of life were used as secondary outcomes. Outcomes were also recorded to 120 days of life or discharge but are not yet available.
Notes	Type of catheter not stated.

Risk of bias

Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Low risk	Masking of allocation: Yes, opaque, sequentially numbered envelopes, allocation centrally co-ordinated.
Allocation concealment?	Low risk	Masking of allocation: Yes, opaque, sequentially numbered envelopes, allocation centrally co-ordinated.
Blinding? All outcomes	High risk	Masking of intervention: No. Masking of outcome: No.
Incomplete outcome data addressed? All outcomes	Low risk	Completeness of follow-up: Yes, all infants appear to be accounted for.
Free of other bias?	Unclear risk	Other comments: Sample size increased after interim analysis showed a potential for an adverse outcome in one of the weight strata. Most outcomes reported only for the first five days of life, even though necrotising enterocolitis, for example, often presents after this time.

Wesstrom 1979

Methods	Single Center randomized trial. Masking of allocation; Can't tell. Masking of intervention; No. Completeness of followup; Yes. Masking of outcome; No.
Participants	62 term and preterm infants; 39 infants had end hole catheters, 23 had side hole catheters.

Wesstrom 1979 (Continued)

Interventions	4 groups initially, high end hole, high side hole, low end hole or low side hole catheter. After the first 15 months the side hole groups were dropped and the final 4 months randomization was to high or low end hole catheters only.	
Outcomes	Thrombosis on angiography performed at the time of removal of the catheter was the primary outcome variable. Necrotising enterocolitis not determined, clinical vascular compromise not stated.	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Adequate sequence generation?	Unclear risk	Masking of allocation: No details of the allocation procedure are reported.
Allocation concealment?	Unclear risk	Masking of allocation: No details of the allocation procedure are reported.
Blinding? All outcomes	High risk	Masking of intervention: Not attempted. Masking of outcome: No.
Incomplete outcome data addressed? All outcomes	Low risk	Completeness of follow-up: Outcomes for all subjects are reported.
Free of other bias?	Unclear risk	Other comments: The reason for dropping the side hole groups was not clearly described. No details of the randomization process are given. There is no hypothesis described and no sample size calculations are given.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Henry abstract	Numbers randomized to each of the 2 groups are not given in this study published only as an abstract. Therefore, results are not interpretable and data could not be added to the meta-analysis.

DATA AND ANALYSES

Comparison 1. High catheter position compared with low position

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Clinical vascular compromise	5	1569	Risk Ratio (M-H, Fixed, 95% CI)	0.53 [0.44, 0.63]
2 Death or occurrence of intraventricular hemorrhage	1	970	Risk Ratio (M-H, Fixed, 95% CI)	1.12 [0.89, 1.39]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3 Death	5	1449	Risk Ratio (M-H, Fixed, 95% CI)	1.11 [0.88, 1.40]
4 Intraventricular hemorrhage	1	970	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.74, 1.32]
5 Necrotising enterocolitis	5	1569	Risk Ratio (M-H, Fixed, 95% CI)	1.34 [0.79, 2.25]
5.1 Diagnosed before discharge	4	599	Risk Ratio (M-H, Fixed, 95% CI)	1.42 [0.73, 2.78]
5.2 Diagnosed before 5 days of age	1	970	Risk Ratio (M-H, Fixed, 95% CI)	1.22 [0.53, 2.80]
6 Aortic thrombosis	1	62	Risk Ratio (M-H, Fixed, 95% CI)	0.31 [0.11, 0.86]
7 Hypertension	3	549	Risk Ratio (M-H, Fixed, 95% CI)	0.75 [0.34, 1.67]
8 Hematuria	1	308	Risk Ratio (M-H, Fixed, 95% CI)	0.45 [0.08, 2.42]

Analysis 1.1. Comparison 1 High catheter position compared with low position, Outcome 1 Clinical vascular compromise.

Analysis 1.2. Comparison 1 High catheter position compared with low position, Outcome 2 Death or occurrence of intraventricular hemorrhage.

Analysis 1.3. Comparison 1 High catheter position compared with low position, Outcome 3 Death.

Analysis 1.4. Comparison 1 High catheter position compared with low position, Outcome 4 Intraventricular hemorrhage.

Analysis 1.5. Comparison 1 High catheter position compared with low position, Outcome 5 Necrotising enterocolitis.

Analysis 1.6. Comparison 1 High catheter position compared with low position, Outcome 6 Aortic thrombosis.

Analysis 1.7. Comparison 1 High catheter position compared with low position, Outcome 7 Hypertension.

Analysis 1.8. Comparison 1 High catheter position compared with low position, Outcome 8 Hematuria.

WHAT'S NEW

Date	Event	Description
4 August 2009	New search has been performed	<p>This review updates the existing review "Umbilical artery catheters in the newborn: effects of position of the catheter tip" published in the Cochrane Database of Systematic Reviews (Barrington 1999).</p> <p>Updated search found no new trials.</p> <p>No changes to conclusions.</p>

HISTORY

Protocol first published: Issue 1, 1999

Review first published: Issue 1, 1999

Date	Event	Description
22 October 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Keith Barrington (KB) wrote the original review and updated the review in 1999.

The 2009 update was conducted centrally by the Cochrane Neonatal Review Group staff (Yolanda Montagne, Roger Soll, Diane Haughton) and reviewed and approved by KB.

DECLARATIONS OF INTEREST

None

INDEX TERMS

Medical Subject Headings (MeSH)

*Catheterization [methods]; *Umbilical Arteries

MeSH check words

Humans; Infant, Newborn